11th BACSA AND ARACNE PROJECT INTERNATIONAL CONFERENCE

"TRADITIONAL KNOWLEDGE ON SILK GOOD PRACTICES EXPLOITATION FOR CULTURAL, CREATIVE INDUSTRIES AND TOURISTIC AIMS"

"CULTUSERI" 2025

PROCEEDINGS

Tbilisi, Georgia

November 16th – 21st 2025

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The 11th BACSA international conference **"Traditional knowledge on silk good practices exploitation for Cultural, Creative Industries and Touristic aims" "CULTUSERI" 2025** was held at Tbilisi, Georgia, from 16th to 21st November 2025. The conference was organized jointly with the EU Horizon project ARACNE.

The Georgian State Silk Museum, Agriculture University of Georgia and Georgian Scientific - Research Center for Agriculture were hosting the meeting in collaboration with the Black, Caspian Seas and Central Asia Silk Association (BACSA) and Horizon ARACNE Project (Grant Agreement 101095188).

The Silk Roads, historically significant as trade routes, have transcended their original purpose to become essential conduits for cultural exchange across Eurasia. These routes facilitated the sharing of knowledge, ideas, and beliefs, allowing cities along their paths to flourish as vibrant centres of learning and culture. This interaction among diverse populations led to profound influences on languages, religions, and cultures throughout the region. The legacy of the Silk Roads is still visible today, with numerous historic buildings and monuments reminding us of this interconnected past.

Currently, there is a renewed interest in silk production, especially in Europe's Mediterranean, Balkan regions and Caucasus and, which has prompted the Horizon Europe project ARACNE. This initiative aims to revive silk production and establish a resilient and innovative Silk Route that honours traditional practices while promoting cultural and architectural heritage. Central to ARACNE's vision is the creation of a Silk Innovation Ecosystem—a collaborative network involving academia, industry, public organizations, and civil society. This ecosystem is designed to foster research, innovation, and knowledge sharing through a systemic and bottom-up approach.

A critical aspect of this ecosystem is the preservation of traditional silk knowledge, which faces threats due to declining global production driven by shifts in the textile industry. By collaborating with Cultural and Creative Industries, ARACNE seeks to valorise this knowledge in contemporary contexts, bridging the gap between ancient traditions and modern applications, particularly in cultural tourism. Cultural tourism serves as an effective platform for promoting the silk legacy, encouraging travellers to immerse themselves in local cultures, participate in events, visit museums, and savour local cuisine.

Organizing committee:

President: Prof. Dr P. Tzenov, President of BACSA and Director of Scientific Center on Sericulture under the Bulgarian Agricultural Academy.

Vice-president: Dr. Silvia Cappellozza, Coordinator, Horizon ARACNE Project (Grant Agreement 101095188) and Responsible of the Sericulture Laboratory of Padua, Council for

Agricultural Research and Economics, Research Center for Agriculture and Environment, Padua, Italy

Members:

Prof. Dr. George Japoshvili - Agriculture University of Georgia, Institute of Entomology-Director,

Georgian National Academy of science, Corresponding Member.

Prof. Dr. Nargiz Baramidze, Lepl Scientific -research center for Agriculture.

Dr. Maia Khutsishvili, Agriculture University of Georgia, Institute of Entomology, researcher.

Ms. Nino Kuprava, Director, Georgian State Silk Museum

Dr. Irakli Gujabidze, Agriculture University of Georgia, Head of Laboratory of Sericulture

Scientific committee

Dr. S. Cappellozza

Prof. Dr. D. Grekov

Prof. Dr. P. Tzenov

<u>Venue:</u>

Ibis Stadium Hotel, Tbilisi, Conference Hall

PROGRAMME

16th November (Sunday)
Arrival of the participants, their meeting and transfer to the hotel by the local hosting institution, check in at Ibis Stadium Hotel in Tbilisi.

17th November (Monday)

9:00 – 9:30 registration.

9:30 – 10:30 opening ceremony.

10:30 – 13:30 "Traditional knowledge on silk good practices exploitation for Cultural and Creative Industries and Touristic aims", Session 1. Chairperson: Dr. Skarlatos Dedos

10:30 – 10:45 The educational activities in the framework of the ARACNE project, by Alessio Saviane, Silvia Cappellozza, Diana Mantegazza, Manlio Piva, CREA – Research Centre for Agriculture and Environment, Padua, Italy

10:45 – 11:00 Exhibition of Chinese Silk Culture - Silk Museum, by Miao Yungen, College of Animal Sciences, Zhejiang University, Hangzhou 310058, Zhejiang, China

11:00 – 11:15 Tourism and silk museums in Spain. The case of the Silk Museum of Valencia by Ricard Huerta, University of Valencia, Spain

11:15 – 11:30 The creation of a silk cultural and economic hub at Villa La Palladiana is a key achievement of the "Aracne" project, by Silvia Cappellozza[1], Giampietro Zonta[2] & Elena Valier[2] , [1]Council for Agricultural Research and Economics, Research Centre Agriculture and Environment, Laboratory of Sericulture, Padua, Italy

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11:30 – 12:00 Coffee break and visit the sericulture products exhibition (30 minutes)

12:00 – 12:15 Multiomics analysis of the Silkworm cocoon shell, by

Panagiota Fragkou[1], Ioannis Martakos[2], Georgia Rouni[3], Demetrios Vasilakos[1], Evangelos Koutsoukos[1], Alesssio Saviane[4], Silvia Cappellozza[4], Nikolaos S. Thomaidis[2], Marios G. Kostakis[2], Martina Samiotaki[3], Sotiris Kotsiantis[5], Mariana Barcenas[6], Skarlatos G. Dedos[1] , [1] Department of Biology, National and Kapodistrian University of Athens, Panepistimioupoli Zografou, Athens 15784, Greece, [2] Department of Chemistry, National and Kapodistrian University of Athens, Panepistimiopolis Zographou, Athens 15771, Greece. [3] Institute for Bio-Innovation, BSRC "Alexander Fleming",16672,Vari, Greece[4] Council for Agricultural Research and Economics, Research Centre for Agriculture and Environment, Sericulture Laboratory of Padova, Padova, Italy. [5] Department of Mathematics, University of Patras, 26504, Patras, Greece **[6]** Metabolomics Core Facility**,** EMBL Heidelberg, Meyerhofstraße 1, 69117 Heidelberg, Germany

12:15 – 12:30 Fashion and Textile Heritage, Tourism, & Digital Media: research experiences and a roadmap, by Lorenzo Cantoni, USI – Università della Svizzera italiana, Swtzerland

12:30 – 12:45 Mulberry Germplasm Diversity as a Cornerstone of European Sericulture and Cultural Landscapes, by Andreja Urbanek Krajnc[1], Marco Pietrella[2], Gianni Fila[3], Panomir Tzenov[4], Ana Pagan[5], Elena Ruiperez[5], Špela Jelen[1], Anna Gasperl[1], Mario Lešnik[1], Silvia Cappellozza[3] , [1]University of Maribor, Faculty of Agriculture and Life Sciences, Pivola, Slovenia; [2]Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria (CREA), Forlì, Italy; [3]CREA Padua, Italy; [4] Agricultural academy, Scentific Centre on Sericulture, Vratsa, Bulgaria; [5]Instituto Murciano de Investigación y Desarrollo Agrario y Medioambiental (IMIDA), Murcia, Spain

12:45 – 13:00 Possibilities for collaboration between Japan's tourism and sericulture industries: A case study of the Kagemori Sericulture Farm, by Mari KOZAWA, Institute of Science, Tokyo, Japan

13:00 - 13:15 The work of the Mercy Corps Georgia ALCP2 Programme in reviving the silk sector in Georgia, by Maia Lomidze, Helen Bradbury, MERCY CORPS, Telavi, Georgia

13:15 – 13:30 The Current Status and Future Trends of China's Sericulture Industry Development, by Miao Yungen, College of Animal Sciences, Zhejiang University, Hangzhou 310058, Zhejiang, China

13:30 – 14:30 Lunch

14:30 – 17:00 Traditional knowledge on silk good practices exploitation for Cultural and Creative Industries and Touristic aims", Session 2. Chairperson: Dr. Andreja Urbanek Krajnc

14:30 – 14:45 The Chronicles of Wild Silk, by P Sivakumar, Dileep Kumar R, and Padmanav Nayak, INTERNATIONAL SERICULTURAL COMMISSION, Bengaluru, INDIA

14:45 – 15:00 An Examination of Turkey's Silk Heritage: Museums, Traditional Production Centers, and Silk Textile Products, by Ümran Şahan, Bursa Uludag Unıversity, Turkey

15:00 -15:15 Silkworm Gene Pool and its Significance in the Revival of Georgian Silk, by Nargiz Baramidze, Agricultural Scientific- Research Center, Georgia

15:15 – 15:45 Coffee break and visit the sericulture products exhibition (30 minutes)

15:45 – 17:00 Group discussion

20:00 Welcoming Dinner

18th November (Tuesday)

9:30 – 12:30 Field visits to Agriculture University of Georgia, Laboratory of Sericulture in Tbilisi and Lepl Scientific - research center for Agriculture in Tsilkani Village.
12:30 – 13:30 Lunch
14:00- 15:00 – State Silk Museum visit
15:30 – 18:00 ARACNE project meeting.

19th November (Wednesday)

8:30– 10:00 Drive towards Uplistsikhe Cave Town

10:00 – 12:00 Visit the historic site.

12:00 – 13:00 Drive to Chateau Mukhrani Winery and learn about the 8000 years old unbroken winemaking heritage of Georgia.

13:00 - 15:00 Vineyard and Winery Tour, Tasting and Lunch.

15:00 - 15:30 Drive to Mtskheta to visit Jvari and Svetitskhoveli Cathedral (UNESCO).

15:30–16:30 Visit Mtkheta and Svetitskhoveli Cathedral.

16:30 – 17:00 Drive to Jvari.

17:00 – 18:00 Visit Jvari Monastery.

18:00 – 18:45 Return to the hotel.

Uplistsikhe Cave Town

Uplistsikhe, or "Fortress of the Lord," is an ancient rock-hewn town near Gori, dating back to around 1000 BC. It once served as a major religious and political center of ancient Iberia. Carved into a rocky plateau above the Mtkvari River, the site includes massive halls, narrow corridors, a pagan temple, a water system, secret tunnel, market area, and the remains of Georgia's oldest known theatre.

Blending pagan and early Christian features, Uplistsikhe flourished until the Mongol invasions in the 14th century. It's now a remarkable archaeological monument and is on Georgia's tentative list for UNESCO World Heritage status**.**

Mtskheta: Jvari Monastery & Svetitskhoveli Cathedral

Mtskheta, one of Georgia's oldest continuously inhabited towns, was the capital of the eastern Georgian kingdom of Iberia from the 3rd century BCE to the 5th century CE. Though it later ceded political importance to Tbilisi, it remains the spiritual heart of the nation. The town is home to two of Georgia's most iconic religious sites: Jvari Monastery, a 6th-century church perched on a hill where Saint Nino is said to have erected a wooden cross; and Svetitskhoveli Cathedral, an 11th-century masterpiece believed to enshrine the robe of Christ. Both monuments are part of the UNESCO World Heritage Site "Historical Monuments of Mtskheta." Rich in history, faith, and architectural beauty, Mtskheta continues to be a major pilgrimage and cultural destination in Georgia.

The Living Heritage of Georgian Wine

Georgia's winemaking story is inseparable from its national identity—stretching back over 8,000 years, it is one of the oldest wine cultures in the world. The country is home to more than 500 endemic grape varieties and the ancient qvevri method, which involves fermenting and storing wine in large clay vessels buried underground. This unique practice remains central to Georgian viticulture and is recognized by UNESCO as part of the world's intangible cultural heritage.

Château Mukhrani is a historic estate nestled in the heart of Kartli, blending 19th-century aristocratic legacy with contemporary Georgian winemaking. Once the royal residence of Prince

Ivane Mukhranbatoni, it now produces premium wines using both traditional and modern techniques in a majestic setting.

20th November (Thursday)
8:30 – 12:00 Scientific and technical session. Chairperson: Dr. Alessio Saviane

8:30 – 8:45 Evaluation of the method of cryopreservation of the genetic resource of silkworm, by Maia Khutsishvili, Agriculture University Of Georgia, Institute Of Entomology, Sericulture laboratory, Tbilisi, Georgia

8:45 – 9:00 Mulberries in Georgia, by Irakli Gujabidze, Maia Khutsishvili, Zoia Tskaruashvili, Agriculture University Of Georgia, Institute Of Entomology, Sericulture laboratory, Tbilisi, Georgia

9:00 – 9:15 MULBERRY(*Morus*) HERBAL GREEN TEA PRODUCTION FOR A-BETTER HEALTH, by Jadhav Ashwini*, Pawar Jayant*, Shinde Ravindra*, Jadhav Priyanka** and Jadhav Adhikrao***, * Krishna Institute of Technology, Krishna Vishwa Vidyapeeth Karad, MS, India, **Sambru Agro industries Kadegaon Tadsar Road, Tadsar, Sangli, MS,India, ***Bharati Vidyapeeth LMK, College of Agriculture, Kadegaon, MS, India

9:15 – 9:30 APPLICATION OF PHEROMONES BY USING SILK COCOON AS A DISPENSER TO CONTROL PESTS, by Jadhav Sagar 1, Jadhav Tejashwini 2, Jadhav Ashwini 3, Jadhav Adhikrao 4, Dhawale Mahindra 5, and Mastoli Basavaraj 6, 1. Department of Agro - Chemicals and Pest Management ,Shivaji University ,Kolhapur ,MS, India, 2. Innovo Group ,Level 2,Dubai Hills Estate Business Park Dubai, UAE, 3. Krishna Institute of Science and Technology, Krishna Vishva Vidyapeeth (Deemed to be University) Karad ,MS, India, 4. Loknete Mohanrao Kadam College of Agriculture, Kadegaon, MS, India, 5 Directorate of Sericulture, Nagpur ,MS, India, 6. Commissionerate of Agriculture, Kolhapur, MS, India

9:30 – 9:45 "Indo-Bulgarian Collaboration": A Productive bivoltine silkworm hybrid for Indian Sericulture, by S. Manthira Moorthy, V. Sivaprasad, K. Madhusudhan, L. Kusuma and P. Tzenov*, Central Sericultural Research and Training Institute, Central Silk Board, Ministry of Textile, Govt.of India, Mysore, India, *Agricultural academy, Scientific Center on Sericulture, Vratsa, Bulgaria

9:45 – 10:00 Evaluating the productivity of two silkworm breeds fed mulberry leaves supplemented with yeast, by, Mihaela Habeanu, Anca Gheorghe, Nicoleta Lefter, Teodor Mihalcea, Research Station for Sericulture Baneasa, Bucharest, Romania

10:00 – 10:15 Evaluation on Service Value of Mulberry-base Fishpond Ecosystem in Huzhou, by Lingxia Huang, College of Animal Sciences, Zhejiang University, Hangzhou 310058, Zhejiang, China

10:15 – 10:30 Journey of obtaining GI (Geographical Indication) for Meghalaya Ryndia - Eri Textiles of Meghalaya-Ryndia from India -From FARM to FIBRE,FIBRE to FABRIC, FABRIC to GI, by Frederick Roy Kharkongor, Textiles Meghalaya, India

10:30 – 10:45 Mulberry - an ideal plant for semi-arid regions, by Nona Chkhaidze, Irine Chargeishvili, Georgian Agrarian University, Tbilisi, Georgia

10:45 – 11:00 Mulberry Gene Pool in Georgia and its Economic, Environmental and Cultural Significance, by Tinatin Dalalishvi, Lia Mdzeluri, Agricultural Scientific- Research Center, Georgia

11:00 – 11:15 Coffee break (15 minutes)

11:15 – 11:30 SERICULTURE - A RURAL TOOL FOR DOUBLING THE FARMERS INCOME IN MAHARSHTRA, by Jadhav Adhikrao *,Dhawale Mahindra**, Jadhav Tejashwini ***and Jadhav Sagar*, * Principal, BV s Loknete Mohanrao Kadam College of Agriculture, Kadegaon, MS, India
, Directorate of Sericulture, Nagpur ,MS, India, * Innovo Group ,Level 2, Dubai Hills Estate Business Park Dubai, UAE, ****Department of Agro -Chemicals and Pest Management, Shivaji University, Kolhapur, MS, India

11:30 – 11:45 INNOVATIVE TECHNOLOGIES AND SCHEMES FOR ENHANCING MAHARASHTRA FARMERS INCOME IN SERICULTURE, by Dhawale Mahindra*, Mastoli Basavaraj**, Jadhav Adhikrao** and Jadhav Ashwini****, * Directorate of Sericulture, MS, Nagpur, MS, India, ** Commissionerate of Agriculture, Kolhapur, MS, India, ***LMK College of Agriculture, Kadegaon, Sangli, MS, India, ****Krishna Institute of Science and Technology, Krishna Vishyavidyapeeth (Deemed to be University) Karad, MS, India

11:45 – 12:00 Euphorbia Latex Biopesticide for Sustainable Management of Mulberry Whitefly, by Jadhav Sagar*, Patil Anjali** and Jadhav Adhikrao***, *Department of Agrochemical and pest managements Shivaji university Kolhapur, MS, India, ** Department of Botany Rajaram college Kolhapur, MH, India, ***Bharati Vidyapeeth LMK, College of Agriculture, Kadegaon, MS, India

12:00 – 12:40 Posters session. Chair person Dr. Irakli Gujabidze

12:00 – 12:05 Encapsulation of Mulberry Phenolic Extracts in Sericin Nanoparticles for Functional Coatings with Enhanced Antioxidant and UV-Protective Properties, by SENEKOVIČ, Jan [1], KUREČIČ, Manja [2], MIKULIČ-PETKOVŠEK, Maja [3], JELEN, Špela [1], LEŠNIK, Mario [1], BERGLEZ, Laura [4], SEM, Vilma[1], URBANEK KRAJNC, Andreja [1], CAPPELLOZZA, Silvia [5], HRIBERNIK, Silvo [4] , [1] Faculty of Agriculture and Life Sciences, University of Maribor, Pivola 10, 2311 Hoče, Slovenia, [2] Faculty of Mechanical Engineering, University of Maribor, Smetanova 17, 2000, Maribor, Slovenia, [3] Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, 1000 Ljubljana, Slovenia [4] Faculty of Electrical Engineering and Computer Science, University of Maribor, Koroška ulica 46, 2000, Maribor, Slovenia, [5] Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria, Centro di Ricerca Agricoltura e Ambiente (CREA-AA), Via Eulero 6a, 35143 Padua, Italy

12:05 – 12:10 Threads of Silk Heritage: From Sericulture to Contemporary Patterns and 3D Visualization, by Sonja Šterman, Andreja Rudolf, Petra Jerič, University of Maribor, Faculty of Mechanical Engineering, Maribor, Slovenia

12:10 – 12:15 Isolation of *Pseudomonas* phytopathogens causing mulberry bacterial blight in samples collected across Slovenia and their genomic and biochemical identification, by Tadeja Vajdič[1], Andreja Urbanek Krajnc[2], Mario Lešnik[2], Marjanca Starčič Erjavec[1,3] ,

[1]University of Maribor, Faculty of Natural Sciences and Mathematics, Maribor, Slovenia; [2]University of Maribor, Faculty of Agriculture and Life Sciences, Pivola, Slovenia; [3]University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia

12:15 – 12:20 Graphene Oxide-Enriched Diet Enhances Growth, Silk Production and Mechanical Performance of Silkworm Gut Fibers in *Bombyx mori,* by J.J. Pérez-Cuadrado, A. Pagán, J.M. Palazón Sánchez, Salvador D. Aznar-Cervantes, Research Group of Biotechnology, Murcian Institute for Agricultural and Environmental Research and Development (IMIDA), Murcia, Spain

12:20 – 12:25 THE INFLUENCE OF MURCIA ON MODERN SERICULTURE: THE IMPORTANCE OF ITS "HIJUELA" PRODUCTION, by

Marta Sánchez-Alcaraz, Francisco J. López-Andreu, Salvador D. Aznar-Cervantes, Manuel Erena-Arrabal, Ana Pagán-Bernabeu, Murcian Institute for Agricultural and Environmental Research and Development (IMIDA), Spain

12:25 – 12:30 EFFECT OF DRYING TEMPERATURE OF MORUS ALBA LEAF ON THE POLYPHENOLIC PROFILE AND ANTIOXIDANT ACTIVITY OF THE EXTRACT, by María Quílez-Simón, Gustavo J. Cáceres-Cevallos, Salvador D. Aznar-Cervantes, María J. Jordán-Bueso, Ana Pagán-Bernabeu, Murcian Institute for Agricultural and Environmental Research and Development (IMIDA), Spain

12:30 – 12:35 Model of Silk Folk Craft Development in Georgia, by

Chkhaidze Nona [1], Chargeishvili Irine [2], Bezhashvili Lamara [3], [1] Georgian Agrarian University, Tbilisi, Georgia, [2] Georgian Agrarian University, Tbilisi, Georgia,[3] Farmer, Individual Entrepreneur, Sighnaghi, Kvemo Magaro, Georgia

12:35 – 12:40 ROLE OF CIVIL ENGINEERS IN CONSTRUCTION MANAGEMENT OF SIKWORM REARING HOUSE STRUCTURES, by Jadhav Patil Tejaswini *, Dhawale Mahindra**, Jadhav Adhikrao *** and Mastoli Basavaraj****, * Innovo Group ,Level 2,Dubai Hills, Estate Business Park, Dubai, UAE, **, Directorate of Sericulture, MS, Nagpur, MS, India, *** BV s Loknete Mohanrao Kadam College of Agriculture, Kadegaon, MS, India ****, Commissionerate of Agriculture, Kolhapur, MS, India

12:40 – 12:45 Bacteriophages for Control of Experimental Enterococcus faecalis Infection in Silkworm (Bombyx mori L), by Maia Khutsishvili, Zoia Tskaruashvili, Irakli Gujabidze, Agriculture University Of Georgia, Institute Of Entomology, Sericulture laboratory, Tbilisi, Georgia

12:45 – 13:15 Group discussion and closing the conference
13:00 – 14:00 Lunch
14:00 – 18:00 Tbilisi Old Town Tour
20:00 Farewell Dinner

Tbilisi

Stroll through Tbilisi’s Old Town, a vibrant blend of history and charm, where cobblestone streets, centuries-old churches, and lively cafés paint a vivid picture of the city’s multicultural heritage. Every turn reveals a rich cultural mosaic—a story of resilience, diversity, timeless beauty, and the warm pulse of everyday life.

21st November (Friday)
Conference participants independent departure.

CULTUSERI 2025 – List of Participants

№	Name and Surname	Country	Institution	Contact Info
1	Panomir Tzenov	Bulgaria	President of BACSA and Director of the Scientific Center on Sericulture under the Bulgarian Agricultural Academy.	panomir@yahoo.com
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48	Luminita Mihalcea Camelia	Romania		
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52	Maia Martodze	Georgia	Agricultural Scientific Research Center	
53	Mariam Shergelashvili	Georgia	Exhibition projects Curator State Silk Museum	mariami.silkmuseum@gmail.com
54	Salome Phachuashvili	Georgia	Collection Curator, State Silk Museum	spachuashvili.silkmuseum@gmail.com
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OPENING SPEECH

By Prof. Dr. P. Tzenov, President of BACSA

Dear ladies and gentlemen,

I would like to take this opportunity to express my full - hearted welcome to this conference, including those who are still coming on the way and also who wanted but could not make it this time.

In this conference participate delegates from 13 countries. Guest of our conference is Mr. P. Sivakumar, Secretary General of the International Sericultural Commission which is the biggest international sericultural organization.

And also my greetings to each one of you in anticipation of this conference to be meaningful to the extent of being historical, successful to being productive, connecting people together between scientists, experts, agricultural/industrial producers and traders, businessmen, museums workers, administrators, developers working in each step or link of production and trade chains for silk and silk commodities, from land to mulberry leaf to cocoons to raw silk to silk yarns and fabrics and to final silk products.

Welcome again all of you, coming from far and near to be present here today, in an effort to make impact of this conference, being maintained in your country and also in the World, through the years to come.

This event would not have been come into today's realization without continued supports and contributions from various authorities, offices, institutes and individuals during the period of conceiving the idea, planning, organizing and preparing for follow-ups. Please accept my sincerely appreciation, and I remain deeply grateful to The Government of Georgia, Georgian Silk Museum, the Agricultural University of Georgia and Georgian Scientific - Research Center for Agriculture for volunteering to host this conference with generous inputs of the European Commission project ARACNE for operational support and travel arrangements, expert panelists prepared for round-table meetings, and all other participants with their scientific papers and development ideas which brought here from various parts of the world.

In addition, I am also grateful personally to Dr. Silvia Cappelloza, ARACNE project coordinator for her contribution to this conference for smooth progress towards fruitful outcome, preparing for the last 6 months and also being prepared for post-conference activities, and particularly for enduring additional workloads for this conference, in hidden places and behind the stage.

The Silk Roads, historically significant as trade routes, have transcended their original purpose to become essential conduits for cultural exchange across Eurasia. These routes facilitated the sharing of knowledge, ideas, and beliefs, allowing cities along their paths to flourish as vibrant centres of learning and culture.

The legacy of the Silk Roads is still visible today, with numerous historic buildings and monuments reminding us of this interconnected past.

This conference is one of outcomes from previous preparatory activities of BACSA and ARACNE project. A critical aspect of the Global sericultural industries existing is the preservation of traditional silk knowledge, which faces threats due to declining global production driven by shifts in the textile industry.

The main purpose of this conference is to provide an opportunity to sit together in order to discuss common challenges and opportunities, problems and prospects, while creating environments among participating people and institutions as cooperating partners for mutual benefits, working together in sensitizing and attracting attention from respective Governments, International Organizations and NGOs and seeking for policy and financial supports, sharing experiences and scientific knowledge, practical technologies and markets, resources and information exchange, and lots more.

By collaborating with Cultural and Creative Industries, ARACNE project seeks to valorise this knowledge in contemporary contexts, bridging the gap between ancient traditions and modern applications, particularly in cultural tourism.

Currently, there is a renewed interest in silk production, especially in Europe's Mediterranean, Balkan regions and Caucasus, which has prompted the Horizon Europe project ARACNE. This initiative aims to revive silk production and establish a resilient and innovative Silk Route that honours traditional practices while promoting cultural and architectural heritage.

Finally, I wish you all pleasant stay in Tbilisi and successful participation in this conference to the end, and safe trip back to your home countries along with fruitful results to put into practice for the restoration of past glories and significance in silk production and trade, all along the final stretch of the ancient silk road.

Thank you very much again for coming this far and listening.

The educational activities in the framework of the ARACNE project

By

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(Abstract)

The ARACNE project has developed a replicable educational format to engage high school students across partner countries in researching Europe's silk heritage. This initiative combines

two main educational paths: **'Cultural Heritage'** and **'Agricultural Landscape'**. The ultimate goal is to create a comprehensive digital 'European Silk Route' map, merging the research collected by participating schools. To support this, a range of teaching materials and digital tools were prepared. The project website features a dedicated 'Education' area with resources, including a 'Teacher Area' containing video tutorials, documents, and guides. For the mapping activities, the **ArcGIS Online platform** was chosen for its accessibility and customisation features, allowing students to geolocate points of interest and embed multimedia content. A dedicated web gallery and a YouTube playlist were set up to host the images and videos produced by students, ensuring protected and standardized access. The teaching activities were structured in four main phases: **literacy, field research, mapping, and dissemination**. The literacy phase involved meetings with local experts who introduced students to the history of sericulture and mulberry cultivation in their regions. During the field research phase, students, organized in small groups, conducted on-site visits, interviewed local community members, and produced multimedia materials like photos and videos. The mapping phase took place in computer labs, where students learned to use the ArcGIS platform to create their digital maps, adding points of interest with descriptions in both their native language and English. Several schools across Italy, Greece, and Slovenia successfully participated in the 2023-2024 academic year. In Italy, schools like the "Enzo Ferrari" High School in Catanzaro and the "Fabio Filzi" High School in Rovereto researched local silk history, from archives to former silk mills. In Greece, students from Soufli conducted interviews and held an exhibition of their work. In Slovenia, students from Anton Martin Slomšek Grammar School mapped historical sites related to sericulture, such as the Dominican Monastery in Ptuj and Castle Turnišče. Meanwhile, students from the High School of Design in Maribor engaged in creative workshops, producing silk scarves, jewellery, and other artifacts inspired by local silk history and mulberry collections. Furthermore, a crucial component of the activities to be carried out with schools in the future involves the rearing of the silkworm using an educational kit that employs artificial diet as a feeding substrate. This approach allows the rearing process to be de-seasonalized and enables completion of the biological cycle within the constraints of the school calendar.

Keywords: students, cultural heritage, agricultural landscape, ArcGIS, points of interest

Exhibition of Chinese Silk Culture - Silk Museum

By

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ABSTRACT:

The silk industry, with origins dating back over 5,000 years, began in ancient China and continues to hold cultural and historical significance. Sericulture, the cultivation of silkworms for silk production, represents a vital component of China's intangible cultural heritage. Numerous silk museums across the country preserve and showcase this legacy. This article provides an overview of the current state of silk museums in China, exploring their historical context, core missions, ongoing activities, and their connections to local sericultural practices. It also discusses policies aimed at increasing public engagement, financial frameworks, and operational models. Furthermore, we present a forward-looking vision for leveraging sericulture traditions and best practices to support cultural preservation, creative industries, and tourism development. Finally, we propose strategies to integrate the valuable assets of silk museums with the growth of modern sericultural industries.

Keywords: Sericulture; Silk Museum; Intangible Cultural Heritage; Cultural Tourism; Creative Industries

Silkworm breeding originated in China. As early as 5,000 to 6,000 years ago, people began cultivating mulberry trees, raising silkworms, reeling silk, and weaving silk fabrics. Notable silk museums in China include the China National Silk Museum (Hangzhou), the Suzhou Silk Museum, and the Jiangning Weaving Museum in Nanjing etc.

1. Suzhou Silk Museum (苏州丝绸博物馆)

Suzhou Silk Museum is the first Chinese museum specialized in silk. Established in 1991, it is located at 2001 Renmin Road, near the Beisi Pagoda in the historic old town of Suzhou. Covering an area of 9,500 square meters, the museum features six main exhibition halls: the Ancient Silk Exhibition, the Modern Silk Exhibition, the Future Silk Exhibition, the Mulberry Yard, the Silk Weaving Machinery Exhibition, and the Silk Cultural Art Gallery named after Master Qian Xiaoping.

Notably, the History Hall includes several sections: the Gallery of Ancient Silk, the Sericulture Room, the Weaving & Dyeing Room, the Gallery of Imperial Weaving from the Qing Dynasty, the Gallery of Silk Garments from the Republican Era, and the Gallery of Intangible Cultural Heritage. Together, they comprehensively illustrate China’s 6,000-year history of silk culture—from mulberry cultivation and silkworm rearing to silk production and exquisite garments.

In addition to the exhibitions, the museum hosts live demonstrations of traditional silk weaving techniques, as well as displays showing how modern silk technologies are applied in daily life. Suzhou Silk Museum offers a unique blend of static exhibits and interactive experiences, seamlessly integrating tradition with modernity.

The museum has received provincial and municipal honors as a leading institution for popular science and patriotic education. Beyond its exhibitions, it includes a multifunctional lecture hall and activity rooms used for various educational and community programs, such as academic exchanges and popular science lectures on silk. These initiatives have been widely welcomed and highly praised by the public.

As a research base for two weaving techniques recognized as intangible cultural heritage—Songjin (lampas) and Zhangduan (patterned velvet)—the museum is also renowned for its contributions to the restoration and conservation of silk artifacts. In 1995, a reproduction center authorized by the

State Administration of Cultural Heritage was established within the museum to support this important work.

2.Jiangning Imperial Silk Manufacturing Museum (江宁织造博物馆)

Jiangning Imperial Silk Manufacturing Museum（or Jiangning Weaving Museum), located at 123 Changjiang Road, Xuanwu District, Nanjing City, Jiangsu Province, is a modern museum built on the site of Jiangning Weaving in the Daxing Palace area of Xuanwu District. It was designed by the famous architect and academician of the Chinese Academy of Sciences, Mr. Wu Liangyong. The museum covers an area of 18700 square meters and has a building area of 37000 square meters. It is a local heritage museum. In 2004, the Nanjing Municipal Government started the reconstruction of the "Jinling Dream of Red Mansions Cultural Museum" within the site of Jiangning Weaving Bureau. In 2013, Jiangning Weaving Museum officially opened to the public. After the opening, the museum was renamed from the original "Jiangning Weaving Mansion Museum" to "Jiangning Weaving Museum".

3.China National Silk Museum (NSM) （中国丝绸博物馆 ）

The China National Silk Museum (NSM), located near the scenic West Lake in Hangzhou, is one of China's first state-level museums. It spans a total area of 42,286 square meters, with a building area of 22,999 square meters. Officially opened on February 26, 1992, the museum has been offering free admission to the public since January 1, 2004. In 2015, NSM underwent a significant expansion and renovation, and after a year of dedicated efforts, reopened with a fresh, modern look to welcome visitors from around the globe.

The History, Mission, and Current Activities of the China National Silk Museum (NSM)

As a non-profit permanent institution, the museum is devoted to the collection, preservation, research, exhibition, inheritance, and innovation of textiles—starting with Chinese silk and expanding into areas such as costume history, traditional craftsmanship, textile conservation, and contemporary fashion. NSM is committed to advancing its international influence and contributing to the sustainable development of culture, the economy, and society.

Through the dedicated efforts of its team, NSM has made significant strides in acquiring silk collections, organizing both domestic and international exhibitions, preserving textile heritage, inheriting sericulture and silk weaving techniques, conducting public science education, and promoting silk culture to broader audiences.

In recent years, the museum has established collaborations with academic institutions worldwide and co-founded the **I**nternational Association for the Study of Silk Road Textiles. This platform has facilitated extensive international cooperation, helping to share the beauty of Chinese silk and its rich cultural legacy with the world.

Main Responsibilities of the China National Silk Museum

- **Collection and Preservation**: Responsible for the collection, protection, display, restoration, reproduction, and authentication of silk, textiles, and related clothing cultural relics.
- **Intangible Cultural Heritage**: Committed to the safeguarding, inheritance, and development of intangible cultural heritage, including sericulture, silk weaving, dyeing, and embroidery.
- **Exhibitions**: Organizes exhibitions related to silk, textile technology, and traditional handicrafts.

- **Cultural and Creative Development**: Develops cultural and creative products and provides professional guidance for cultural and museum-related industries.
- **International Exchange**: Promotes Silk Road cultural heritage and fosters cross-cultural exchanges and international cooperation.
- **Academic Research and Training**: Conducts academic research on silk and related fields, and undertakes training of relevant professionals.
- **Digital Innovation**: Leads the development and implementation of digital application systems for silk cultural heritage and promotes cross-sector integration.
- **Policy Implementation**: Carries out additional tasks assigned by the national authorities in the fields of culture, tourism, and cultural relics.

Connection Between the China National Silk Museum and Sericultural Activities

The China National Silk Museum plays a vital role in preserving and promoting sericulture and silk heritage by integrating traditional techniques with contemporary cultural education. The museum is closely connected with surrounding sericultural bases, engaging the public through interactive experiences, seasonal festivals, and educational programs.

Labor Day and National Silk Day Celebrations

Visitors enjoyed a vibrant celebration during Labor Day and National Silk Day, which included:

- Experiencing ancient weaving techniques such as heald weaving.
- Discovering the elegance of traditional velvet production.
- Creating silk screen floral hairpins by winding silk threads.
- Learning about silk reeling—from cocoon to silk—through hands-on participation in dyeing and painting cocoon-based artworks.

Silkworm Village Monthly Program

The museum's acclaimed project, "Silkworm Village Monthly Order", recognized as one of the top ten national cultural heritage research cases, has consistently engaged the public through:

- The "Silkworm Parent-Child Research" event, where 20 parent-child groups explored the life cycle of silkworms through interactive games, VR experiences, and hands-on learning at the Xiaoyunlong Sericulture Park—a designated national sericulture research and learning base.
- Observing silkworm anatomy, breathing organs, movement, and silk spinning using immersive technology.

Modern Sericulture Exploration

At the nearby sericulture base:

- Children and families observed large-scale silk production, explored silk products like quilts, and expressed creativity through cocoon-based paintings and decorations.
- Participants experienced mulberry picking, savoring the fruits of their labor—a joyful and educational culmination of their field practice.

Parents and children praised the event as a perfect integration of knowledge, practice, and culture, calling it both *"a unity of theory and hands-on learning"* and *"education by doing."*

Museum–Community Integration

The museum effectively links seasonal sericulture cycles with education through:

- A comprehensive curriculum covering spring sericulture, folk customs, and manual techniques, conducted from April to June.
- Collaboration with **local schools and enterprises**, embedding sericulture into children's formal and informal learning.

Additionally, the "Everyone Raises Silkworm Babies" activity, in collaboration with Xiaoyunlong Park and other sericultural bases, has been held annually since 2021. Families receive a free silkworm-feeding box and engage in home-based sericulture. This initiative enhances children's awareness and appreciation of silk culture.

To further promote the tradition, the museum hosts school visits, science exhibitions, and lectures, encouraging students to return with cocoons for silk reeling and craft activities—bridging classroom learning with hands-on heritage practices.

These programs not only enrich students' extracurricular experiences but also strengthen their cultural identity and awareness of traditional Chinese sericulture.

Preservation Efforts and Engagement Policies of the China National Silk Museum

The China National Silk Museum houses an extensive and valuable collection of silk cultural relics and historical materials, spanning from the Neolithic period to modern times. Its core mission is to protect, exhibit, and revitalize the heritage of Chinese silk culture.

Collections and Exhibits

The museum's rich collections include:

- Ancient silk fabrics from the Han and Tang Dynasties discovered along the Silk Road.
- Artifacts from the Liao and Jin Dynasties, showcasing the culture of the northern grasslands.
- Song Dynasty clothing from southern China and imperial textiles from the Ming and Qing periods.
- Modern garments, including cheongsam and image-printed fabrics.

Visitors can explore these treasures across themed exhibition zones: the History Museum, Modern Museum, and Future Museum.

Key Features of Public Engagement

- **Classic Silk Exhibits**: The Autumn Exhibition features masterpieces of ancient silk such as clothing, embroidery, and intricate woven fabrics, showcasing the historical excellence of Chinese craftsmanship.
- **Live Demonstrations of Silk Techniques**: Skilled artisans conduct real-time demonstrations of **silkworm raising, cocoon reeling, and weaving**, vividly illustrating traditional practices.
- **Interactive Experiences**: The museum offers hands-on activities, allowing visitors to **touch silk fabrics**, **make small silk crafts**, and engage directly with silk heritage.
- **Silk Road Heritage**: Exhibits also delve into the **cultural exchanges** facilitated by the Silk Road, using maps, texts, and relics to trace its historical impact.
- **Blending Tradition with Modernity**: By displaying **modern silk design innovations**, the museum emphasizes the fusion of traditional techniques with contemporary fashion, ensuring silk's relevance in modern society.
- **Cultural Preservation and Knowledge Transmission**: Through dedicated educational and preservation projects, the museum highlights the methods used to protect silk relics, ensuring their legacy continues for future generations.

General Policies for Museums to Attract Tourists and Organize Exhibitions

The China National Silk Museum employs diverse strategies to attract tourists and organize its exhibitions. These strategies include a combination of long-term and temporary exhibitions, as well as interactive public engagement tools to enhance visitor experience.

Exhibition Organization

The museum’s exhibition programming is categorized into:

- **Permanent Exhibitions**, such as:
  - *Jincheng: China's Silk and the Silk Road*
  - *Changing Notes: China’s Fashion Art (1920s–2010s)*
  - *From the Countryside to the City: 400 Years of Western Fashion*
  - *Tianchan Lingji: Intangible Cultural Heritage of Sericulture and Silk Weaving*
  - *Qimengzhen: Western Fashion Digital Art*
  - *Sky Sampling: China's Silk Design Material Exhibition*
  - *One Flower, One World: Silk Road Cultural Relics Poster Exhibition*
  - *The Silk Road and Its Imagery*
- **Temporary Exhibitions**, which offer thematic and seasonal highlights, such as:
  - *Whispering: Embroidery Warm Ear Covers from the Late Qing and Republican Period*
  - *Calligraphy and Painting Exhibition on Themes of Diligence, Integrity, and National Rejuvenation*

Interactive Tools for the Public

The museum offers a range of interactive technologies and activities to engage the public, including:

- **Virtual Reality (VR)** and **Mixed Reality (MR)** to create immersive experiences. For example, visitors can role-play as soldiers from the Shang Dynasty.
- **Immersive Cultural Experiences**, such as the *Qingming National Silk Gathering*, where visitors engage in traditional sericulture, understand solar terms, and participate in handicrafts within the scenic museum grounds.

Target Audience

The museum caters to a wide range of visitors, including:

- General tourists
- Students and educators
- Scholars and researchers
- Cultural and heritage enthusiasts

Through its multifaceted exhibition offerings and educational programming, the museum aims to promote the cultural legacy of silk and the Silk Road to diverse audiences.

Museum Financing

The China National Silk Museum is funded through a combination of public and self-generated revenue streams:

Primary Sources of Funding:

- Government Financial Allocations: Cover routine operations, including staff salaries, facility maintenance, and infrastructure.
- Business Revenue: Includes proceeds from cultural activities, exhibitions, and government-subsidized projects.
- Ticket Sales and Cultural Product Sales: Contribute to operational costs and allow for reinvestment in exhibitions and visitor services.
- Project-Based Funding: Derived from functional departments and institutions supporting cultural, academic, or educational programs.

Strategic Development

The museum is continuously working to expand its influence and services through:

- Exhibitions focused on silk, textiles, and handicrafts
- The development of cultural and creative products

- Academic research in sericulture and silk history
- Public education and training in silk-related skills

  These initiatives reflect the museum's commitment to preserving and innovating within the realm of traditional Chinese silk culture, ensuring its relevance and sustainability for future generations.

Development Strategy of the China National Silk Museum

The development strategy of the **China National Silk Museum** encompasses the following key areas:

1. Exhibitions and Events (展览和活动)

The museum regularly curates high-quality exhibitions and cultural events to enhance public engagement and showcase the richness of silk culture. Recent highlights include:

- **"Zhejiang Top Ten Archaeological Discoveries Exhibition" (浙江十大考古发现展)**
  This exhibition features major archaeological findings in Zhejiang Province, including artifacts from prehistoric settlements, ancient tombs, and city ruins. It is designed to tour across the province to reach broader audiences.
- **"Square and Round Body – Tonic Art of the Ming and Qing Dynasties" (方圆章身——明清补子艺术展)**
  Focuses on *"tonic"* badges—decorative patches on officials' robes—exploring their historical significance, design evolution, and cultural influence across generations.
- **"Prairie Silk Road Exhibition" (草原丝绸之路展)**
  A key part of *Silk Road Week*, this special exhibition showcases over 150 exquisite artifacts from the Northern Grassland Silk Road, illustrating the vibrant cultural exchanges of the time.
- **"From Inside to Outside – The Evolution of Pajamas to Casual Wear" (从内到外——睡衣到休闲服的演变展)**
  Traces the transformation of pajamas into contemporary casual wear in Western fashion, reflecting changes in lifestyle and social norms.
- **"National Silk Hanfu Month: Tiangong Nishang" (国丝汉服月·天工霓裳活动)**
  Celebrates traditional textile craftsmanship and Hanfu heritage through reconstructed historical fashion shows, academic forums, and demonstrations of intangible cultural heritage skills.

2. International Exchange and Cooperation (国际交流与合作)

The museum actively promotes international cultural dialogue and collaboration:

- **Silk Road Digital Museum (丝绸之路数字博物馆)**
  Co-established with over 40 museums across 18 countries (including the UK, USA, and Russia), this digital platform offers online access to collections, virtual exhibitions, educational content, and cloud-based curatorial tools.
- **International Cooperation Projects (国际合作项目)**
  In partnership with institutions such as the Kazakhstan National Museum of Arts, the museum hosts dual-city events featuring exhibitions, performances, and cross-border collaborations to advance global awareness of traditional Chinese culture.

3. Academic Research and Public Education (学术研究和社会教育)

The China National Silk Museum is deeply engaged in academic scholarship and cultural education:

- It has made significant contributions to **research, exhibition development, international academic exchanges, and social education**.
- These efforts have earned the museum **widespread recognition and considerable influence** both domestically and internationally.

Utilizing Sericulture and Silk Traditions for Cultural, Creative Industries and Tourism Development

1. Industrial Upgrading and Technological Innovation (产业升级与技术创新)

Intelligent Production (智能化生产):

Promote industrial-scale silkworm rearing and adopt advanced equipment such as automatic cocoon-picking machines to boost production efficiency by up to 300%. In Nanning, the application of constant-temperature breeding technology has led to significant improvements in both cocoon quality and yield.

Development of the Complete Industrial Chain (全产业链建设):

Drawing on the Changyi Model, a full industrial chain encompassing spinning, weaving, printing, dyeing, and finished product manufacturing has been established. This model accounts for 90% of the national market share in decorative fabric production.

2. Deep Development of Cultural IP (文化IP深度开发)

Revitalization of Intangible Cultural Heritage (非遗活化):

Develop distinctive cultural IPs such as the "Leizu Memorial Ceremony" and the "Legend of the Silkworm God". These are integrated into cross-border cultural tourism initiatives, particularly in countries like South Korea and Southeast Asia where Leizu worship traditions persist.

Immersive Experiences (沉浸式体验):

Establish silk-themed museum clusters, such as the Liutuan Silk Culture Museum, which presents live demonstrations of traditional weaving techniques and houses over 30,000 cultural artifacts, creating a living historical narrative.

3. Integration and Innovation of Culture and Tourism (文旅融合创新)

Thematic Research and Learning Programs (主题研学路线):

Design integrated courses combining sericulture technology, ancient silk reeling, and cultural creative design, inspired by the hands-on educational model of the Hangzhou China National Silk Museum.

Festival Economy Development (节庆经济培育):

Organize events such as the Mulberry Picking Festival and Silk Culture Week. For example, the Changyi Xiangjie Festival attracts over 100,000 tourists per day, significantly boosting local tourism and cultural engagement.

4. Policy Support System (政策保障体系)

Cross-Sectoral Collaboration (跨部门协作):

Establish joint working groups involving agriculture, culture, tourism, and commerce departments. Provide financial incentives such as a subsidy of 2,000 yuan per mu for mulberry field development.

Brand Strategy (品牌战略):

Cultivate nationally recognized fashion brands like Qingyun Dyeing, and leverage platforms such as Douyin to achieve massive exposure. This strategy has increased the market premium of silk products by up to 300%.

Strategies to Connect Silk Museum Resources with Modern Sericulture Industry Development

As a major custodian of China's silk heritage, the China National Silk Museum plays a vital role in linking tradition with modern sericulture through digitization, design innovation, and industrial integration. The following strategies illustrate how these connections can be leveraged:

1. Digital Preservation and Innovative Applications (数字化保护与创新应用)

The Suzhou Silk Museum uses its "Intelligent Lighting Original Collection" system to build a high-resolution silk pattern database, supporting creative and commercial applications. Similar digitalization technologies could be adapted across the sericulture sector to establish comprehensive resource databases.

The China Silk Museum has highlighted the origins of silk through archaeological discoveries such as a 7-cm silk thread. These findings are digitized and transformed into educational content, enhancing the cultural value embedded in modern silk production.

2. Revitalizing Traditional Skills through Modern Design (传统技艺活化与现代设计)

A team of young designers (average age 26) leads the integration of traditional silk patterns into modern products like fashion apparel and home furnishings, ensuring cultural continuity through innovation.

Research on historical textiles, such as jacquard models, informs improvements in contemporary textile machinery, accelerating technological upgrades in the industry.

3. Collaborative Industrial Chain Development (产业链协同发展)

Adopt the "Museum + University + Enterprise" collaborative model—such as partnerships between the Suzhou Silk Museum, Beijing University of Posts and Telecommunications, and Suwentou—to build integrated platforms for research, education, and production.

Develop cultural tourism routes themed around sericulture and extend the economic value chain through exhibitions at the Silk Museum, such as displays of Dunhuang patterns and Maritime Silk Road artifacts.

4. International Cultural Exchange and Brand Building (国际文化交流与品牌建设)
Create high-end customized products based on cultural relics from the Silk Road, such as the Red-Winged Horse Brocade, to enhance the global visibility of the "Chinese Silk" brand.

Promote Leizu culture and other intangible heritage elements (e.g., the Qianshanyang site) to establish a strong cultural identity for the modern sericulture industry.

These strategies represent a holistic transformation—turning the preservation of cultural relics into a driver for industrial revitalization. By combining technology, design, and cultural narrative, China's sericulture and silk industries are evolving into dynamic engines for economic, cultural, and international development.

Tourism and silk museums in Spain. The case of the Silk Museum of Valencia

By

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ABSTRACT:
Spain has become the country with the highest tourist influx worldwide. The arrival of 100 million tourists annually doubles the country's population. This reality is transforming the cities and environments of Spain, which in just a few years has seen tourism impose its rules on all economic, cultural, and social aspects. Given this situation, and taking into account that political authorities will continue to promote tourism and tourist arrivals, museums are beginning to take measures to meet cultural and tourist demand. On September 12, 2025, the First Meeting of Museums of Valencia will be held, with the aim of addressing these issues, proposing future challenges and coordinated actions. This and other similar initiatives aim to improve museums' response to the new demands of the tourism sector and new audiences. In 2026, we will celebrate 10 years since the inauguration of the Valencia Silk Museum, the museum that organized the First International Congress of Silk Museums in 2018. This tenth anniversary encourages us to develop creative initiatives that can address both the needs of the tourism market and provide effective heritage

education projects, both for visitors from other countries and for the local population. The transformation of Spanish cities due to the tourist influx can destabilize many current balances, so it is important to analyze the situation and take preventive measures to ensure that these initiatives are beneficial for all parties involved.

Keywords: tourism, museums, heritage, heritage education, Silk Road

Spain has become the country with the highest tourist influx worldwide. The arrival of 100 million tourists annually doubles the country's population. This reality is transforming the cities and environments of Spain, which in just a few years has seen tourism impose its rules on all economic, cultural, and social aspects. Given this situation, and taking into account that political authorities will continue to promote tourism and tourist arrivals, museums are beginning to take measures to meet cultural and tourist demand. On September 12, 2025, the First Meeting of Museums of Valencia will be held, with the aim of addressing these issues, proposing future challenges and coordinated actions. This and other similar initiatives aim to improve museums' response to the new demands of the tourism sector and new audiences. In 2026, we will celebrate 10 years since the inauguration of the Valencia Silk Museum, the museum that organized the First International Congress of Silk Museums in 2018. This tenth anniversary encourages us to develop creative initiatives that can address both the needs of the tourism market and provide effective heritage education projects, both for visitors from other countries and for the local population. The transformation of Spanish cities due to the tourist influx can destabilize many current balances, so it is important to analyze the situation and take preventive measures to ensure that these initiatives are beneficial for all parties involved.

Tourism in Valencia

Valencia is one of the Spanish cities with the highest tourist records in Spain and Europe. The devastating effect of the torrential rains that caused the DANA storm in October 2024 has not changed the increasing pace of tourist arrivals to the city during 2025. The data reflect solid national and international demand, driven by an extensive network of flight connections, which has been strengthened with the opening of new routes to strategic markets. In terms of the origin of travellers, foreign tourism represents 59% of the total in the city, whereas national tourism accounts for 41% of the total, thus consolidating the cosmopolitan character of the destination and contributing to the economic and labour stability generated by this activity. The hotel offer has remained stable and the average number of nights spent in a hotel increased in 2025. Furthermore, interest in Valencian culture and heritage continues to grow, as reflected in the increase in the number of visitors to museums, monuments and leisure facilities. Tourism has a direct impact on Valencia. The increased number of flight connections makes the city more competitive and favours the development of various economic activities. Moreover, the arrival of visitors boosts the range of dining and entertainment options available, while strengthening the cultural sector, generating social and economic benefits for Valencia and improving the quality of life of its citizens. The massive increase in tourist arrivals also has detrimental effects on the local population. These negative effects are exacerbated by rising housing prices and the rampant construction of tourist apartments. While tourism facilitates the movement of people and capital, it is also true that when it becomes excessive, it can damage the social and cultural heritage of this historic city. We must develop a tourism model that respects the city's heritage and resources. Furthermore, we must take advantage of the improvements brought about by tourism, such as investment in museum infrastructure, to enhance the quality of civic education and promote creativity as an educational resource among the local population (Huerta & Alfonso-Benlliure, 2025)

The average length of stay is 2 nights for the domestic market and 3 nights for the international market. The profitability indicators showed an average hotel price of €120, which represents an increase of 9% with respect to the previous financial year. Valencia enjoys mild temperatures all year round, allowing visitors to enjoy its natural and cultural attractions at any time of year, with more than 310 clear days per year, and 275 days with temperature over 20ºC. The arrival of visitors to the city by plane has broken all records. Ryanair, an airline specializing in flights between European cities, transported more than three million passengers to Valencia during 2024. The arrival of passengers on tourist cruise ships has also exceeded 4,000 tourists per day during the last year. The three million annual visitors come mainly from countries such as Italy, the Netherlands, Germany, the United Kingdom, France and Belgium. Also important is the arrival of tourists from the United States, China, Japan, Canada, and Brazil. Valencia offers a very important gastronomic scene, with a considerable increase in restaurants and cafes in recent years, and a rich array of original dishes and drinks, with Paella standing out as its star dish. Among the main cultural and leisure facilities offered by the city, it is worth highlighting: 4 UNESCO World Heritage Monuments (*Lonja de la Seda* - Silk Exchange, *Tribunal de las Aguas* – Medieval Historical Water Tribunal, Mediterranean Diet, and Fallas Festival), 37 museums and cultural centers, 22 theaters, the *Palau de la Música* (Symphonic and classical music, opera, concerts, and art exhibitions), the *Palau de les Arts* (Opera, music, ballet, and theater), the City of the Holy Grail, and the Silk Road.

Figure 1. Silk Museum of Valencia. Hall of Fame with 18th-century ceramics.

In terms of museum and heritage site admissions, based on 2023 data, counting only ticketed admissions, the number of visitors to the city's museums was: Oceanogràfic (1.942.063 visitors): Museo de las Ciencias - Sciences Museum (1.125.954); CaixaForum Valencia (806.697); Lonja de la Seda – Valencia Silk Museum (757.075); Bioparc (650.000); Valencia Cathedral (540.904); MUVIM Valencian Museum of Illustration and Modernity (508.419); Hemisfèric - Planetarium (479.415); Serranos Towers Monument (340.906); Miguelete - Cathedral bell tower (254.508); Museo de Bellas Artes – Fine Arts Museum (239.504); Museo Nacional de Cerámica - Ceramics Museum (236.947); IVAM Valencian Institute of Modern Art (174.854); Municipal Historical Museum (159.610); Bombas Gens Centre d'Art (137.680); Museo Fallero (111.513); L'Etno (110.958); L'Almoina - Archaeological site with Roman ruins (98.511); Museum of Prehistory (95.769); Quart Towers (89.754); Museo del Corpus - Casa de las Rocas (86.119); Paleontological Museum (77.042); Reales Atarazanas - Royal Shipyards (34.352); Ciy Museum (23.877); Museum of History of Valencia (21.318); Almudín - Medieval city granary building (20.772); Casa Museo Benlliure (18.700); Museo Taurino (18.403); Palacio Cervelló (13.946); Historic Air Raid Shelter of the City Hall (13.939); Museo Semana Santa Marinera - Holy Week Maritime Museum (13.137) Crypt of Saint Vincent Martyr (11.568); Rice Museum (11.423); Blasco Ibáñez Museum House (10.568); Municipal Exhibition Hall (9.661); Galería del Tossal (3.408); Concha Piquer Museum House (1.639). These data have increased considerably, so that in the last year, the Bombas Gens Art Center has exceeded 300.000 visitors.

Figure 2. Facade of the Silk Museum of Valencia.

We can see, therefore, that Valencia has become a leading tourist destination. The city offers a wealth of attractions, such as a pleasant year-round climate, extensive and well-connected beaches, a significant culinary scene, and a wealth of cultural and heritage sites (Soto-González et al., 2025). This flourishing tourism industry has also attracted people from numerous countries around the world who are currently working in the local tourism market. From waiters and cooks to tour guides and real estate developers, Valencia is brimming with economic and cultural activity, with a significant increase in workers supporting both the housing construction market and the needs of the tourism sector. Immersed in this tourist and economic boom that is transforming the city, a top-level historical and heritage element stands out: The Silk Museum of Valencia.

Valencia on the Silk Road

The Silk Road was born in the mid-1980s as a cultural integration project promoted by UNESCO. After several decades, among the achievements fostered by this transnational idea, which promotes a spirit of cooperation between territories historically linked by trade and economic relations, we can highlight the creation of numerous silk museums, which have become true elements of cultural, economic, and tourist cohesion. The concept of "migrant heritage" takes into account the cultural, economic, and political changes that each historical moment generates (Huerta & De la Calle, 2013). In this sense, the constant modifications perceived in the treatment of heritage assets are marked by presences and absences that shape their characteristics and functions. Transit and change are factors that particularly concern migrant heritage. That which flees, which travels, and which may belong to us at a given moment, is considered a heritage asset, of a migrant nature. The geographical displacement of heritage, something that is very evident when dealing with migrant heritage, thus becomes a value to be considered, both in terms of the object or subject of heritage, and in terms of its cultural significance (Franch Benavent, 2024). By promoting the blending of ideas and fostering the integration of approaches, migrations, exchanges, and knowledge transitions constitute a highly vital mechanism. The so-called Silk Road creates a veritable geographical route, highlighting commercial activity and exchange, something significantly reflected in the museums of the different countries along this immense historical path. We find silk museums in China, such as the National Silk Museum, the Suzhou Silk Museum, and those in Nanjing and Jiangnan; we also have them in Japan, in Yokohama and Nomura; and so, from the easternmost reaches to the westernmost edge of Europe, an impressive route is traced, featuring the silk museums of Tbilisi in Georgia, Bsous in Lebanon, as well as the Soufi Silk Museum in Greece, the Taulignan Silk Museum in France, the Macclesfeld Silk Museum in the United Kingdom, the Stockholm Silk Museum in Sweden, and finally some of the most spectacular in Italy, where we find examples of continuity between the productive world of yesterday and the present day. Each museum projects itself onto the city and its surrounding areas (Navarro Espinach & Huerta, 2020). The routes that linked the cultures of East and West through the Silk Roads have now migrated from their initial commercial function towards new implications, such as tourist, educational and heritage research uses.

Figure 3. Handloom in the Silk Museum of Valencia.

The exchange and dissemination of technical resources, consumption patterns, iconographic models, and design styles have given rise to significant cultural blending that has led to global processes of social interaction. In this sense, the Silk Roads have fostered the emergence of new museum strategies, which have contributed to reinforcing the idea of cultural exchange, while also helping to recall the skills learned from silk heritage. This highlights identities and knowledge that become immediate points of reference for dialogue between cultures, respect for diversity, and the defence of values. Given the flexible and fluid nature of migratory heritage, a clear example of migratory heritage is the foundations and museums that use both art collections and emblematic buildings to emphasize their presence in different geographical locations. Silk museums are not just art spaces; they also combine interesting elements such as history, trade, design, industry, international relations, and the crafts of each region. An important part of the history of the city of Valencia and the heritage legacy that characterizes it is the manufacture and trade of silk.

As the historian Germán Navarro Espinach explains, sixteenth century brought the decline of Granada with a simultaneous consolidation on the part of Valencia. The massive arrival of an ever-increasing number of Genoese artisans in Valencia can be ascertained from the second half of the fifteenth century and no earlier: 2,000 velvet weavers are identified by different historical sources during the period 1450–1525 in a city of 70,000 inhabitants. 40% of them were foreigners from outside the Valencian kingdom, including, in particular, 377 artisans from Genova and Liguria. The Genoese migration led to a significant technological transfer, in terms of thread processing, loom construction, and weaving, in order to promote the new fashion of black velvet. The frst guild of velvet masters known in Spain, the *Art de Velluters of Valencia*, was founded in 1477-1479 by Genoese and Valencian masters. There were 96 artisans with 172 looms in the city (Navarro Espinach, 2022). During the period 1474-1489 the prosopographical outlines of 716 velvet-makers and over 300 veil-weavers have been reconstructed. The Valencian silk industry then became the most important production centre on the Iberian Peninsula from the fifteenth to the sixteenth centuries. In all of this, it must not be forgotten that the Guild of the Silk Weavers in Genoa was founded in 1432. From Genoa to Valencia, different varieties of Genoese-type velvet were adopted with reeds of 20 to 22 *ligaduras* (thread groups). The highest-quality product was *vellut senar*, or singular velvet of 22 *ligaduras*, but there was also velvet of 21 *ligaduras*, *vellut doble* (velvet with two pile warps per dent) with only 20 *ligaduras*, and velvety velvet (*vellut vellutat*) with satin ground. Many Castilian emigrants, whether silk craftsmen or apprentices, travelled from Toledo, Seville, and Granada to Valencia to become part of its expanding labour market (Navarro Espinach, 2025). The example to be followed in the development of the new silk industry in the Kingdom of Majorca during the sixteenth century was that of Valencia. In 1531, there was an attempt to subsidise the travelling and lodging expenses of a master craftsman from Valencia, with a view to enabling him to teach his techniques to those living on Majorca. Moreover, the *Art de Velluters* was one of the oldest craft brotherhoods of Valencia under the patronage of St Jerome and also the origin of the future *Colegio del Arte Mayor de la Seda* (Guild of the High Art of Silk), founded by Charles II, King of Spain, in 1686. (Navaro Espinach, 2020, pp.195-197).

Figure 4. *La Pometa* (the small apple) Room in the Silk Museum of Valencia.

Between 1450 and 1800, the European silk industry underwent significant transformations within an increasingly globalized and competitive context, where the flexibility and adaptability of guild corporations were common features (Muñoz Navarro & Franch Benavent, 2021). This was a cumulative process in which the occasional introduction of small innovations either resulted from the unintended outcome of craftsmen going about their normal business or from initiatives adopted by entrepreneurs who increasingly controlled their activity (Franch Benavent & Navarro Espinach, 2017). Therefore, it is essential to place these decisions within their historical context (Navarro Espinach, 2021). If we compare the evolution of Valencia with that of other Mediterranean silk centres, such as Lyon or Venice, we can observe the diversity of the European guild system and the constant process of adaptation to the market, albeit with disparate results. While for Lyon, innovation and modernization of production according to new fashions was a successful example on an international scale, based on a new way of producing within the guild, the Venetian case presents a clear counterpoint, reorienting its production towards luxury fabrics to try to cope with growing international competition, although without being able to prevent the definitive decline of this industry. For its part, Valencian silk production developed during its period of greatest splendour, thanks to the impetus of a local bourgeoisie that emerged from the artisan elite, and oriented its production primarily towards the American market (Navarro Espinach, 2018). However, the emancipation of the colonies and the unstable Spanish political context of the first half of the 19th century, together with productive traditionalism and the lower competitiveness of Valencian silks compared to goods of French and Asian origin, marked the beginning of an irreversible crisis, in which the guild could do little (Muñoz Navarro & Franch Benavent, 2021).

The two major historical periods in the city of Valencia coincide with the rise of silk. The end of the medieval era, coinciding with the 15th and 16th centuries, marked a golden age for Valencia, which became the world capital of silk. Monuments such as the Silk Exchange (*Lonja de la Seda*) and the Silk Museum itself are testament to this period. The leading expert on this historical period is the historian Germán Navarro Espinach. The other period of great expansion for silk production and trade in Valencia was the 18th century, a period meticulously studied by the historian Ricardo Franch Benavent. Some of the most spectacular traditions of our culture, such as the traditional Valencian dress, are linked to silk culture. The women and men who participate in the Fallas festival currently wear clothing that has its roots in the luxurious dresses of the 18th century. The spectacular dresses worn by women during the Fallas festival are notable for their splendorous majesty. As Ricardo Franch tells us: rom the end of the late Middle Ages, the activities related to the cultivation of mulberry and the fabrication of silk have had a deep importance in the Valencian history and culture. Although traditional Islamic fabrics were already manufactured in Valencia with silk proceeding from the Kingdom of Granada, it was a the end of the 14th century when Genovese traders contributed to the spread of the cultivation of mulberry from the south of Italy (Navarro Espinach & Aparici Martí, 2022). Later, they also transmitted the new textile technology that was used in Genoa in the elaboration of “velluto” or silk velvet. That is what made them to collaborate in the “velluters” guild in Valencia in 1479, which soon became the most important profession of the city and played an important role in the Revolt of the Brotherhoods (Navarro Espinach, 1996). Nevertheless, the spread of this manufacture was moderated, since Toledo became the main Spanish silk centre of the Habsburg period. In this epoch, the Kingdom of Valencia stood out, especially, as the most important producing area of raw material of the Monarchy. In fact, the Corts Valencianes already proclaimed in 1547 that silk was the “principal fruyt del dit Regne", since they moved with the creation of a tax that mortgaged the exports to Castille with the objective of financing the surveillance and defence of the littoral against the incursions of North African corsairs.

Figure 5. Cover image of a book about Valencian silk dyers in the 16th century. Collection of the Silk Museum of Valencia.

The spread of the cultivation of mulberry intensified the in the 17th century and reached its peak in the first third of the 18th century, when silk was produced in the 90% of the Kingdom of Valencia's 500 villages, although the most part of it was gathered in the regions of l'Horta de València, la Ribera Alta and Baixa of the Xúquer and el Baix Segura. Also, as well as being the most important silk producing area in Spain, Valencia became on the 18th in the main manufacturing centre of the country due to the decline that Toledo experienced. The foundations of the expansion laid towards the end of the 17th century. That could be observed in the privilege got by the “velluters” guild in 1686 by which it was granted to them the status of “colegio del arte mayor de la seda”. The market policies adopted after the ending of the War of Succession favoured the manufacturing growth of the activity in Valencia, where around the 94% of the 4000 looms in the Kingdom were gathered in the second half of the 18th century. Although in 1788 worked directly in them 7,764 operators, the previous work of spinning, winding, throwing, tinting, etc., generated an intense activity, since it was estimated that around the half of the population od the city of Valencia worked, directly or indirectly, in the sector. That explains the deep impact of silk, not just on the urban physiognomy and economics, but also the social relations and the cultural manifestations of the city. Even though the textile manufacturing suffered a serious crisis from the beginning of the 19th century, the cultivation of mulberry and the spinning of silk survived, thus experimenting an important mechanisation process in the first half of the century. Nevertheless, the irruption of the pebrine’s epidemic from 1854 significantly weakened the sector, which basically disappeared at the end of the century. But the testimonies of the over 400 years in which the sector has had an intense spotlight in the Valencian history and culture are very numerous. The Universitat de València wants to contribute to its recovery with this web site and with the scientific and cultural activities that has organised in the framework of the initiatives launched by Les Corts and the Valencian Government on the occasion of the entrance of Spain in the WTO and UNESCO’s Silk Road.

From the Canary Islands to Japan, we see the enduring relevance of the Silk Road concept, a term coined by the German geographer Ferdinand von Richthofen in 1877. The importance of silk heritage is reflected in the museums established in all the countries along the route between Asia and Europe. The Silk Museum of El Paso, on the island of La Palma (Canary Islands), is conceived as a permanent exhibition dedicated to the presentation, dissemination, and promotion of the artisanal work of silk production in the municipality of El Paso. In southern France, several silk museums allow us to journey through history in towns such as Bussières, Saint Jean du Gard, and Taulignan (Huerta, 2023). Silk museums are also found in the United Kingdom, most notably the Macclesfeld Silk Museum. In Sweden, we can visit the K. A. Almgren Silk Museum in Stockholm. In 1846, the majority of employees in Swedish silk factories were women. The Almgren Silk Factory, which operated until 1974, produced silks for fashion, coats for the clergy, bow ties and umbrellas, as well as ribbons and handkerchiefs. During World War II, they were forced to use Swedish artificial silk, as it was not possible to import natural silk.

Figure 6. Library room of the Georgian National Silk Museum in Tbilisi.

In Turkey lies the important silk-producing city of Bursa, home to the Merinos Textile and Silk Museum. In the 15th century, Bursa boasted over a thousand silk looms, and production continued until the mid-20th century. Moving on to Georgia, its National Silk Museum in Tbilisi is one of the oldest silk museums in the world and the only one in the Caucasus region. Founded in 1887, the museum is part of the Caucasian Sericulture Station, serving as an educational and scientific research center dedicated to the study of silk production throughout the Caucasus. The building is listed as a cultural heritage monument in Georgia. The building was purpose-built as a museum and is listed as a cultural heritage monument in Georgia. It houses a wide range of artifacts related to sericulture, as well as objects and books from fifty different countries. Artistic and scientific research in this field is fundamental, as is the preservation and dissemination of the materials in the museum's collections. The museum welcomes new initiatives, contemporary art projects, artist residencies, workshops, and educational activities. The museum's heritage is particularly significant in the Georgian National Silk Museum because it is located in the central area of the Silk Road, making it a major hub of commercial and cultural exchange.

Figure 7. Main exhibition hall of the Georgian National Silk Museum in Tbilisi.

The Silk Road was important not only because of the trade, but also because of the constant exchange that took place during the trips. An exchange of other products that arrived to Valencia, such as porcelain or tea, and an exchange of the knowledge and ideas brought by scientists, priests, adventurers, and intellectuals. Thus, parallel to the commercial exchange there was also a cultural and scientific exchange that enriched every place it passed through. The European project of the Horizon Heritage Programme *ARACNE: Advocating the role of Silk Art and Cultural Heritage at National and European scale* https://aracneproject.eu is coordinated by CREA in Padua (Italy). Spanish professor José Luis Cenis is participating in this ARACNE project, developing a cultural route along European silk, following the model of the Council of Europe's cultural routes https://www.coe.int/es/web/cultural-routes The researcher is undertaking the task of locating and georeferencing all sites in Europe within the ARACNE project (Italy, France, Spain, Greece, Slovenia) where any silk-related activity has taken place or is currently taking place.

Figure 8. Filatoio di Caraglio, silk museum in Italy.

The project also plans to document these sites at various levels: a basic description of the activity, data on its management, historical context and background, sources of historical information, and an assessment of the economic, educational, and exhibition value of each site. The aim is to document the historical, commercial, and technological relationships between the different sites, allowing for the identification of established routes and patterns of movement between them. To this end, the creation of these routes is proposed, maximizing the development of tourism value and historical and cultural content. The information will be presented in the form of interactive maps, using GIS technology and allowing users to query the information at different levels of complexity, thus optimizing the visualization of the geographical component of the routes. A significant contribution involves conducting a comparative analysis of the most suitable GIS platforms for the intended purpose: ArcGIS, OpenStreetMap, and Google Earth Pro. So far, Cenís has geolocated and provided basic documentation for 185 sites linked to the Silk Road.

The Silk Museum of Valencia

The College of the Major Art of Silk in Valencia has existed for over five centuries, maintaining its role as a business and commercial organization, especially for textile manufacturers. Heir to the medieval guild of the "velluters," this College owns the building that in 2016 became the Silk Museum of Valencia, thus preserving its historical legacy while addressing new needs. It boasts impressive spaces such as the archive, with its documentary holdings of the College. Visitors can also explore the main floor of the guild house, which houses a large collection of Valencian Baroque tiles, a Gothic spiral staircase, and paintings by José Vergara, as well as the workshops, which feature antique textile machinery and demonstrate the process of weaving traditional

Valencian brocade. The College also features an attractive shop, called Espai Seda, a café and restaurant with a terrace located on the site of the College's former orchard. Its galleries host temporary exhibitions with silk as the central theme. The Archive of the College of the Greater Art of Silk, one of the most important guild collections in Europe, consists of 48 parchments, 660 books, and 97 boxes of documents dating back to the 15th century. It preserves the records of income and expenses of the corporation and its confraternity continuously from 1479 to the 19th century, with lists of registered masters, journeymen, and apprentices, minutes of meetings, names of the guild's trustees and foremen for each period, records of the arrival of foreign workers, festivals, works, inventories, and the privilege granted by King Ferdinand II of Aragon in 1479. Currently, the city of Valencia has become a tourist destination, with an exponential increase in visitor numbers; institutions such as the Silk Museum are a major attraction for certain audiences, including scholars (Huerta, 2024).

In November 2018, the Silk Museum of Valencia organized an international congress to explore the history and characteristics of silk museums worldwide from a transdisciplinary perspective. This initiative was linked to Valencia's designation as “Silk City 2016-2020” and a UNESCO Focal Point within the Silk Road Program. The congress addressed complex issues and featured presentations from leading figures in the global silk scene. It proposed the creation of a network of silk museums to develop joint projects and exchange experiences. It was at this meeting that we identified an interest in the educational and heritage-related aspects of these museums. Within a service-based society, museums, as well as institutions dedicated to the conservation and dissemination of heritage in general, are transforming into entities with a clear social and educational dimension. In Southern European countries, heritage and culture are becoming cornerstones of the economy. New energy is needed to develop innovative ways of sharing culture, especially considering that we are talking about generations born with the internet. Museums cannot afford to stagnate. We need to create new ways of sharing culture. Good practices must be nurtured by respect for tradition, collective memory, and a desire to innovate to improve our lives. This is possible by combining the voices of experience with the voices of young people, driven by enthusiasm and constant experimentation. In this ongoing, intergenerational, and intersectional exchange, it is essential to always bear in mind the fundamental value of craftsmanship.

Figure 9. Chapel of the Silk Museum of Valencia, decorated with a diagonal white and green tile floor that creates a spectacular optical effect.

A silk museum can be an educational museum for all audiences, sensitive to the needs of each sector, and engaged with its surroundings (Huerta, 2021). It is important to listen to the voices of its visitors, and therefore it is worthwhile to strive for a participatory, inclusive museum, open to ideas, realistic and feasible, one that understands its potential, remains grounded, and enjoys and celebrates its characteristics and unique features, fostering aesthetic development. Silk weaving is a complex technology, constantly evolving with knowledge. Valuing a tradition of more than five centuries of producing and trading exquisitely crafted fabrics, we are well-positioned to adapt to the transformative impact of digital technologies. We approach this new reality with a positive, open, and sensible attitude, as the pandemic has revealed the potential of digital technology. In the same way that we keep the tradition of silk weaving alive, we can forge a direct connection with cutting-edge technologies.

Figure 10. Antique spinning machinery on display at the Silk Museum of Valencia.

The tradition of the silk fabrication and commerce in Valencia was born several hundred years ago. This accumulated heritage was created in the splendid moment of medieval Valencia, in the origins of the Valencian preponderance in the Mediterranean, in a plural scenario where diverse cultures and religions were shared. In medieval Valencia, the corporate spirit that made the birth of the Silk College, later ratified by royal ordinances such as Silk College of Art, emerged strongly. The heritage burden characterizes this important institution which is history, present, and future. One has to make the tradition visible, while taking into account the need to innovate. Innovation is the result of respect and memory. The historical building has undergone a recent transformation brought about by the efforts of its leaders, with the support of the Hortensia Herrero Foundation. This architectural intervention and recovery of the impressive amount of decorative and artistic elements (especially ceramic flooring and wall paintings) has placed it as a nerve center of urban recovery. It is a historical and cultural reference of great importance for the city. The decisions taken here have important repercussions on the local scene, but also on a global level, since Valencia was the world capital of the silk trade in the fifteenth century.

We value the possibility of considering it as an authentic house-museum. The Guild space is an environment inhabited by its owners for more than five centuries. The meetings of the representatives of the families of Valencian silk manufacturers have inhabited this house for centuries, and it continues to be their home. Within this architectural space, the memory of the different material and immaterial testimonies present in their vestiges, also in their current use, is still alive. The concept of house-museum is reinforced as it is a guild house converted into a museum, which maintains the spirit of ancestral generations belonging to the community of

Valencian silk manufacturers and merchants. The Silk College of Art, heir to the medieval guild of the “velluters”, owns the building that is now a museum. Due to its status as a private entity, public institutions never opted to invest in this project. Since its opening in 2016, Valencia has been a place to learn about the history of silk making, an occupation that marked the future of the city until it became an indispensable part of its culture.The Silk Museum of Valencia has four different spaces: 1) The permanent exhibition, where there is a tour through the history of silk; 2) The archive, with documentary funds of the College, which make up the most extensive and oldest guild documentary record in Europe; 3) The noble floor of the guild house, which preserves a large set of Valencian Baroque tiles, a Gothic spiral staircase and paintings by José Vergara; 4) The workshops, which have old textile machinery where the process of the artisanal weaving of the Valencian spur is shown.In addition, has an attractive store space, as well as a restaurant that has a terrace in the place where the garden was located. Its rooms host temporary exhibitions with silk as a common thread, with very pending themes of the territorial and historical reality of the closest heritage. The headquarters of the museum are a prominent building, located in the historical area of the city center. Very close to the museum, we find the lavish building of *La Lonja*, an emblem of the Mediterranean civil Gothic, as well as the framework of what was a huge neighborhood of manufacturers of silk fabrics.

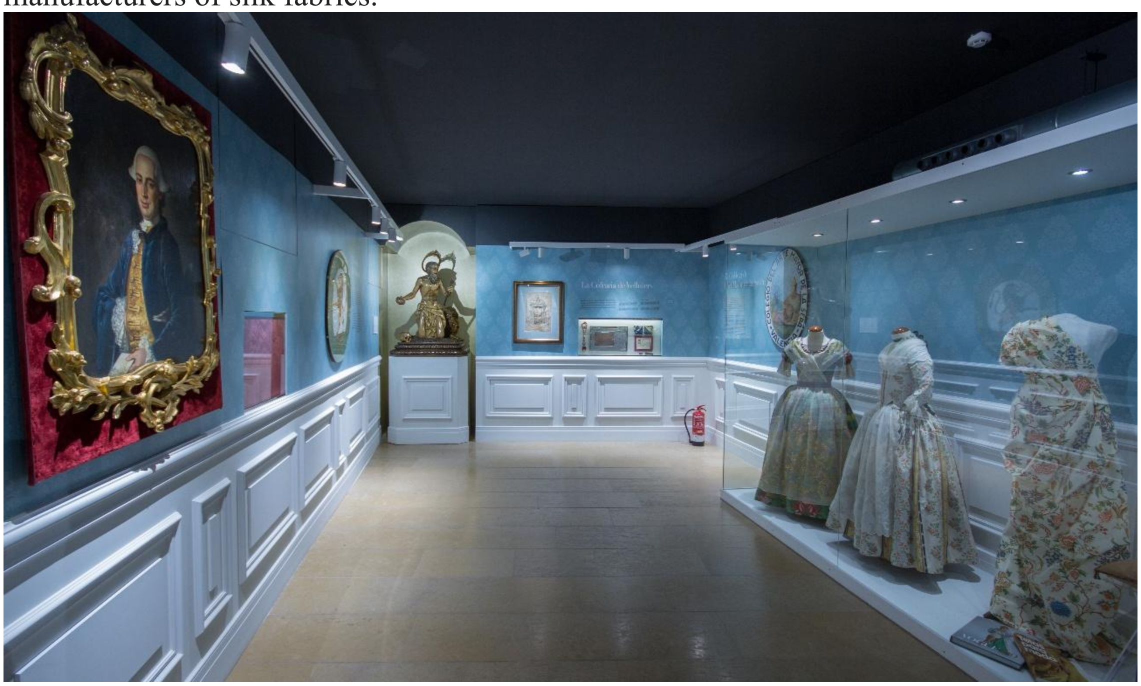

Figura 11. Sala con recreaciones históricas y vestidos del siglo XVIII en el Museo de la Seda de Valencia.

The protagonists of the history of silk in Valencia were workers and merchants, women and men, children and the elderly, slaves, servants, teachers and apprentices, officers and families who dedicated their lives to a variety of artisanal activities between agriculture and market. A part of that community was organized in corporations and brotherhoods of trades since the end of the 15th century. Thanks to historical research, these anonymous people have a voice today, and their material and immaterial legacy is valued in this museum. Museum is an educational space of excellence that identifies the objects and elements that characterize society in the same place where they worked centuries ago. The fact of it being called “college” appeals to its condition as a place to teach, since the silk trade was learned here and it is where the titles were delivered to be able to practice as a silk teacher. The Historical Archive of the Silk Museum is a heritage jewel. There are numerous silk museums in different cities and countries of the world, but none of them have the particularity that characterizes that of Valencia, its Historical Archive. One of the most important works that the preservation of the manuscripts has required is the construction of an airtight vault, in which all these documents maintain an adequate temperature and humidity for their better conservation. Scientific research, especially from the humanities, is being carried out to better understand the history of this institution and is based on the importance that silk had as an industry and international trade in both the 15th and 18th centuries. Contacts between peoples and civilizations generate a common heritage in continuous movement. That is where the concept of movement, of route and of cultural interaction becomes fundamental for addressing the issue of migrant heritage. We cannot be seduced by museum approaches dominated by the obsession of tourist attraction or entertainment, which in the short term may work; however, in the medium and long term, they destroy any possibility of progress, or they deteriorate the very sense of the heritage concept. While paying attention to the tourist reality and entertainment, what we verify in the silk museums is the intention of assuming a commitment to prioritize their interests toward diverse realities, understanding their role from the social and educational dimension. Silk museums combine history and memory to prepare us for the future. It is in this necessary duplicity that the proposals that are defined by the educational and heritage facets fit together. Faced with this reality, the silk museums are a good example of a combination of past and future, creating aesthetics that unite the educational and the heritage, properly using the knowledge acquired in the past to deal more consistently with current problems and the challenges of the future. Silk museums are articulators of past and future and as entities that are memory and also experimentation and social creativity. These are museums that emerge from educational practices and that explore the identities of each place, exploring the voices and residues of enriched memories.

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The creation of a silk cultural and economic hub at Villa La Palladiana is a key achievement of the "Aracne" project

By

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(oral presentation)

The creation of a silk cultural and economic hub Atelier Treesure at the Villa "La Palladiana" is a key achievement of the Aracne project.One of the Aracne project's objectives is to establish a

connection between the cultural tradition of silk production in the various European regions and their economic development. A key initiative in this respect is the promotion of the cultural heritage embodied by the Venetian villas. Following the Venice's conquest of the Veneto-Friuli mainland between the 14th and 15th centuries, the Venetian aristocracy became interested in land ownership. The foundation of large estates was accompanied by significant agricultural investments, often funded by merchant incomes, which were then rewarded through the productivity of the same estates. The symbol of this 'world' was the Venetian villa, combining the aesthetics and grandeur of a stately residence with the buildings necessary for managing the surrounding crops. In the 16th century, Andrea Palladio developed a specific type of Venetian villa known as the Palladian villa. The Palladian villas of Veneto (24 villas) have been included in the UNESCO World Heritage List and have inspired numerous creations by subsequent architects in northeastern Italy and many other parts of the world. Some historians have recently emphasised the significant connection between the villas commissioned by noble patrons of Palladio and the profits derived from mercantile activities associated with silk production and trade. They even suggested that the Venetian villa landscape is akin to the agricultural landscape of "Piantata veneta", which was bordered by rows of mulberry trees. Therefore, D'orica's decision to install its small restored Japanese Nissan reeling machine in the barn of a Venetian villa as part of the Aracne project has great symbolic value. It creates a space-time *continuum* in which the agricultural heart of the villa (the barn) once again becomes the driving force for new economic development linked to silk. The project for 'Atelier Treesure' with an exhibition itinerary to present silk and gold jewellery to clients is a new way of looking at the artistic heritage of these magnificent ancient buildings (the 4,000 Venetian villas in the Veneto region) and of reviving economic activity through the appeal of fashion and luxury.

Keywords: silk heritage, Palladium villa, silk and gold jewels, Treesure, D'orica, Piantata veneta

Multiomics analysis of the Silkworm cocoon shell

By

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Employing phenomics, proteomics, metabolomics and lipidomics, this study identifies the introduction routes and anthropogenic evolution of European silkworm races, a clade of silkworm races with unresolved and obscure ancestry. Prompted by recent findings on the genomic variability that underlies the ancestry and cocoon shell colour of the silkworm, Bombyx mori, we carried out a large-scale analysis of historical and contemporary cocoon shells of this species. By taking our datasets through a series of dimensionality reduction and clustering algorithms, in conjunction with narratives from historical archives that attest to continuous familial interbreeding and constant influx of silkworm races in Europe, we identify three regional hotspots of diversification of these European silkworm races. Furthermore, and in agreement with recent genomic analyses which show an early evolutionary divergence of European silkworm races, we show that these races exhibit human-driven phenotypic innovations, during their domestication in Europe, caused by continuous familial breeding, selection for a limited number of traits and limited regional segregation. Our multiomics datasets provide a valuable foundation for advancing further exploitations of silkworm cocoon shells and show that the European silkworm races are lineages of races that evolved in Central Asia and the Middle East before arriving in Europe and then continuously interbred and improved through introduction of Chinese and Japanese silkworm races.

Keywords: Bombyx mori L., European silkworm races, cocoon phenomics, Silk Road

Fashion and Textile Heritage, Tourism, & Digital Media: research experiences and a roadmap

By

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In the last few years, the links between Fashion and Tourism have attracted a growing attention, not only when it comes to shopping tourism or souvenirs but also highlighting the relevance of fashion and textile heritage for Cultural Tourism.

The outstanding success of *Heavenly Bodies. Fashion and the Catholic Imagination*, the most visited exhibition so far at the MET in New York, with more than 1,6 mio visitors, has led this process, positioning fashion and accessories at the very center of interest of cultural and heritage tourists. Fashion, in fact, provides a very direct and "relatable" access point to approach and understand every culture, from ancient to contemporary ones. The presentation will outline such an itinerary, made of dedicated museums and exhibitions, but also of new tourism experiences and fashion destinations; it will furthermore explore how digital media – which have been playing a major role both in Tourism and in Fashion – are helping to connect both domains and are offering further avenues for interested people to know and understand new fashion-scapes.

In particular, we can position fashion as an integral component of the creative economy, linking it with sustainability, cultural heritage, and destination development. Two primary relationships can be analysed:

1. From tourism to fashion – how travel and cultural interaction influence dress codes, fashion products, and consumer trends.
2. From fashion to tourism – how fashion events, brands, and creative expressions attract visitors and enhance cultural tourism experiences.

Key themes include:

- Fashion as cultural expression: Beyond commerce, fashion embodies identity, heritage, and creativity, contributing to place-making and storytelling.
- Sustainability and ethics: fashion tourism has the potential to promote social, cultural, and environmental sustainability, emphasizing fair trade, intellectual property protection for indigenous communities, and the responsible use of cultural symbols.
- Creative collaboration: Partnerships between designers, artisans, and destination managers can generate innovative tourism products that preserve traditional craftsmanship while embracing digital and technological innovation.

The presented experiences include:

- The analysis of the digital representations by shoe museums, which highlights different levels of integration of Information and communication media
- The creation of digital exhibitions of Google Arts and Culture
- The creation of digital experiences within a fashion exhibition
- The role of uniforms of flagship airlines in providing a dressed welcome to travellers
- The extent to which fashion (heritage) is included within National Tourism Offices' websites in Europe
- The integration of AI to enrich the experience of textile heritage while visiting a destination

Mulberry Germplasm Diversity as a Cornerstone of European Sericulture and Cultural Landscapes

By

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(oral presentation)

This study, conducted within the ARACNE project, presents the results of a comprehensive effort to identify, characterise, and preserve germplasm of old mulberry tree varieties that are essential for both sericulture and future ecosystem services. Mulberry varieties were catalogued across European germplasm collections, with particular focus on those maintained by CREA (Italy), the Vratsa Sericultural Centre (Bulgaria), IMIDA (Spain), and the University of Maribor (Slovenia). Morphological and phenological descriptors were applied to evaluate the diversity of traits among these accessions, providing an overview of available genetic resources. Detailed morphological studies included leaf parameters, shoot and bud descriptors, sexual expression, and analyses of male, female, and polygamous inflorescences, as well as infructescence types. Statistical models were applied to classify accessions using both vegetative and reproductive traits. Comparisons between morphological predictions and genetic classifications showed strong alignment, underscoring the reliability of integrated approaches. Clustering analyses revealed four distinct groups corresponding to *M. alba* s.l., *M. indica* s.l., and *M. rubra* cf., depicting hierarchical genetic relationships. In parallel, a large-scale inventory of old mulberry trees in sericultural regions was conducted using MorusAPP, a digital tool developed for field recording. The application documents taxonomic, morphological, and phytogeographical descriptors, along with historical and cultural information, enabling the mapping of monumental trees as living heritage resources. Genetic analyses using SNP markers were employed to clarify relationships among varieties and to trace the historical dissemination of mulberry from Asia to Western Europe, thereby contributing to the understanding of the species' evolutionary and cultural trajectory. Additionally, pilot activities were initiated to recreate landscapes enriched with mulberry trees. These actions underscore the multifaceted role of mulberries in agroecosystems, ranging from biodiversity support to cultural heritage preservation.

This comprehensive research provides a foundation for conserving mulberry genetic resources in germplasm collections, safeguarding material for sericulture development, and restoring landscapes that embody the ecological and historical value of mulberry trees.

Keywords: Mulberry, *Morus* sp., genetic relationship, germplasm resources, inventory, morphological characteristics, single nucleotide polymorphism SNP markers

Possibilities for collaboration between Japan's tourism and sericulture industries: A case study of the Kagemori Sericulture Farm

By

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(oral presentation)

ABSTRACT:
In recent years, the number of farming households in Japan's sericulture industry has decreased to approximately 130. The aging workforce and shortage of successors in the country have also raised concerns about the industry's sustainability. Nevertheless, younger farmers are engaging in innovative collaboration through participation in tourism activities. This presentation examines the tourism projects developed by Kagemori Sericulture Farm, which is a family-run business that has been in operation for 150 years in Chichibu, a region in Japan with a history of sericulture and silk culture spanning more than 2,000 years. These projects involve collaboration with an apparel brand that consistently integrates sericulture, silk weaving, and design from within Chichibu. Kagemori Sericulture Farm has also participated in the production of a documentary that highlights the current situation of Japan's silk-producing regions and the organization of tours to related production sites. Through these initiatives, this presentation explores the potential of tourism that utilizes the history and cultural heritage to revitalize the sericulture industry.

Keywords: sericulture, tourism, Chichibu, Japan

1. Introduction: Promoting Agricultural Tourism in Japan

Today, Japan's sericulture industry faces the threat of extinction. The number of sericulture households nationwide reached its peak of 2.21 million in 1929, but by 2024, this figure had plummeted to just 134. At the same time, the industry is experiencing rapid aging among its workforce, with more than 60% of main workers aged 70 or older. Furthermore, while Japan had 1,871 silk-reeling factories in operation at its peak in 1959, only seven remained by 2024 (Ministry of Agriculture, Forestry and Fisheries 2025a: 1, 2, 4). Consequently, the long-term sustainability of Japan's silk industry has become a matter of serious concern.

Meanwhile, Japan possesses several cultural heritage sites associated with the silk industry. Especially, the Tomioka Silk Mill in Gunma Prefecture, established in 1872; Takayama-sha

Sericulture School, which conducted educational activities related to sericulture; Tajima Yahei Sericulture Farm, a pioneer in sericulture innovation; and Arafune Cold Storage used for preserving silkworm eggs, were collectively registered as a UNESCO World Heritage site in 2014. Following this designation, the Tomioka Silk Mill attracted 1,337,720 visitors in fiscal year 2014. However, due to the impact of the COVID-19 pandemic, the number of visitors declined sharply to 177,419 in fiscal year 2020, before recovering to 368,919 in fiscal year 2024 (Tomioka City Tourism Association 2025).

In addition to tourism initiatives that make use of cultural heritage, in recent years, opportunities to observe and experience sericulture and silk weaving have been created in each region. For example, in Fukushima Prefecture, sightseeing tours have been organized to communicate with enterprises and workers that continue to preserve traditional sericulture and weaving cultures. These include the Tomita Silkworm Seed Factory in Date City, the only one in the Tohoku region, the silk weaving company known for producing the world's thinnest silk fabric in Kawamata Town, and sericulture farmers in the Iino district in Fukushima City (Enishi Travel 2025).

There are also initiatives for *Nōhaku* (farm stays) in collaboration with sericulture experiences. Specifically, from 2025, an accommodation plan will be offered at Ashizawa Sericulture in Yamanashi Prefecture, one of Japan's largest sericulture farms, where guests can experience sericulture work and enjoy interacting with the local nature, food, and people (TAKEO Inc. 2025).

According to the Ministry of Agriculture, Forestry and Fisheries, *Nōhaku* refers to "rural stay-type travel," in which visitors stay in rural areas and engage in activities and dining experiences that make use of local resources. By providing diverse tourism offerings that incorporate regional assets such as traditional houses, game meat, and rice terraces, *Nōhaku* initiatives aim to promote longer stays and spending. In addition, such initiatives seek to create employment opportunities, ensuring sustainable resources of income, and fostering the development of a *kankei jinkō* (related population), individuals who build ongoing relationships with rural areas and may eventually relocate there (Ministry of Agriculture, Forestry and Fisheries 2025b: 1).

The *Nōhaku* is also attracting attention as a Japanese policy. The total number of guests in *Nōhaku* areas has increased steadily, rising from 1.903 million in fiscal year 2017 to 3.661 million in fiscal year 2018 and 5.892 million in fiscal year 2019. Due to the COVID-19 pandemic, the number dropped significantly to 3.906 million in fiscal year 2020. However, the number has rebounded, reaching 4.483 million in fiscal year 2021, 6.108 million in fiscal year 2022, and 7.942 million in fiscal year 2023. In response to this upward trend, the Japanese government has set a target of 12 million guests by fiscal year 2029, aiming to attract a wider range of visitors, including both international tourists and returning visitors (Ministry of Agriculture, Forestry and Fisheries 2025b: 2).

In order to increase incomes in these rural areas and create a *kankei jinkō*, the Japanese government has implemented comprehensive measures to support *Nōhaku* initiatives. These include strengthening management and operational frameworks, refining local food culture and natural scenery as tourism resources, promoting these areas both domestically and internationally, and encouraging the renovation of traditional houses as accommodations. Specifically, this project has been allocated 7,389 million yen in the fiscal year 2025 budget (Ministry of Agriculture, Forestry and Fisheries 2025b: 4). In this way, large-scale collaborative efforts between the tourism and agriculture industries are being actively promoted across Japan today.

Furthermore, silk industry-related tourism initiatives are also receiving support. Regarding "Tourism Content Creation Support Project to Attract Inbound Local Tourists and Expand Consumption," two of the 800 projects selected in the first public offering for fiscal year 2023 were related to silk cultures. Specifically, these included a promotional project for the "Samurai Silk Night" event, which utilizes the Matsugaoka Reclamation Land, a historic site in Yamagata Prefecture, and another project promoting *Tango Chirimen*, a traditional silk fabric produced in Kyoto Prefecture (The Dainippon Silk Foundation 2025: 16). In recent years, increasing attention has been directed toward revitalizing the history and traditions of Japan's silk industry, with growing efforts to incorporate these regional silk-related resources into tourism content.

2. The History and Current State of the Silk Industry in Chichibu

This presentation examines the case of Kagemori Sericulture Farm, a silkworm-rearing facility located in the Chichibu region of Saitama Prefecture. Saitama Prefecture, situated to the north of Tokyo, has a population of approximately 7.3 million. Chichibu City, located in the western part of Saitama Prefecture, is surrounded by mountains and has a population of around 50,000. It is said that *Chichibuhiko-no-mikoto*, the legendary founder of the Chichibu settlement, introduced sericulture and weaving techniques to the region 2,000 years ago.

Since then, silk culture has taken root in the lives of the people in Chichibu. During the Kamakura period (late 12th to early 14th century), *Negoya silk* was highly acclaimed as "*Negoya* lining," a fabric that gained popularity throughout Japan, including among textile wholesalers in the Kansai region. In the Edo period (early 17th to late 19th century), a thick weave of Chichibu silk was called *Oni-Chichibu* among the people, and it became popular as a stylish and durable silk fabric (Nozawa 2021: 13).

The weaving technique known as *Chichibu Futori* originated from the domestic production of women in sericulture households, who spun and wove with their hands. Although the transmission of this technique was once threatened by the decline in sericulture households, *Chichibu Futori* was designated as an Intangible Cultural Property of Chichibu City in 1996. At present, two weavers continue to preserve and produce this traditional silk fabric.

In addition, the signature silk fabric of Chichibu is the *Chichibu Meisen*. In the early 1900s, a dyeing and weaving technique called *Hogushi-Nassen* was established, enabling craftsmen to print patterns directly onto warp threads and mass-produce patterned textiles. This innovation led to the emergence of *Chichibu Meisen*, a plain-weave silk fabric characterized by its affordability and distinctive modern designs. The fabric gained widespread popularity, particularly among female students in the Kanto region, for its stylish appearance and accessibility.

At present, only three companies continue to produce *Chichibu Meisen*, each pursuing distinctive initiatives to sustain and revitalize the craft. Henmi Orimono, the oldest of the three and a manufacturer of *Chichibu Meisen* for over 100 years, collaborates with Local Vitalization

Cooperators to design new patterns aimed at promoting regional development. Arakei Textile maintains an integrated production system, handling every process in-house from design to weaving. In the field of tourism, Yokoyama Orimono offers *Meisen* weaving classes and hands-on workshops that allow visitors to experience indigo dyeing and weaving. Through these efforts, the three companies are leveraging their respective strengths to preserve and promote the silk culture of the Chichibu region by integrating traditional textile production and tourism-based initiatives.

In Chichibu, sericulture, along with the silk weaving, once formed a key industry that sustained the regional economy. Before World War II, Saitama Prefecture reached its peak annual cocoon production of 23,574 tons in 1939, with more than 8,000 sericulture households in Chichibu (Sano 2006: 79). However, after the war, younger generation increasingly turned away from agriculture, and local production gradually shifted from sericulture to fruit cultivation and other crops. As a result, sericulture lost its position as a core industry in Chichibu. As of 2025, only two sericulture households remain active in the region.

The Kagemori Sericulture Farm's family originally settled in Chichibu approximately 300 years ago and engaged in the rice wholesale trade for generations. They began sericulture about 150 years ago, during the industry's peak, and the current head of the family, Yuhei Kume, represents the fifth generation. The family raises silkworms eight to nine times annually from May to September, feeding them entirely with mulberry leaves from the early larval stage without use of artificial feed.

Generally, sericulture farmers in Japan rear silkworms four times a year to supply cocoons to agricultural cooperatives. However, because the Kagemori Sericulture Farm is able to rear young silkworms independently, they also supply cocoons directly to individual textile craftsmen as well as food and cosmetics companies, thereby establishing a production system to meet each individual's needs. The distribution of Kagemori Sericulture Farm's shipments is as follows: agricultural cooperatives (10%), weavers (50%), and corporations (40%). The farm raises approximately 500,000 silkworms annually, yielding 1 ton of cocoons each year. Kagemori Sericulture Farm has developed independent sales channels to market his cocoons and continued to sustain production.

3. Sericulture and Tourism: A Case of Kagemori Sericulture Farm

Through the social media platforms, they have also received inquiries from tourists interested in observing and experiencing sericulture. Chichibu itself is a well-known tourist destination, celebrated for its rich traditional culture and natural environment. The city hosts the Chichibu Night Festival each December, which has been registered as a UNESCO Intangible Cultural Heritage, and is home to the 2,000-year-old Chichibu Shrine, alongside numerous outdoor activities such as mountain climbing and river rafting. Before the COVID-19 pandemic, the area attracted approximately 6 million visitors annually (Saitama Prefecture 2024). In recent years, a number of startups have emerged to develop tourism initiatives, and Chichibu has become one of the regions actively emphasizing tourism-oriented content.

At Kagemori Sericulture Farm, inquiries regarding tours and hands-on experiences are received through the social media platforms and official website. In addition, new initiatives have emerged that sericulture farmers were not previously directly involved in, such as filming, artistic activities and media. The detailed composition of visitors and the total number of participants are presented in Table 1 below. Furthermore, income from these sources other than cocoon production is approximately 300,000 to 600,000 yen.

Table 1: Tourism-Related Income at Kagemori Sericulture Farm

Category	2024	2025 (Prospects)
Sericulture experience	132	249
Educational Program	6	6
Shooting / Art collaboration	4	2
Media Interview	6	3
Visitors	322	481
Income (Yen)	298,000	571,600

Yuhei Kume, the head of Kagemori Sericulture Farm, joined his family's sericulture business in 2011 and focused on cocoon production until 2023. However, in recent years, the family has sought to monetize its operations by developing experiential programs. As part of its tourism initiatives, Kagemori Sericulture Farm collaborates with educational organizations and local tourism businesses to offer sericulture tours and hands-on workshops that allow participants to learn about the silk production process.

Generally, the program is held during the summer vacation period from July to August, and is targeted at elementary school students. It includes lectures on the history and current state of sericulture in Chichibu, as well as on the various uses of silkworms and cocoons and future developments. During the silkworm-rearing season, participants also have the opportunity to tour the mulberry fields, feed silkworms, assemble a sericulture tool called a *mabushi*, and harvest cocoons. Designed for children experiencing sericulture for the first time, these activities aim to promote an understanding of the history and current state of the sericulture industry, as well as the ecology of silkworms.

Feedback from participants has also been positive, with comments such as, "I love silkworms," "I learned a lot about sericulture," and "I became more interested in the process of sericulture." In this way, some visitors develop a comprehensive understanding of Japanese silk culture through such sericulture experiences and come to regard the process as an attractive tourist activity.

Picture 1: Silkworm Farming Experience
(Provided by Children's Town Project)

At the same time, Kagemori Sericulture Farm has been conducting sericulture workshops in collaboration with REINA IBUKA, an apparel brand based in Chichibu that utilizes silk fabrics made from Kagemori Sericulture's cocoons. The brand was established in 2019 by designer Reina Ibuka, who previously operated a lingerie brand in Paris, France, for over a decade. This brand produces shirts, dresses, jackets, and other apparel for both men and women using traditional Chichibu silk fabrics, including *Chichibu Meisen* and *Chichibu Futori*. In particular, the *Chichibu Futori* fabrics are created through collaboration with a local workshop that draws silk threads directly from cocoons produced at Kagemori Sericulture Farm, enabling direct communication among the sericulture farmers, weavers and designer. In short, REINA IBUKA represents a valuable model of circular manufacturing and local industry collaboration in Chichibu.

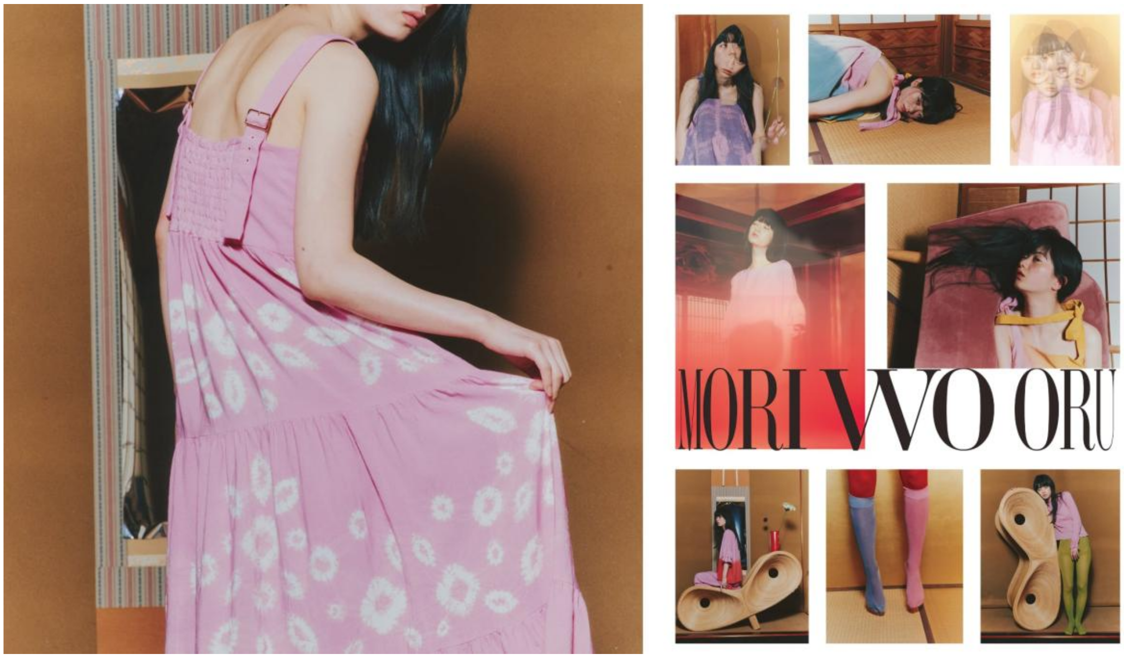
Aiming to convey the process of silk production in Chichibu to consumers, Ibuka has organized events at Kagemori Sericulture Farm that include both a sericulture experience and an exhibition of her latest products since 2023. Participants, ranging from children to adults, can engage in activities such as feeding silkworms and touring mulberry fields, followed by viewing silk fabrics and apparel created by REINA IBUKA using cocoons produced at Kagemori Sericulture Farm. Through this program, visitors can understand the traditional sericulture and circular manufacturing processes.

Picture 2: The Exhibition of REINA IBUKA
(Provided by REINA IBUKA)

4. Reconsider "Made in Japan" through the Transformative Tourism

In addition to its tourism activities within the Chichibu region, Kagemori Sericulture Farm also engages in nationwide collaborations. The Kyoto-based apparel brand MORI WO ORU (weaving the forest) produces fashion items made from Japanese silk fabrics, including *Tango Chirimen* from the town of Tango, located north of Kyoto. MORI WO ORU collaborates with Kagemori Sericulture, the Miyasaka Silk Reeling Co. in Okaya, Nagano Prefecture, and silk-weaving factories in Tango to create products that are entirely "Made in Japan."

As a brand identity, the brand also emphasizes an animism for silkworms, a sensibility that has long been held by Japanese sericulture farmers and silk industry workers. This philosophy is embedded in MORI WO ORU's identity, which reflects the Japanese spirit of craftsmanship, including expressions of gratitude toward silkworms and memorial practices honoring their lives.



Picture 3: Brand Image by MORI WO ORU
(Provided by MORI WO ORU)

MORI WO ORU not only produces and sells products but also conducts workshops on plant dyeing and tie-dyeing using *Tango Chirimen* at its studio in Kyoto. *Tango Chirimen*, a white silk fabric, was first created in 1720 and became firmly established as a regional brand during the Taisho and Showa periods during 20 centuries with the mechanization of production and the founding of the Tango Textile Industrial Association (Kitano 2013: 220). At MORI WO ORU, visitors can create garments and bags made from *Tango Chirimen*, experimenting with their preferred colors and tie-dye patterns. MORI WO ORU seeks to promote greater awareness of Japanese silk cultures such as *Tango Chirimen* and traditional plant-dyeing techniques by offering experiential opportunities for both domestic and international visitors to Kyoto.

In 2025, MORI WO ORU also produced the documentary film *Weaving the Forest*, which explores the manufacturing processes and current state of Japan's silk industry which is now facing the threat of disappearance. The film features Kagemori Sericulture Farm, the Miyasaka Silk Reeling Co., and *Tango Chirimen* weavers. *Weaving the Forest* has been nominated for several international film festivals such as the International Indie Film & Screenplay Festival, contributing to the global recognition of Japan's silk cultures.

Picture 4: A Documentary about Japan's Silk Culture Produced by MORI WO ORU (Provided by MORI WO ORU)

In the future, MORI WO ORU plans to utilize this film to organize tours that enable participants to meet the producers featured in the documentary. Specifically, the tours will include visits to Kagemori Sericulture Farm in Chichibu, a silk-reeling company in Okaya, and silk-weaving workshops in Kyoto. At the same time, MORI WO ORU is planning programs that allow participants to experience traditional spiritual practices, such as visiting local shrines deeply rooted in the region's silk culture.

In Japan, shrines and temples have long embodied *Kuyō* beliefs, rituals of gratitude and memorial offerings for silkworms that perish in the process of silk production. Even today, sericulture farmers continue to participate in these rituals, reflecting an enduring animistic reverence toward silkworms. Thus, they are not merely engaged in the economic production of cocoons but also uphold and transmit a cultural ethos rooted in reverence for life through the spirit of *Kuyō* (Kozawa 2024).

MORI WO ORU embodies the traditions and spiritual culture of Japan's silk industry and collaborates with stakeholders across the silk industry through tourism initiatives. By engaging a wide range of participants, from international tourists and educators to businesses and consumers, it aims to revitalize Japan's silk industry. Furthermore, MORI WO ORU aspires to contribute to the revitalization of people, society, and the natural environment through environmental conservation and job creation. Yumi Komori, the representative of this brand, has emphasized her commitment to the concept of "Transformative Tourism," which fosters personal growth and self-reflection through encounters with local culture, history, and people (Kozawa 2025b).

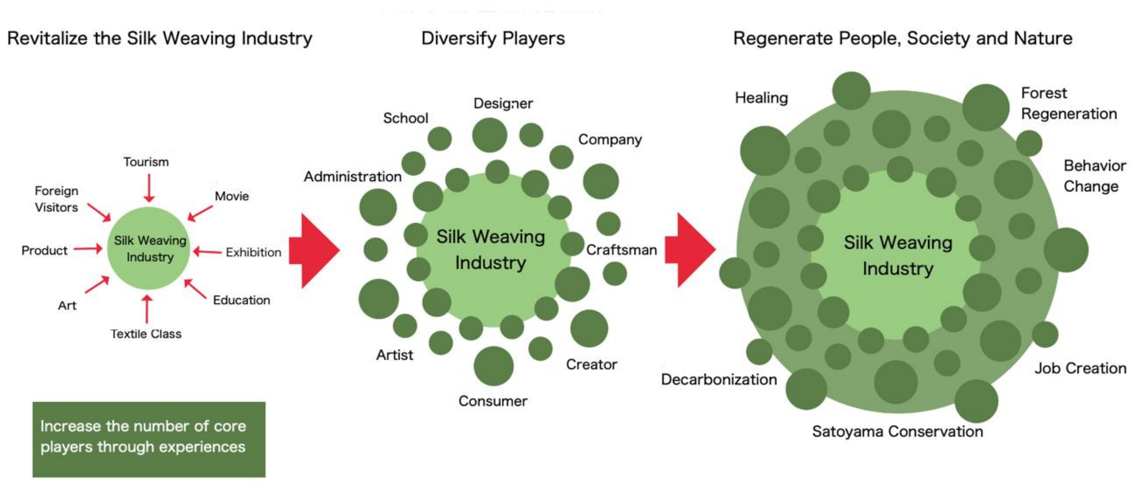


Figure 1: The Process towards Regenerative Manufacturing (Provided by MORI WO ORU)

5. Conclusion: Possibilities to Collaborate between Sericulture and Tourism

As discussed above, Kagemori Sericulture Farm not only produces cocoons but also creates opportunities to communicate the processes and cultural context of silk production through tourism initiatives such as experiential sericulture programs and collaborations with apparel brands. These efforts present an opportunity to reconsider the sustainability of the silk industry, not only within the Chichibu region but across Japan as a whole.

In recent years, Japan has actively promoted sustainable tourism as a tourism strategy. The Japan National Tourism Organization (JNTO) defines sustainable tourism as a framework for protecting and nurturing local environments, cultures, and economies. It aims to contribute to regional development through the conservation of nature and biodiversity, the preservation and transmission of Japan's tangible and intangible cultural heritage, the revitalization of local economies, and the creation of stable and long-term employment opportunities (Japan National Tourism Organization, 2025). In this context, the silk industry can be regarded as particularly well-suited to serve as a distinctive form of sustainable tourism in Japan.

In Europe, ARACNE, an industry–government–academia consortium related to the silk industry, has been established. Utilizing research funding from Horizon Europe, the consortium seeks to explore the interconnections between the cultural heritage of the silk industry and tourism. If Japan were to join Horizon Europe in the future, new possibilities for collaboration between Japan and Europe in the silk industry could emerge (Kozawa 2025a: 53). Tourism, as an activity that fosters interaction among people, the natural environment, and craftsmanship, can offer a valuable opportunity for visitors to understand the current state of the global silk industry and to reimagine the Silk Road in a contemporary context.

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The work of the Mercy Corps Georgia ALCP2 Programme in reviving the silk sector in Georgia

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ABSTRACT:
Since the collapse of the Soviet Union, the culturally significant sericulture sector in Georgia has been devastated due to the absence of a functioning value chain. In 2022, the ALCP2 programme conducted market research and found that rural families, particularly women seeking additional income, were interested in raw silk production. They viewed it as a low-input, seasonal activity with deep cultural roots in Georgian rural tradition. However, the sector’s revival faced many challenges: lack of coordination among scattered stakeholders, lack of access to quality silkworm eggs, limited knowledge and training, inadequate rearing conditions and equipment, and the absence of market opportunities.
Recognizing that the mass-market model of the Soviet era is no longer viable, the programme chose to put effort in reviving sericulture in the spirit of its pre-industrial roots — as a small-scale, artisan-driven craft with strong links to rural tourism.

To achieve this, the programme carried out a series of step-by-step activities, which will be presented in more detail during the presentation:
2023: Pilot Production - Facilitated pilot raw silk production by four families, supported by a hired local sericulture specialist. **2024: Establishment of the Georgian Silk Association (GSA) -** Fifteen women formed a silk farmers initiative group, and then registered the GSA. **Challenging Year -** Despite training for silkworm farmers, and eggs from the Ministry of Environmental Protection and Agriculture of Georgia's Sericulture Lab, the silk crop was decimate by disease, and unfavorable weather conditions. **2025: Respond and Adapt -** The programme redoubled efforts to strengthen civil and private linkages, boost market entry points and secure a sustainable egg supply. **Quality Eggs -** Obtained two new sources of disease resistant silkworm eggs from a local private breeder in Georgia and imported from Bulgaria. **Knowledge Increase -** Hired a sericulture specialist from the Agrarian University and developed Silkworm Rearing Guidelines and simple guidelines and increased training of silk farmers. **Silkworm Rearing Guidelines adopted -** Silkworm Rearing Guidelines have been adopted into the curriculum at the Agrarian University from September 2025. **Technical Capacity -** Helped the GSA to equip silkworm farmers with proper rearing equipment. **Workshops at State Silk Museum -** Helped the GSA to partner with the State Silk Museum, which has been offering a series of workshops in silk crafting to silk producers. **Expanding Social Media Presence -** Facilitated the GSA to create a Facebook Page and supported production of video reports. **Strengthening Rural Value Chains -** Co-financed a local egg supplier to ensure quality egg supply and supported the establishment of a sericulture hub in western Georgia. **Market -** Working with the GSA, facilitated linkages with rural tourism representatives, VET colleges, State Silk Museum, artisans, soap producers, quilt and pillow makers, and private buyers who serve as market for raw silk and crafts. As a result, in 2025 fourteen families and one public school from Kakheti, Imereti, Samegrelo, and Tbilisi have successfully harvested 100 kg raw silk, marking Georgia's first organized silk production in decades.

Keywords: Heritage, Tradition, Rural Tourism

Introduction

Silk production in Georgia has a long and distinguished history dating back to the fifth century, when King Vakhtang Gorgasali introduced silkworm eggs from India. Historical records show that sericulture and silk weaving were practiced for centuries across different regions of the country. By the mid-nineteenth century, during the Imperial Russian period, silk craftsmanship flourished. More than 3,000 domestic looms operated in Eastern Georgia and nearly 1,000 in the Imereti region of Western Georgia, producing a wide variety of silk-based fabrics such as headscarves, quilts, and gloves.

During the Soviet era, particularly during the 1960s, Georgia became one of the leading silk producers in the region. Annual cocoon production reached approximately 4,000 tons, and more than 100,000 rural households were engaged in cocoon rearing, making silk a significant source of income. Following the collapse of the Soviet Union, however, the sector suffered a dramatic decline due to the breakdown of supply chains, loss of expertise, and lack of market opportunities, leaving sericulture on the verge of extinction.

Since 2023, the ALCP2 has been implementing a structured initiative to revive Georgia's traditional silk sector. The first steps included piloting raw silk production and supporting the establishment of the GSA, aimed at organizing and representing the network of silk farmers and artisans.

Through partnerships with academic, cultural, and local actors, including the State Silk Museum and the Sericulture Laboratory of the Agricultural University of Georgia, the initiative helped reconnect traditional sericulture with rural development and tourism, with promising signs of the sector's gradual revival already emerging. By 2025, fourteen families and one public school across several regions successfully harvested a hundred kilograms of raw silk, marking Georgia's first organized silk production in decades and a significant milestone in the revival of this ancient craft.

Recognized since 2018 as part of Georgia's intangible cultural heritage, silk today represents both cultural legacy and renewed opportunity. Its revival reflects a shift toward small-scale, artisan-driven production that connects sustainable rural livelihoods, heritage and innovation, making the intangible tangible.

Sericulture Market Research & Key findings
Major constraints, Drivers, and strategy

Before designing or implementing any intervention, the ALCP2 conducts comprehensive market research to identify key constraints, drivers and opportunities, and leverage points within the market system. Based on these findings, the programme then develops its interventions or entry points. The ALCP2 applies a Market Systems Development (MSD) approach, working with the core market functions as well as the supporting functions and rules that influence them. This ensures that interventions are both sustainable and systemic in nature.
At the time of the research, it was found that since 2007 only a few small-scale cases of silkworm production and use had emerged across the country. These cases, together with focus group discussions with farmers, revealed a clear interest among the rural population, especially women seeking additional seasonal income, in silkworm farming. However, these sporadic efforts had not developed into sustained activity due to gaps and weaknesses across all stages of the value chain.
A key finding of the Sericulture Market Research, later confirmed during the implementation of interventions, was the absence of a functioning value chain. In particular:

Lack of access to quality silkworm eggs – no availability of silkworm eggs for sale in Georgia. A few cases of private breeders producing silkworm eggs were identified, but these were very limited in scale and remained isolated.

Lack of updated applicable knowledge and available training – farmers struggled to maintain optimal rearing conditions, ensure proper feeding, and manage disease effectively, highlighting the need for simple, practical recommendations to guide their daily activities.

Lack of proper silkworm rearing conditions and equipment – lack of proper rearing facilities and inventory which are critical, as silkworms are extremely sensitive and require a carefully controlled environment.

Lack of coordination and linkages among scattered and fragmented sericulture stakeholders – isolation and lack of the necessary connections to initiate or scale sericulture related activities.

Lack of market – the research revealed a lack of market opportunities. Without reliable and regular buyers, farmers see no incentive to produce cocoons beyond a one-time trial.

DRIVERS

The programme identified drivers within the existing system that could be harnessed as incentives and opportunities for development and growth within the silk sector:

Rural tourism and Domestic 'Eco' Markets. A priority of the government for over a decade, though often still largely favourable to investor led developments there was however a growth in the acknowledgement of the importance of locally produced, sustainable/'eco' products reflecting local heritage and well-being as a part of local rural and domestic tourism. Women were often key forces in local guest house and product development and sales for local markets.

Heritage:

The importance of silk in the local and national cultural heritage of Georgia. Held fondly in the living memories of many people remembering the summers in villages and helping feed the silkworms or accompanying mothers and grandmothers to collect eggs or deliver cocoons. Silk also loomed large in the national image, the silk route, the geographical pivot point between west and east.

Social and Media Networks:

Social and online media also provided an opportunity formerly unavailable for scale and connectivity. Hundreds of thousands of women were engaged on Facebook and Instagram, local media TV stations had long been aware of the importance of rurally appropriate content for their audience and were hungry for new stories and the rural sector had seen the growth of rural influencers celebrating Georgian rural culture.

Climate Change:

Rural producers were acutely aware of climate change and the negative impacts on all forms of production, women were proving to be some of the most active proponents of local solutions driven by a desire to continue, celebrate and generate income from traditional livelihoods for their children and communities.

Strategy:

It was clear that the ALCP2 could not hope to resurrect a comprehensive strategy for industrial scale production. What had survived was at the hands of women steeped in their communities, craft and heritage. Crafters and makers of artisanal products such as soaps were interested. A main player still extant was the State Silk Museum and there were remnants of preservation in VET colleges and the Agricultural University. Rural tourism and domestic markets aimed at people wishing to buy eco-products crafted with Georgian materials offered potential entry points.

ALCP2 FACILITATION ACTIVITIES

In 2023, the ALCP2 began facilitating the step-by-step revival of Georgia's long-dormant sericulture sector. The work began with small pilot activities to test local capacity and generate interest among rural women and convene stakeholders, later expanding into sector coordination, organized production, stimulation of the domestic market and other market linkages. Through these efforts, the programme has focused on building the foundations for a self-sustaining silk value chain - supporting farmers and connecting production with heritage-based tourism and domestic markets. The following sections outline the key milestones and results achieved between 2023 and 2025.

Pilot Production in 2023/24

In 2023, the ALCP2 hired a remaining sericulture specialist who had been the manager of one of the last silk cocoon drying facilities in Soviet times and, in collaboration with the Akhmeta Women's Room, identified rural women enthusiasts to pilot raw silk production. Four families from Akhmeta Municipality, Kakheti Region, were provided with five grams of incubated silkworms from a private breeder. All four families successfully produced around ten kilograms of silk cocoons. The trial generated strong motivation among participants and sparked interest from other local farmers, laying the foundation for scaling up in the next season. In 2024 ten families and one school reared five grams of each supplied by the Sate Laboratory but the crop was struck by disease, decimating production, exacerbated by unfavorable weather conditions, including heavy rains and rapid temperature changes.

Establishment of the Georgian Silk Association (GSA)

The Akhmeta case highlighted the need for structured support, both at the farmers' level and within the broader sector to ensure effective services, knowledge and collaboration. In response, with the support of the ALCP2, women silk farmers from Akhmeta established the Georgian Silk Association in June 2024, which serves as an essential support for rural producers wishing to farm silkworms, provide information and training, access to resilient silkworm eggs, production techniques and linkages within the sector and with the media.

2025 Sericulture Season Overview and Impact Highlights

In 2025, the ALCP2 redoubled efforts to secure a sustainable egg supply, strengthen civil and private linkages, boost market entry points. The following summarizes the season's key activities and highlights their impact.

Silkworm Egg Supply

Due to the lack of a sustainable egg supply locally in Georgia for expanded production, the GSA recognized the need to secure alternative sources of quality silkworm eggs. As a result, the programme facilitated the GSA to obtain disease resistant silkworm eggs from two new sources: a local private breeder in Georgia and Bulgaria.

- **Import of silkworm eggs:** With guidance from a sericulture specialist at the Agricultural University of Georgia, the GSA identified Bulgaria as the most reliable source for importing high-quality silkworm eggs[1]. The silkworm eggs were incubated and hatched at the sericulture laboratory of the Agricultural University at the end of April 2025, then reared until their third instar stage at the GSA's facility in Kakheti under the supervision of a local sericulture specialist and then distributed among silkworm farmers.
- **Domestic egg supply:** A private individual who is a silkworm egg and cocoon producer, craft maker, and rural tourism provider with over fifteen years of experience in sericulture, hatched silkworm eggs at her facility, reared them until the second and third instar stages and then distributed among the silkworm farmers. The programme coinvested in her enterprise to expand production in 2025.

Knowledge Increase

One of the challenges of revitalizing the sector is the lack of knowledge and technical skills in silkworm rearing and cocoon production. Farmers struggle with managing optimal rearing conditions, proper feeding, and effective disease control.

Prior to starting the rearing season in 2025, the programme facilitated the GSA to start working on increasing the knowledge of silkworm farmers in silkworm rearing and quality raw silk production. The previous year's season showed, that farmers needed a practical, step-by-step guidance that would help them in everyday activities of rearing. As a result, with the involvement of sericulture specialists, the GSA produced a practical one page brochure *Ten Things to Remember for Silkworm Success* *(See Annex 3)* and *Silkworm Rearing Guidelines*, that were disseminated among silkworm farmers. Alongside these efforts, the GSA organized in-person and online informational meetings and trainings for silkworm farmers and created a Facebook chat group to facilitate easy communication and exchange of questions throughout the entire rearing and raw silk production process.

Mulberry Leaves	The primary source of food for silkworms, essential for their growth and development.
Loppers & Pruners	Tools to cut mulberry shoots and leaves from trees and chop into suitable sizes for feeding silkworms.
Basket And Damp Cloth	To keep mulberry leaves before giving to silkworms.
Mountage Material	Mounting is the process of moving mature silkworms, at the end of the fifth instar, to special structures called mountages where they spin their cocoons. These mountages, whether natural or artificial, should be odorless and are typically placed directly on the feeding beds.
Step Ladder	Equipment to safely reach the upper sections of the silkworm rearing bed.

[1] Supplied by Professor Dr. Panomir Tzenov, director of the Scientific Center on Sericulture, who is also the president of the Black, Caspian Seas and Central Asia Silk Association (BACSA). The Georgian specialist is also serving as Georgia's official representative within the organization.

Figure 1 An Example of Knowledge Provided in the Silk Work Rearing Guidelines: Food and Equipment Needed for Silk Cocoon Production

Technical Capacity

The work in 2023-2024, showed, that as the sericulture sector in Georgia is only now being revived after years of inactivity, most silkworm farmers lacked access to dedicated rearing facilities. In many cases, rearing took place in rooms within farmers' homes, not adequately equipped or designed for optimal silkworm development. Essential tools such as rearing beds, temperature and humidity meters, and proper insulation were often missing.

These conditions are critical, especially as climte change increases unpredicatable or unseasonal weather conditions, as silkworms are extremely sensitive and require a carefully controlled environment. A proper rearing space should be dry, well-lit, clean, well-ventilated, and insulated, with reliable protection against dust, insects, rodents, and birds. Maintaining stable temperature and humidity levels throughout the rearing cycle, approximately forty days, including cocoon harvesting, is essential for producing high-quality cocoons. The ALCP2 facilitated the GSA to equip silkworm farmers with proper rearing equipment and inventory.

Successful Production

As a result, in 2025, fourteen families and one public school, equipped with relevant equipment and knowledge, successfully harvested 100 kg of high-quality silk cocoons, with approximately 80% of the yield coming from the Bulgarian eggs. Production has expanded beyond the Kakheti region and included Imereti, Samegrelo, and Tbilisi. 67% of the cocoons have been sold as raw silk, primarily to the State Silk Museum, the GSA, and private buyers, while the remaining 33% are being used by silkworm farmers to create value added products.

Partnership with the State Silk Museum of Georgia

Technical Skills Transfer

While the aim is not to revive the mass market model of sericulture in Georgia, but rather small scale, artisan driven craft sector tapping into rural tourism markets, it means that silkworm farmers who wish to produce silk and then process it into a more value-added products, need relevant knowledge and skills.

To support silkworm farmers and artisans in developing new skills, the GSA partnered with the State Silk Museum to deliver a series of workshops on silk paper and thread making, natural dyeing, eco-printing, embroidery, design, and product branding. These workshops aimed to enhance both technical and creative capacities, helping participants make their products more marketable. Natural dyeing and eco-printing techniques use renewable plant materials, generate minimal pollution, and are non-toxic, biodegradable, and environmentally safe, while producing rich, distinctive colors and patterns. Forty participants from Tbilisi, Kakheti, Imereti, and Samtskhe-Javakheti regions took part in the workshops.

Akhmeta Silk Fair

With the facilitation of the ALCP2, Georgia held its first-ever Silk Fair on September 20th, in the old silk cocoon drying facility in Atskuri, Akhmeta municipality, Kakheti Region, organized by the Georgian Silk Association and the State Silk Museum with support from Akhmeta Municipality. The event marked a major milestone, the successful revival of raw silk production in three regions of Georgia in the country's first coordinated effort in decades.

The old Soviet-era facility is the only one of its kind still preserved in Georgia out of more than three hundred that once operated across the country. It provided an excellent venue for the fair and the joy and energy of the new guardians of the silk sector in Georgia.More than fifty of participants took part: silk farmers, artisans, scientists, museum curators, educators and rural women entrepreneurs. Local villagers and tourists, enjoyed exhibition stalls showcasing silk, wool, wood, and clay crafts, masterclasses on traditional silk thread making as well as silk and felt crafts were held alongside competitions and traditional songs performed by local ensembles.

The silk sector was always unique in that industrial level manufacturing was fueled by silk produced in rural HH's. The fair was a major step forward in making the intangible tangible again in rural communities in Georgia.

Expanding Social and local Media

Harnessing media has become a powerful part of programme activities, helping to raise awareness and renew public interest in Georgian silk. In January 2025, the ALCP2 supported the GSA in launching its official Facebook page to promote the sector, connect stakeholders, and share information with a wider audience. An influencer film reached over 102K views, while nine online video reports disseminated through local TV channels and their online outlets released since 2024 have gained more than 1.5 million views, generating nostalgic reactions and broad engagement across the country. This growing visibility continues to strengthen recognition of the GSA, attract new stakeholders, and build momentum for the ongoing revival of the silk sector.

Strengthening Rural Value Chains and Market Linkages

A functioning market is the final and most crucial part of the value chain, without which production cannot be sustained. To address this, the ALCP2 has been strengthening connections between the GSA and potential buyers, including VET colleges, the State Silk Museum, artisans, soap producers, and quilt and pillow makers. These linkages play a key role in creating demand for raw silk and building a foundation for a functioning market.

Beyond facilitating the GSA's role as a central coordination and services platform and co investing in the domestic supply of eggs, the programme is supporting domestic market development and stimulation by co-financing private businesses in their production of silk products for the domestic market[2] and encouraging innovation within the sector. To further expand opportunities, the ALCP2 is facilitating the establishment of a sericulture hub in Western Georgia at the Otia's Ezo Museum and a textile enterprise now incorporating silk into its products. Both enterprises also plan to offer

[2] One business is supplying silk masks , bed linen and baby products for the domestic markets as well as providing trainings and masterclasses for local people. Otia's Ezo Museum is building a gift shop and master class space to source and sell silk products from local artisans as well as train them and other people wishing to produce and craft from silk. The museum has thousands of visitors a year.

master classes which are in great demand from local (mainly) women in what is becoming a local and social media-based movement for sustainable heritage-based handicrafts. Together, these efforts aim to create new market outlets for raw silk, stimulate the production of silk-based crafts, and connect rural producers with tourism and creative industries, turning production into sustainable income opportunities.

Conclusion

Reviving a whole sector requires patience, clear vision, and a strong sense of direction. It is easy to become overwhelmed by the many needs and challenges that arise, such as the lack of mulberry plantations or optimal varieties, which is of great importance for the sustainibility of the sector going forward but not currently essential in kick starting production and a market from which to build.

What truly matters is defining a realistic and practical path that is ultimately focussed on a realistic market; in this case the domestic and rural tourism markets largely created and supplied by women handicrafters and artisans, strongly informed by heritage, culture and sustainable communities and environment. By concentrating on achievable, well-sequenced steps, such as stimulating the domestic market, strengthening supporting functions to ensure a sustainable egg supply and farmer knowledge and capacity, and building cohesion among key actors, it becomes possible to lay a strong foundation for future development. This grounded, market-driven approach allows revival efforts to grow steadily and meaningfully over time, driven by a network of market actors who are connected and amplified on social media and are turning traditional knowledge and heritage into living, sustainable opportunities.

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The Current Status and Future Trends of China's Sericulture Industry Development

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ABSTRACT:
Silkworm rearing originated in China. As early as 5,000 to 6,000 years ago, people began cultivating mulberry trees, raising silkworms, extracting silk, and weaving silk fabrics. From the ancient Silk Road to the modern Belt and Road Initiative, sericulture has held an important place in Chinese history and culture. Since the beginning of the 21st century, China has ranked first in global silkworm cocoon production, accounting for over 65% of the world's total output. However, with societal development and shifts in the economic structure, China's sericulture industry has shown a gradual decline. In particular, its share in the eastern regions has decreased, while the western regions have experienced significant growth—an evolution often referred to as the "migration of mulberry cultivation from east to west". Additionally, the sericulture industry is embracing new trends, characterized by diversification. These include the multifunctional use of silkworms, the use of mulberry trees as animal feed, their ecological applications, and their integration into cultural, creative, and tourism industries. Large-scale factory rearing of mature silkworms with artificial diets has also gained momentum. The implementation of such innovations has helped sustain the vitality and continued development of sericulture in China.

Keywords: Sericulture; Diversified Utilization; Desertification; Factory Rearing; Artificial Diet

As one of the oldest agricultural sectors in Chinese history, sericulture can be traced back to the mid Neolithic period, forming a complete system including mulberry tree cultivation, silkworm breeding, silkworm cocoon processing, and other links. The industry had established management systems during the Xia and Shang dynasties, and became a trade link between the East and the West through the Silk Road during the Han dynasty. In the Ming and Qing dynasties, a differentiated technological system was formed between the north and the south. The modern sericulture industry has achieved industrial transfer through the strategy of 'moving from east to west', forming an industrial cluster with the Guangxi Zhuang Autonomous Region as the core in the western region. By 2023, the silkworm cocoon production in Guangxi will account for 84% of the national total.

1. General situation of sericulture development in China

Silkworm breeding originated in China. In 5000 or 6000 years ago, people began to collect mulberry and raise silkworms, take silk and weave silk fabric. The earliest silkworms in ancient times were wild silkworms that lived in mulberry trees. After long-term cultivation and selection from generation to generation, they gradually became silkworm species with good economic value. The development of sericulture has made the textile industry of the China central plains civilization ahead of the world, and also made China a big country in clothing. The beautiful "silk" has spread to western countries through the "Silk Road", and has become a bridge for the prosperity and development of Sino foreign cultural trade. In September, 2009, "Chinese sericulture and silk weaving technology" officially entered the fourth batch of "representative list of human oral and intangible cultural heritage" published by UNESCO. The ancient sericulture will continue to be well preserved and developed in the new era.

In 2024, the overall development of China's sericulture industry showed a trend of decreasing mulberry garden area but increasing seed production and cocoon production. The total area of mulberry gardens in China was **710200 hm²**, a decrease of 34400 hm² or 4.62% over the previous year. Nevertheless, the annual seed production reached **17.9641 million boxes**, an increase of 336000 boxes over the previous year, an increase of 1.91%; The output of silkworm cocoon was **773000 tons**, an increase of 15300 tons over the previous year, an increase of 2.01%.

2. Sericulture development in Zhejiang Province

The sericulture industry in Zhejiang has a long history and profound cultural heritage, and is one of the traditional industries in the province. The cocoon production of Zhejiang province occupies an important position nationwide, mainly due to its advanced sericulture technology and high production efficiency. Zhejiang Province has performed well in terms of cocoon production in 2024. Although the proportion of cocoon production in the eastern region has declined, the cocoon production in Zhejiang Province has increased due to silkworm rearing with artificial diet. In addition, the export of cocoons in Zhejiang Province is mainly "silkworm factory silk", which is mainly sold to India, and the export time is concentrated in the first half of the year.

Since the reform and opening up, Zhejiang Province has actively promoted the development of cocoon industry, formed the trend of large-scale production, and introduced advanced breeding technology and equipment to improve the yield and quality of cocoons. The government encouraged farmers to participate in sericulture production organized by cooperatives or enterprises, widened cocoon sales channels, and further promoted the development of the sericulture industry.

The sericulture industry is mainly concentrated in the Hangzhou Jiaxing and Huzhou Plain and the Ningshao Plain, where the natural conditions such as climate and soil are very suitable for the growth of mulberry trees and the breeding of silkworms. In recent years, with the continuous advancement of technology and the expansion of the market, the sericulture industry in Zhejiang has also been constantly innovating and developing.

The scale of sericulture in Zhejiang Province is large and extensive. Currently, the total area of mulberry orchards in the province exceeds 1 million mu, and the number of breeding households has reached 100000, forming a large-scale breeding pattern.

Zhejiang Province has the highest level of sericulture production in the country, with an annual output of over 100000 tons of silkworm cocoons. The sericulture industry chain in Zhejiang Province is complete, covering mulberry tree planting, silkworm seed breeding, silkworm cocoon production, silk processing and other links

3. Future Trends of China's Sericulture Industry Development

China is the birthplace of sericulture, which has a history of more than 5500 years. From the ancient Silk Road to the Belt and Road today, it occupies an important position. Since the 21st century, China's silkworm cocoon production has been ranked first in the world, accounting for over 65% of the world's total silkworm cocoon production. The development of China's sericulture industry has to some extent influenced the changes in the global sericulture industry. From a domestic perspective, the pattern of the main production areas of China's sericulture industry has undergone profound changes in recent years, mainly due to the significant changes in the two major developments of "moving from the east to the west of sericulture" and "the rise of Guangdong and Guangxi" with the development of society and the advancement of technology, the sericulture industry has expanded from simple sericulture and silk processing to a diversified pattern of sericulture and silk industry. However, in recent years, the sericulture industry has continuously faced severe challenges such as internal contradictions, international competition pressure, competition for alternative products, and practical technology bottlenecks. The development of the sericulture industry urgently needs to be transformed.

4. The traditional knowledge on silk good practices exploitation for cultural, creative industries and touristic aims

4.1 Local silkworm culture activities (Sericulture custom)

For instance, ‘sweeping the silkworm flower field’(a traditional folk custom in Deqing County, Zhejiang Province, is one of the national intangible cultural heritages),‘rolling silkworm flowers’(the folk custom has been circulating for thousands of years, One of the national intangible cultural heritage), etc.

4.2 The ecological and tourism and sightseeing roles of mulberry

The ecological role of mulberry in rocky desertification control and the development of mulberry tourism products (Mulberry fruit picking garden, mulberry juice, mulberry wine, etc.)

Sericulture is an industry with high wealth creation per unit area of cultivated land, with remarkable characteristics of ecological, environmental protection and circular development, and plays a positive role in ecological protection. Mulberry trees possess many desirable properties suitable for phytoremediation, silkworms and by-products can also increase farmers' income. The sericulture has constantly explored the sustainability of coordinated development of economic benefits, ecological benefits and social benefits from the earliest “mulberry fish pond” to the current “mulberry - silkworm - livestock - medicine - mushroom” model. Mulberry trees play multiple roles in the management of rocky desertification. Firstly, the root system of mulberry trees is well-developed, which can block rock fissures, maintain water and soil, and effectively prevent soil erosion and further deterioration of rocky desertification

Secondly, mulberry trees have a wide range of adaptability, are drought resistant and barren, and can grow well in rocky desertification areas, thereby improving the ecological environment

In addition, mulberry trees can also adsorb heavy metals in the soil, improve soil quality, and further promote the restoration and improvement of the ecological environment

Rock desertification is one of the biggest ecological and environmental problems in Guangxi, and the situation of governance is very severe. Mulberry trees, as an economic crop, are widely cultivated in Guangxi and have shown strong biological growth advantages, soil and water conservation, ecological restoration and other ecological advantages in the use of rocky desertification land. They also have the economic advantages of fast investment return and good economic benefits Therefore, in the severe situation of rocky desertification in Guangxi, the utilization of mulberry trees plays an extremely important role,

5. The Development of Large-Scale Factory Rearing with Artificial Diet in China

China's sericulture industry has evolved from traditional silkworm rearing and silk processing into a diversified and integrated sericulture-silk industry. However, in recent years, it has faced a series of serious challenges, including internal structural issues, increasing international competition, the emergence of alternative products, and technological bottlenecks in practical applications. To ensure sustainable growth, the industry urgently requires a strategic transformation and modernization—particularly through innovations such as large-scale factory rearing with artificial diets.

5.1 Rural co-cultivation of small silkworm rearing with artificial diet

The so-called co-breeding of small silkworms with artificial feed is usually done by feeding silkworms with artificial diet at 1-2 instar of age (7-10 days), and then switching to feeding silkworms with mulberry leaves from 3 instar. There are three major benefits to raising silkworms with artificial feed: firstly, it saves labor and time. Traditional silkworms need to be fed with mulberry leaves three times a day at 1-2 instar old, which is 21 times based on 7 days of breeding, while artificial diet rearing only needs to be fed twice, greatly improving labor efficiency; secondly, it reduces the occurrence of silkworm diseases and pesticide poisoning. The environment for raising silkworms with artificial diet rearing is strictly disinfected, and the feed is also sterilized at high temperatures. The factory's feed residue inspection is qualified, and with sterile feeding technology, artificial feed silkworms will not suffer from silkworm diseases and poisoning; thirdly, feeding silkworms with feed at 1-2 instar old can reduce the incidence of tender leaves in mulberry gardens. The picking quantity is to ensure that as many tender leaves as possible grow into mature mulberry leaves, thereby increasing the yield of mulberry leaves by more than 10%.

5.2 Large-Scale Factory Rearing of Full-Age Silkworms Using Artificial Diet

The "China Silk Road Shengzhou – Babe Group Full-Age Artificial Feed Factory Silkworm Breeding Achievement Conference" was recently held in Hangzhou, where Babe Group officially announced to the world that it has successfully overcome the global challenge of full-age, factory-based sericulture using artificial feed.

This pioneering approach involves feeding silkworms with artificial diet throughout all five stages of their development and enables year-round continuous production—a feat with no precedent globally. The Babe team endured hundreds, if not thousands, of failed trials before achieving success. In 2019, the factory-based sericulture project entered mass production. The quality of silk produced meets or exceeds the national 5A standard, with an average daily cocoon output of 90 tons—equivalent to the total annual yield of 600 traditional sericulture farmers.

Today, Babe Group has established a complete industrial chain encompassing "tie manufacturing + industrial sericulture + advanced silk processing." The second-phase silkworm cocoon factory is expected to reach full capacity after just one year of operation, while the third-phase project aims to achieve an annual output of 20,000 tons. This innovation is playing a key role in reversing the long-standing decline of the sericulture industry in Zhejiang Province.

The Chronicles of Wild Silk

By

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The popular narrative on the origin of silk industry centered around the domestication of mulberry silk during the 3rd millennium BCE in the ancient Yellow Empire ruled by the legendary Chinese Emperor, Huang-ti. Silk was kept guarded secret by Chinese for more than 2000 years, By 106 BCE Wu-ti, the mighty Han Empire, for the first time started trading silk with other regions.
The discovery of Muga and Tasar silks from the artefacts of Indus Valley civilization by Irene Good of Harvard University has proved the existence of another type of silk Industry contemporary with the mulberry silk industry. Detailed analysis of three samples of Indus artefacts indicated that the silk fibers are reeled and degummed, confirming the usage of advanced processing technology. The Indus silks are dated between 2200-2450 BCE. These silk materials were also not locally produced as the Muga is endemic to Assam state which is about 3000 kms from Indus regions. The tasar silk producing area located in the northern and central regions of India. These three regions are economically and culturally linked with the divine rivers of ancient India namely; the Indus, Ganges and Brahmaputra. These evidences confirms that the Muga and Tasar silk industry was existing in the neolithic settlements of eastern, northern and central regions of Indian sub-continent by the beginning of 3rd millennium BCE. These silk materials were transacted with Indus regions as well as with the Eurasian civilizations. With the decline of Indus civilization in 1900 BCE, the Indus people moved to southern and northern regions and forming new civilizations by mixing with the local population. Later, the northern and central regions, witnessed a wave of male only migration from Steppe regions (Eurasia) which culminated the evolution of Ancient North Indians (ANI). This civilization laid the foundation for codifying and streamlining the entire human activities, as known to them. This laid the foundation of Hindu culture. The usage of silk that was inherited from the Indus ancestry, continue to reign supreme as a material to be used by royals and temples. Thus, silk has been extensively mentioned in the Indian classics like Vedas, Ramayana, Mahabharata, etc. The newly formed civilizations continue to maintain relations with their Eurasian ancestry and also with the other contemporary settlements outside the sub-continent. Silk was one of the major items transacted with their counterpart nations. As a proof of this, archaeological silks dating 1000-1500 BCE were excavated from the cultural sites of these nations. Of late, many of these artefacts were confirmed as Tasar and Eri silks. Since the mulberry silk has gone out of China only after 106 BCE due to the advent of Mulberry Silk Route, the archeological silk found in Eurasian regions were proved to be originated from the Indian sub-continent. The evidences and events narrated above conclusively confirm this theory. In order to bring credibility to the discovery, the International Sericultural Commission, mapped the Wild Silk Route by linking the regions and the related incidents. This route has been distinctly different from Mulberry Silk Route in terms of the cultural connotations and trade activities. The anthropological and cultural developments that occurred as part of the Wild Silk Route activities have facilitated in synthesizing one of the earliest and mightiest civilizations of the world, namely the Hindu Culture, which continues to be practiced even now by about 15% of the global population.

The popular narrative on the origin of silk industry has been centered around the domestication of mulberry silk during the 3rd millennium BCE in the ancient Yellow Empire ruled by the legendary Chinese Emperor, Huang-ti. His wife, Hsi Ling is considered as the First Sericulturist and worshipped as a Patheon from Shang Dynasty period onwards. Hsi Ling is credited for domesticating the mulberry silkworm and later systematising the production process among the rural folks.

The archaeological evidence of silk found in Liang-chu civilization dating to BCE 2850-2650 corroborate the timeline on the use of silk in the ancient Chinese civilization. The knowledge on mulberry silk industry was kept as a closely guarded secret by the imperial rulers of ancient China for about 2500 years.

Mulberry Silk Route

By 106 BCE Wu-ti, the mighty Han Empire, for the first time started trading silk with other regions. This decision was preceded by the exploits of Zhang Qian, who led a military team to Western frontier in 138 BCE to forge alliance with other nations against the Xiongnu, the Empire's northern hostile neighbour. This military expedition heralded the opening of a trade route, which was later named as the "Silk Route". In the course of time, this route has become a cultural bridge between the East and the West.

Neolithic Wild Silk Industry

The theory on the origin of silk in ancient Chinese empire was well accepted till 2009. However, the discovery of Muga and Tasar silks from the artefacts of Indus Valley civilization, dating to 3rd Millenium BCE, has proved the existence of another type of silk Industry contemporary with the mulberry silk industry. The earliest known archaeological findings of wild silks are the three silk samples obtained from the Indus Valley civilization. As per the work done by I.L. Good et al. (2009), Harvard University, the evidence of the usage of silk in Indus civilization has been revealed very recently. A team of researchers comprising J.M. Kenoyer and R.H. Meadow, the University of Wisconsin in 1999 and 2000, extracted three silk samples from two ornamental artefacts excavated from Harappan sites. The basic information generated on these silk samples are given below:

#	Location	Material	Description	Date (cal)
1	Harappa; inside copper or copper alloy bangle fragment	Silk thread fibres	**S** plied **Z** twist continuous filament of Antheraea assamensis (Muga silkworm)	2200 BCE
2	Harappa; inside copper or copper alloy bangle fragment	Silk thread intact fragment	**S** plied **Z** twist continuous filament of Antheraea assamensis (Muga silkworm)	2200 BCE
3	Chanhu-daro; copper or copper alloy wire ornament	Silk thread	**Z** twist single ply continuous filament of Antheraea mylitta (Tropical Indian Tasar silkworm)	2450 BCE

The careful study of silk samples revealed that the techniques of degumming and reeling for making the thread. This evidence implies that advanced methods of silk extraction synonymous with the Chinese silk industry were already known to Indus people. The type of silk varieties identified in Indus are the Muga silkworm, Antheraea *assamensis*, and the Tropical Indian Tasar silkworms; Antheraea *mylitta.* Both these silk varieties were not produced in Indus region. While the food plants of Tasar (Arjun, Asan, and Sal) are commonly found in the Central and North Indian Forest patches, the Muga silkworm (Antheraea assamensis) is endemic to the Assam State and located in the Eastern part of the Indian subcontinent and far away from the Indus region by about 3000 kms. In all likelihood, the Tasar and Muga silk threads were produced and processed in some of the Neolithic settlements of Central, Northern and Eastern India. These regions were economically and culturally linked with the divine rivers of India namely; the Indus, Ganges and Brahmaputra. These evidences confirms that the Muga and Tasar silk industry industry were existing in the neolithic settlements of eastern, northern and central regions of Indian sub-continent by the beginning of 3rd millennium BCE. Further evidences indicated that these silk materials were transacted with Indus regions as well as with the then prevailing Eurasian civilizations.

Neolithic Wild Tasar Silks

In the South Asian context, the Neolithic period ranges from 7000 to 1000 BCE. There are records of many Neolithic settlements in the Indian sub-continent. These settlements are located in the present-day provinces of Uttar Pradesh, Bihar, Jharkhand, and Chhattisgarh, wherein naturally grown tasar food plants were available in plenty. Since the tasar silk cocoons are generally available naturally in the forest areas, the Neolithic people have collected these cocoons and extracted the threads for making unwoven garments. It appears that they have cooked the hard Tasar cocoons and extracted the silk by unwinding the filament. Since it was practically not possible to transport the cocoons in huge quantities outside the settlements, they have learned and perfected the art of extracting the thread over the years. The Indus people procured these silk threads as part of their trade and cultural relations with other settlements. The Indus people, who were part of the earliest known bronze civilization in the sub-continent, sourced the silk threads for making dress materials of fine quality. This discovery proves that wild silk materials were produced in the Neolithic settlements of the Indian sub-continent during the third millennium BCE or much before.

It is also pertinent to link the references of silk mentioned in some of the Hindu theological texts like Vedas, Ramayana, Mahabharata, etc., from around 1500 BCE onwards. There wild silks were known as "Kausheyah". Please note that the word "silk" was used only after the advent of mulberry silk sourced from China from second century BCE onwards. The striking coincidence observed is that the tasar silk producing areas of the States of Uttar Pradesh, Bihar, Jharkhand, and Chhattisgarh are in fact the earliest settlements of Gangetic civilization. In the course of time, these groups have synthesized as the dominant population of South Asia known as the "Hindu civilization." In short, silk was a locally available material for the ancient Indian people. It evolved as a divine textile material used for adorning the deities and the royals. For the ancient Indian population, the knowledge of silk was transferred through generations from time immemorial. The earliest known period now dated to 2400 BCE through the findings of Indus silk. As estimated by the experts in the field, the silk production process might have existed in the sub-continent much earlier, at least by another 500 years, but hard evidence of which is elusive so far.

The Eurasian Link

With the decline of Indus civilization in 1900 BCE, the Indus valley population moved to southern, northern, and southern regions of the sub-continent and forming new civilizations by mixing with the local population. Later, the northern and central regions witnessed a wave of male only migration from Steppe regions (Eurasian) which culminated the evolution of Ancient North Indian

(ANI) population. This civilization laid the foundation for codifying and streamlining the entire human activities, as known to them, who are later known as Hindus. The usage of silk that was inherited from the Indus ancestry, continue to reign supreme as a material to be used by royals and temples. Thus, silk has been extensively mentioned in the Indian classics like Vedas, Ramayana, Mahabharata, etc.

The newly formed civilizations continue to maintain relations with their Eurasian ancestry and also with the other contemporary settlements outside the sub-continent. Silk was one of the major items transacted with their counterpart nations. As a proof of this, archaeological silks dating 1000-1500 BCE were excavated from the cultural sites of these nations. Of late, many of these artefacts were confirmed as Tasar and Eri silks. Since the mulberry silk has gone out of China only after 106 BCE due to the advent of Mulberry Silk Route, the archeological silk found in Eurasian regions were proved to be originated from the Indian sub-continent. The evidences and events narrated above conclusively confirm this theory.

Wild Silk Route

The archaeological evidence and textual references indicate that the mulberry silk spread to the Eurasian region only after the advent of the Silk Route (Second century BCE). On the other hand, the excavation of wild silks in the Indus region, the elaborate textual reference to wild silks in the ancient Hindu texts, and other circumstantial evidence establish the existence of an independent wild silk industry in the Indian sub-continent during the Neolithic period itself (3rd Millennium BCE.

While tracing the map of wild silks, it is observed that there were strong trade and cultural relationship existed among these civilizations due to the exchange of resources and materials. Considering these factors, the ISC named this ancient path as the **"Wild Silk Route**." This route has been distinctly different from Mulberry Silk Route in terms of the cultural connotations and trade activities. The anthropological and cultural developments that occurred as part of the Wild Silk Route activities have facilitated in synthesising one of the earliest and mightiest civilizations of the world, namely the **Hindu Culture**, which continues to be practised even now by about 15% of the global population.

Mapping Wild Silk Route

As explained above, the wild silks were extracted for commercial use in the Neolithic settlements of the eastern, northern, and central parts of the Indian sub-continent. These areas were part of the Ganges and Brahmaputra river banks, starting from the eastern region of the subcontinent and extending up to the Indus valley cultural settlements, somewhere in the foothills of the Himalayas. The people living in these three major river valley civilizations were considered as the Neolithic phase of Indian culture. Thus the Wild Silk Route starts from Kamrup, the lower Assam region of eastern India that mentioned as the *"Kosha-Karanam-bhumi"* which translates as the country of cocoon rearers, in the ancient Hindu epic, Ramayana. It is important to note that Muga silk is endemic to this region. The adoption of improved production processes like; degumming and reeling to extract the silk indicates the existence of advanced civilization in the area. The Muga silk produced in the east was traded with Tasar silk among the Neolithic settlements of the Ganges River valley.

While moving to the central part of India, the Neolithic settlements of Chirand in Bihar, Koldiwa, Mahagara, and Sohgaura in Uttar Pradesh produced the Tasar silk. A few more Neolithic settlements in Madhya Pradesh, Chhattisgarh, and Uttarakhand might have also been producing Tasar silk.

There was close economic and trade relationship between the Indus valley and Neolithic Ganges and Brahmaputra civilizations, primarily due to the cultural similarities. Because of this, the Tasar and Muga silks were transacted extensively among them. The trade route developed was through the settlements of the river Ganges till the foothills of the Himalayas that are quite near to the northern periphery of the Indus valley civilization. The bonhomie that existed among these three civilizations has helped the Indus people shift their settlements by around 1900 BCE to the north and eastern part of India because of the climate changes occurred in the Indus river valley region. Thus, the Wild Silk Route starts from the Brahmaputra valley area in lower Assam, passes through the Gangetic settlements and reaches in the Indus valley cultural areas. This path is categorised as the first phase of the Wild Silk Route.

The 2nd phase of the Wild Silk Route originated because of the cultural and trade connection established between the Indus valley civilization and their contemporary civilizations in Egypt and Mesopotamia. Indus seals were excavated from Egypt, Mesopotamia, and a few other Neolithic settlements of Europe. Archaeological silks were also excavated from the historical sites, the details of which are given in Table I. Consequently, the 2nd phase of the Wild Silk Route is mapped from Harappa to Iran (Elamite state), Iraq (Babylon), Egypt, Turkey (Anatolia), Greece (Minoan civilization), Italy (The Etruscans civilization), Germany, and Luxembourg. Due to this, a solid cultural and trade connection between the Pacific nations and the sub-continent was established sometime from 2000 BCE onwards. These relations have greatly helped the regions to exchange knowledge and resources hitherto unknown to them. These cultural connotations could be traced from their cultures, languages, scriptures, and way of life.

Further, the migration of male population from Steppe region to the northern part of India from around 1500 BCE onwards signals the establishment of the 3rd phase of Wild Silk Route. This migration was due to the quest of Steppe population to get access to precious materials and resources from other settlements. Before the Steppe's arrival, the Ganges region was evolved as an advanced civilization due to the merging of migrated Indus and local populations. The Steppe migration and the subsequent genetic mixing with the local populace further fuelled the technological and cultural momentum, which heralded the evolution of Vedic and the Hindu culture. The movement of people among the Steppe and Indian sub-continent and the regions along the route intensified after that. This movement of people has resulted in establishing a trade and cultural route. This path is the 3rd phase of the Wild Silk Route. Silk was one of the commodities that got exchanged along the route. It is pertinent to note that archaeological silks were extracted from a few of the countries along the route, as indicated in the **Table I--.** The connected areas in the route are; the ancient settlements of Afghanistan, Samarkand, Bukhara (Uzbekistan), Kazakhstan, Turkmenistan, and Anatolia (Turkey).

The Book "The Chronicles"

The contents of this article has been extracted from the book "The Chronicles" which was published by ISC in 2022. The Book narrates history and incidents related to mulberry and wild silk industry starting from origin, development and its travel through all most all civilizations of the world. The Book is prepared in two parts; first is the Chronicles of Silk and second part is the collection of silk products from more than 35 countries. The entire contents are spread out in 450 pages supported by high resolution images and concise descriptions. Interested persons may get a copy of the book by sending a mail to iscbangalore@inserco.org

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Table 1.
Archaeological silks excavated in the historical sites of few countries dating to-1000 to 1500 BCE

#	Location/Country	#	Location/Country	#	Location/Country
1	Altier, Lexumberg	7	Gordion, Turkey	13	Loulan, Xinjian
2	Hoch Michele, Germany	8	Toprak Kale, Turkey	14	Lop Nor, Xinjian
3	Hochdorf, Germany	9	Capelli Tepe, Uzbekistan	15	Edson Gol
4	Chiusi, Italy	10	Niya, Xinjian	16	Deir al Medina, Egypt
5	Kerameikos, Greece	11	Pazyryk, Kazakhstan	17	Noin Ula, Mongolia
6	Sardis, Turkey	12	Ukok, Siberia	18	Nevada, India

An Examination of Turkey's Silk Heritage: Museums, Traditional Production Centers, and Silk Textile Products

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(oral presentation)

ABSTRACT:
Throughout history, Turkey has been an important center for silk production and trade due to its location on the Silk Road. Koza Han in Bursa was built in 1491 by Ottoman Sultan Bayezid II. During that period, it served as one of the most significant centers of Silk Road trade in Anatolia. Today, it continues to thrive as a cultural and touristic site, offering silk products, handicrafts, and a preserved historical ambiance. The Hereke Imperial Factory (Hereke Fabrika-i Hümayun) was founded in 1843 during the reign of Ottoman Sultan Abdülmecid, in the town of Hereke. The Silk Museums were established to preserve this heritage and to highlight the cultural and economic value of Turkish silk traditions. Today, silk cottage industries still play an important role in the socio-economic balance by providing income opportunities for disadvantaged women living in rural and suburban areas of Turkey. **Hereke Silk Carpets (Hereke Fabrika-i Hümayun:** Especially, the handmade silk carpets of Hereke, which are found in many royal palaces around the world, reflect the elegance and sophistication of Turkish silk craftsmanship. In modern times, the Hereke Silk / Carpet / Weaving Factory falls under the protection of institutions such as the National Palaces. The Hereke Silk Carpet Factory and Museum is open to visitors. Visitors can

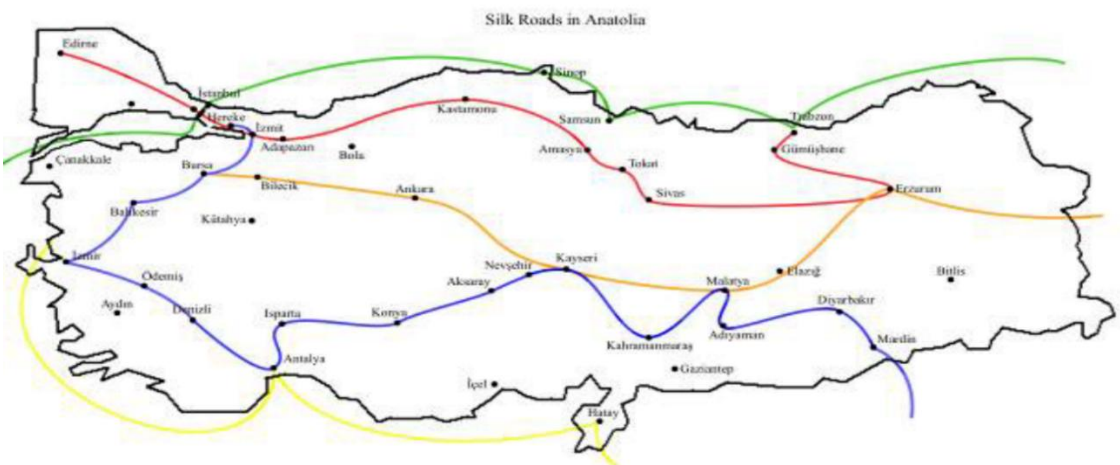
see traditional silk weaving techniques, original looms, and exhibitions showcasing the famous Hereke silk carpets. **Bursa Merinos Textile and Industry Museum and the Preservation of Sericulture Tradition** The Bursa Silk Museum was opened in 2013 by Bursa Metropolitan Municipality. Its purpose is to document the history of silk production in Bursa, transmit sericulture knowledge, and offer visitors an educational experience. **Exhibition of Silk Textile Products**: One of the highlights of the museum is the "Silk Products Gallery." In this section: weaving looms, sample fabrics, and handwoven silk garments from Bursa are is played. **Connections with Local Sericulture Activities:** The museum collaborates with Kozabirlik, universities, and local silk producers to support regional sericulture. **Financing and Sustainability:** The museum is financed through municipal funds, ticket revenues, souvenir sales, and EU-supported projects. **Silk Reeling and Weaving Demonstrations**: In the promotional activities of Museum and Umurbey Silk Production and Design Center, it is stated that visitors can experience the silk production process live on weekdays. **Development Strategy:** The museum's goals include creating digital exhibitions, establishing educational partnerships, and joining international networks. **Bursa City Museum Establishment:** The Bursa City Museum was opened on February14 2004 by the Bursa Metropolitan Municipality. It is recognized as one of the first contemporary city museums in Turkey, founded with the mission of preserving the "memory of the city". **Silk and Textile Exhibits:** The museum features a dedicated section on Bursa's silk and textile heritage, emphasizing the city's historical role as the "City of Silk." The displays include Ottoman-era silk fabrics, traditional Bursa weaves such as kemha, seraser, and velvet, old weaving looms. **Umurbey Silk Production and Design Center** İt was established in 2015 by the Bursa Metropolitan Municipality as part of the "Bursa Silk Re-Life" project. **Function and Structure:** The center aims to preserve and revitalize silk production, combining traditional craftsmanship with design innovation. **Training / Courses:** Held through BUSMEK, with topics like silk design, traditional weaving, accessory making. (BUSMEK = Bursa Municipality Art and Vocational Courses. **Hatay_ Antakya museums and businesses producing silk products** Antakya, has historically been an important center for silk production and trade. In Antakya, sericulture was closely linked to traditional handicrafts; the city became known for handwoven silk fabrics, scarves, and shawls produced on traditional looms. Some of the organizations currently operating in this field are listed below. **The Handicrafts Museum (El Sanatları Müzesi)** in Antakya, opened in a restored historic house by the municipality, exhibits traditional handicraft works including silk weaving, batik. **Defne Magnanery (Silk House)** is a vocational training center established to revive sericulture. It offers training to women in cocoon production, silk reeling, and silk processing techniques. **Yılmaz Silkworks (Yılmaz İpekçilik)** is a family business founded in 1950 by Hasan Büyükaşık. They produce cocoons and hand-woven silk products (silk shawls, textiles, etc.) in Antakya.

Keywords: silk museums, local silk handcraft, creative industries, sericulture

Chapter 1. Introduction

Turkey has a very long tradition and a huge market potential for local silk handicraft and silk carpets, and an increasing opportunity to export them abroad Throughout history,

The introduction of the silkworm and silk to Anatolia took place in 552 A.D. During the Byzantine and Ottoman periods, had started to spread beginning with the Marmara region. Anatolia occupied an important position along the historical Silk Road and greatly benefited from the advantages and prosperity brought by international trade, Bursa had been an importand center for both silk trade and silk woven fabric production.



Figüre 1. Silk Road İn Anatolia

Although sericulture in our country has experienced periods of rise and decline, it has continued to maintain its status as a traditional form of production, possessing national, historical, cultural, and economic value.Today, sericulture continues to create employment through production, reeling, twisting, dyeing, textile, and silk carpet weaving, generating up to fourteen times added value from raw cocoons to finished products..

Given the precious experience of traditional silkworm handicraft and weaving like needle art, beading, edging embroidery and silk carpet waeving, the industry still has a room to expand. Today, handcrafting is supported by many local governments, like Bursa and Diyarbakır. Recently, 216 looms were distributed for carpet weaving and employment opportunities were provided for young women in the rural areas. However, despite the growth potential for silk made products, local cocoon and silk production is not sufficient to meet the demand, even today.

Today, the continuation of traditional silk production is highly important for preserving Turkey's cultural heritage and supporting the local economy. This craftsmanship keeps traditional handweaving alive, creates employment, and strengthens income sources, especially for women in rural areas. In addition, it contributes to tourism and export revenues through unique and high-quality silk products.

Chapter 2. Silk Background Handcraft Cottage İndustries İn The Past

Silk cottage industries were first established in Turkey during the 14th Century, and developed in a short time and to become world famous. With a policy to relive from dependancy to Iran, first sericulture was started at Bursa in 1587.Anatolia had became an important centre for the silkroad and a magical city Bursa started to become the capital of silkworm for the middle east in the silkworm history. During Ottoman Empire silk was important material because of three processes which are producing cocoons, filature,and textile

.The first silk mill was opened in Bursa by Konstanz Bey in 1833, and a second by Boduryan Efendi in 1843. The Hereke Imperial Factory (Hereke Fabrika-i Hümayun) was founded in 1843 during the reign of Ottoman Sultan Abdülmecid, in the town of Hereke.

Especially three different types of materials in this century as ‘Kadifa, Kemha and Tafta’ were wowen in Bursa and these were sought after in European countries, Iran and even China. The silk processing plants in Bursa and İzmit had reached a total of 85 until the year 1860.

Chepter 3. Museums, Traditional Production Centers, And Silk Textile Products

3.1.Kozahan.

Kozahan was the most important silk road center in Bursa. Koza Han was built between 1490 and 1491 by Sultan Bayezid II to provide income for his complex (külliye) in Istanbul.During the Ottoman period, Bursa was an important center for silk production and trade. Not only textile manufacturing but also the trade of silk cocoons, known as “koza”, was actively carried out here. Bursa’s historic Koza Han continues to be a central hub for traditional silk production today. The shops there produce and offer handwoven silk fabrics, scarves, and other traditional products to visitors. This production contributes to the preservation of Turkey’s cultural heritage, supports the local economy, and provides vital income opportunities, especially for women in rural areas. Koza Han offers a unique shopping and cultural experience for both domestic and international tourists.

Figüre 2. In the past, In Koza Han, local silk producers used to sell raw silk cocoons

Figüre 3. Today, Koza Han continues to thrive as a cultural and touristic site, offering silk products, handicrafts

Figüre 4. Shops selling silk textile products in Koza Han.

Chapter 3.2. The Silk Museums

The Silk Museums were established to preserve this heritage and to highlight the cultural and economic value of Turkish silk traditions. Today, silk cottage industries still play an important role in the socio-economic balance by providing income opportunities for disadvantaged women living in rural and suburban areas of Turkey. Especially, the handmade silk carpets of Hereke, which are found in many royal palaces around the world, reflect the elegance and sophistication of Turkish silk craftsmanship.

3.2.1. The Hereke Imperial Factory (Hereke Fabrika-İ Hümayun)

It was founded in 1843 during the reign of Ottoman Sultan Abdülmecid, in the town of Hereke and In modern times, Hereke Silk / Carpet / Weaving Factory falls under the protection of institution such as the National Palaces and functions as a heritage factory / museum as well as a production center. Its initial mission was to produce the textiles, upholstery, curtains, and carpets for the Ottoman palaces.

In modern times,Hereke Silk / Carpet / Weaving Factory falls under the protection of institutions such as the National Palaces (Milli Saraylar) and functions as a heritage factory / museum as well as a production center.

Manufacturing & Technical Aspects

Silk yarn is a primary material in Hereke carpet production. Jakar (Jacquard) looms were imported and used, allowing intricate pattern weaving.Carpets are generally woven using double knots (Turkish / Ghiordes knots). Hereke quality” is assessed by high knot density, fine yarn, crisp pattern transitions, low pile height, and a well-formed backing.

Products & Characteristics

The main product is Hereke silk carpet. These can be used as floor coverings or decorative wall hangings. The main product is Hereke silk carpet. Production is largely handmade.

These can be used as floor coverings or decorative wall hangings. The quality depends heavily on the purity of the silk, knot density, pile height, and overall craftsmanship. These carpets have been exhibited in international fairs They are collector’s items, designed for decorative, museum, palace or elite use.

Challenges & Preservation

Maintaining the traditional craft demands highly skilled artisans, expensive raw materials, and institutional support. Fake “Hereke” carpets are common; to authenticate one examines the back (weft/warp), knot consistency, pattern alignment, and material quality.

Figüre 5. Hereke silk carpet is weaving

Figüre 6. Hereke Silk Carpet

3.2.2.Bursa Silk Museum And The Preservation Of Sericulture Tradition İn Turkey

The Bursa Silk Museum is an important institution preserving Turkey's silk heritage. Through its links with local production, tourism, and creative industries, it carries the sericulture tradition into the future.

History and Objectives

The museum was created to preserve the industrial heritage of the Merinos Wool Factory founded in 1938 upon the initiative of Mustafa Kemal Atatürk as one of the first major textile plants of the Turkish Republic. Today, part of this historic factory complex has been restored and transformed into a museum that showcases both silk and wool weaving traditions.

The Bursa Silk Museum was opened in 2013 by Bursa Metropolitan Municipality. Its purpose is to document the history of silk production in Bursa, transmit sericulture knowledge, and offer visitors an educational experience.

Connections with Local Sericulture Activities

The museum collaborates with Kozabirlik, universities, and local silk producers to support regional sericulture. It also organizes joint activities with traditional

Collection and Exhibitions

The museum's collection includes historical silk fabrics, looms, silkworm cocoons, traditional garments, and modern design items. Visitors can experience the production process through interactive panels and live weaving demonstrations.

Financing and Sustainability

The museum is financed through municipal funds, ticket revenues, souvenir sales, and EU-supported projects. It also collaborates with creative industries such as fashion and design.

Development Strategy

The museum's goals include creating digital exhibitions, establishing educational partnerships, and joining international networks. It also aims to strengthen the 'Bursa Silk' brand. Through its links with local production, tourism, and creative industries, it carries the sericulture tradition into the future.

3.3.3. Bursa City Museum:

It is recognized as one of the first contemporary city museums in Turkey, founded with the mission of preserving the "memory of the city." The museum focuses on Bursa's historical evolution, economic and social life, and especially its traditional crafts and pioneering textile and silk production.

Establishment

The Bursa City Museum was opened on February 14,2004 by the Bursa Metropolitan Municipality. It is recognized as one of the first contemporary city museums in Turkey, founded with the mission of preserving the "memory of the city"Especially its traditional crafts and pioneering textile and silk production. Information panels describe the history of silk production, famous artisans, and the role of silk trade in Bursa's economic history.

Silk and Textile Exhibits:

The museum features a dedicated section on Bursa's silk and textile heritage, a silk fabrics,Traditional Bursa weaves such as kemha, seraser, and velvet, Old weaving looms and silk production tools, Samples from the Republican-period textile ındustry, The exhibition also highlights the city's connection with Kozahan and Umurbey Silk Production Centers, underlining silk as both an economic resource and a symbol of cultural identity.

In the "Crafts Bazaar" section, the traditional crafts of Bursa, including silk weaving and dyeing, are displayed with lifelike reconstructions.Information panels describe the history of silk production, famous artisans, and the role of silk trade in Bursa's economic history.

Financing and Administration

The restoration, organization, and operation of the museum were financed by the budget of Bursa Metropolitan Municipality, through its Department of Culture and Tourism.The museum continues to operate under the municipality's management.Occasionally, private sponsors and local cultural organizations contribute to temporary exhibitions and educational projects.

Visitors can see traditional silk clothing, shawls, and decorative fabrics made with authentic Bursa silk offer visitors an educational experience.-The entire silk production process—from silkworm cocoon to finished fabric—is explained through visual and interactive displays.

Connections with Local Sericulture Activities

The museum collaborates with Kozabirlik, Universities, and local silk producers to support regional sericulture. It also organizes joint activities with traditional centers such as Koza Han and Cumalıkızık Village.

3.3.4. Umurbey Silk Production And Design Center

İt was established in 2015 by the Bursa Metropolitan Municipality as part of the "Bursa Silk Re-Life" Project. Founded by the Metropolitan Municipality to revive traditional silk production; it demonstrates all stages from cocoon to fabric and hosts exhibitions of modern silk designs.

The center aims to preserve and revitalize silk production, combining traditional craftsmanship with design innovation. From raw silk to fabric, production is carried out on traditional weaving looms at this center. In addition, Silk fabrics and carpets are created with unique motifs and designs, combining historical roots with a modern design . Key components:

Exhibition / Promotional Areas: Spaces for showcasing the history of Bursa silk; display of samples and finished products.
Weaving Workshops & Looms: Use of traditional looms, including dobby-Jacquard-type looms, for weaving silk fabrics with Ottoman period motifs.
Design Workshop: Pattern making, integrating traditional ornamentation with newer designs.
Rural Workshops: Allied workshops in various villages, extending production and training beyond the main center.
Training / Courses: Held through BUSMEK, with topics like silk design, traditional weaving, accessory making. (BUSMEK_= Bursa Municipality Art and Vocational Courses).
Umurbey Silk Production and Design Center Products
→ Pure silk fabrics woven on handlooms, produced with traditional Bursa silk weaving 1techniques. Used in fashion design, home textiles, and artistic products.
→Scarves and shawls woven from natural silk yarn, featuring hand-dyed or printed patterns. Combine classical Bursa motifs with modern designs.
Silk Ties and Accessories Elegant→silk ties, pocket squares, and fashion accessories with refined patterns.
Silk Home Textile Products:→Decorative home textile products such as pillow covers, tablecloths, curtains, and wall panels.
Cocoon Art Products → Decorative objects such as flowers, panels, and ornaments made from silkworm cocoons. It is also demonstrated to visitors in a practical way during training workshops.


Figüre 7. Silk Scarve **Figüre 8. Carpet Weaving**

3.3.5.Hatay Antakya Museums And Businesses Producing Silk Products
Silk production in Hatay is a deep-rooted tradition, with a long history of silkworm cultivation and weaving. Weaving looms operate mainly on a household or small workshop scale; feeding, cocoon production, yarn processing, and weaving form a continuous chain of production.

Antakya, located in (Hatay) has historically been an important center for silk production and trade. In Antakya, sericulture was closely linked to traditional handicrafts; the city became known for handwoven silk fabrics, scarves, and shawls produced on traditional looms.

Today, silk textile production continues on a smaller scale, but local workshops and producers strive to preserve traditional techniques. Some of the organizations currently operating in this field are listed below.;

The Handicrafts Museum (El Sanatları Müzesi) in Antakya,opened in a restored historic house by the municipality, exhibits traditional handicraft works including silk weaving, batik.

The Defne district (Harbiye neighborhood), the Defne Magnanery (Silk House) is a vocational training center established to revive sericulture. It offers training to women in cocoon production, silk reeling, and silk processing techniques.

Yılmaz Silkworks (Yılmaz İpekçilik) is a family business founded in 1950 by Hasan Büyükaşık. They produce cocoons and hand-woven silk products (silk shawls, textiles, etc.) in Antakya.

Figüre 9. Silk fabric produced from Hatay yellow cocons

3.3.6. Also Among Traditional Turkish Handicrafts; Embroidery İs Very İmportant.

Weaving is a handicraft which has been practiced in Anatolia for many years and considered as a mean of earning a livelihood.Embroidery, a unique example of Turkish handicrafts, is not only used for decoration but also as a means of communication tool with the symbolism in its designs.

Today, embroiderymade with tools such as the crochet needle, needle, shuttle and hairpin designed either as aborder or motif, and goes by different names according to the implement used and the technique.

These include; needle, crochet needle, shuttle, hairpin, silk cocoon, wool, candle stick, bead and left-over cloth. Embroidery is generally seen in the provinces of Kastamonu, Bursa, Bitlis, Gazi Antep, İzmir, Ankara, Bolu, Kahramanmaraş, Aydõn, İçel,Tokat and Kütahya, although it is gradually losing importanceand becoming restricted totrousseau chests. Below are examples;

Oya (edging embroidery)

It is one of the most elegant examples of Turkish handicrafts. Oya is the name of ornamentation knitted by a colored thread in the shape of a leaf or flower," "Oya is a kind of lacework. It is characteristic of Turkey.

Cocoon Embroidery

The materials used in cocoon embroidery are pieces of cocoon and silk. The main decorative elements are made with cocoons, and then parts knitted with pins or hooked needles are added to the cocoons.

Needle embroidery
It is known as “Turkish lace and does, indeed, resemble lacework at first sight. Silk is the material most generally used for needle embroidery. The invention and development of needle embroidery is largely the result of Anatolia’s being on the Silk Road and having its own silk production.

Conclusion: Silk museums can build a bridge between traditional knowledge and modern creative industries. Integrating the Museums with fashion, design, and tourism will support cultural sustainability. The Silk Museums are an important institution preserving Turkey’s silk heritage. Through its links with local production, tourism, and creative industriesThet carrie the sericulture tradition into the future.

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Silkworm Gene Pool and its Significance in the Revival of Georgian Silk

By

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(oral presentation)

Biological resources are the main value of the planet, they unite the whole world of plants and animals, including sericulture, about which a lot of materials are presented and on the basis of which Georgian silk was given the status of intangible cultural heritage in 2018. Sericulture is the oldest branch of Georgian agriculture, which is rightfully considered the best example of the cultural heritage of the nation. According to the latest scientific research, silk fibers were discovered in the tomb dating the 4th century BC, which indicates the existance of developed sericulture in Georgia in the 4th century BC, that is, 2 centuries before the Great Silk Road passed through Georgia. The silkworm gene pool of Georgia is divided into two parts: varieties obtained by folk selection and varieties obtained by scientific selection. Varieties obtained by folk selection, due to their high fertility, are still kept in the collection as breeding material. They served as the basis for the breeding of subsequent varieties: Tbilniish-1, Tbilniish-2, Kolkhida, Imereti, Kakheti, Kartli, Tbilniish-3 and their hybrids (S. Gvinepadze, 1953). In Georgia, the breeding of silkworm breeds by scientific selection began in 1940. Since 1942, more than 50 breeds of silkworm have been bred. The presence of the gene pool and its preservation is important, as it is the basis for the creation of new breeds.

Keywords: Mulberry silkworm, Genetic fund, breeds, Georgian silk

"Indo-Bulgarian Collaboration": A Productive bivoltine silkworm hybrid for Indian Sericulture

By

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(oral presentation)

An Indo-Bulgarian collaboration in silkworm breeding with Sericulture Experiment Station, Vratza, Bulgaria and Central Sericultural Research and Training Institute, Central Silk Board, Mysore was initiated during 2016-17. Five silkworm genotypes and two hybrids were exchanged from each side through Material Transfer Agreement (MTA). Utilizing Indian and Bulgarian genetic resources, seven oval lines viz., BMO1, BMD2, BMO6, BMO8, BMO9, BM010 and BMO11 and five new dumbbell lines viz., BMD1, BMD2, BMD3, BMD4 and BMD5were developed. These lines and Indian silkworm breeds were used to develop 110 oval and 60 dumbbell foundation crosses, which were hybridized into 488 combinations. Among these, two double hybrids (BFC 1 x BFC10) and (BFC25 x BFC11) emerged as top performers, showing superior rearing traits such as high survival rate (>90), shell percentages up to 24.0, and low renditta values as low as 5.50. These hybrids were undergone preliminary trial at government farms and limited trial at farmers' level. Based on performance, BFC1 x BFC10 was selected as best performer and currently the hybrid is under authorization trial with five lakhs dfls covering major sericulture states of India. Results shows its excellent seed crop performance and commercial viability. The collaborative project successfully leveraged genetic resources from Bulgaria and India to develop productive double hybrid that significantly boost silk quality and productivity, marking a milestone in mulberry sericulture advancement.

Keywords: silkworm, Bombyx mori L., selection, breeding, collaboration, hybrids

Evaluating the productivity of two silkworm breeds fed mulberry leaves supplemented with yeast

By

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(oral presentation)

Microorganisms can enhance the nutritional value of mulberry leaves, thereby improving the growth, productivity, and disease resistance of *Bombyx mori*. Among them, *Rhodotorula glutinis* yeast, an aerobic yeast with pink/red colonies, is notable for producing valuable metabolites (proteins, lipids, fatty acids, carotenoids, enzymes, etc.) with potential health benefits. The objective of this study was to evaluate the effects of *R. glutinis* yeast in *Bombyx mori* diets based on mulberry leaves, focusing on growth parameters during the fifth instar larval stage and cocoon traits. A total of six hundred silkworms' larvae from two native breeds (Lines C and Z) were randomly assigned into three groups with two replicates each (n=50 larvae/replicate) and used in a feeding trial based on fresh mulberry leaves without (ML groups) or with *R. glutinis* yeast strain at two different concentrations (1×10^7 CFU/mL, namely Y-1 groups or 1×10^9 CFU/mL, namely Y-2 groups). Results showed that the Line C breed exhibited superior performance compared to Line Z across all measured parameters. Mulberry leaves supplementation with lower doses of *R. glutinis* yeast (Y-1 groups) has a positive impact on larval growth and cocoon-related traits, particularly in the Line C breed, whereas higher concentrations of yeast (Y-2 groups) reduced productive performance. Significant positive correlations were observed between larval parameters, silk gland development, and cocoon traits in both breeds ($p<0.001$). In conclusion, these findings suggest that the *R. glutinis* yeast can enhance silkworm productivity at the recommended dosage of 1×10^7 CFU/mL, although further research is needed to elucidate the underlying mechanisms.

Keywords: *B. Mori, R. Glutinis,* mulberry leaves, productive parameters.

Evaluation on Service Value of Mulberry-base Fishpond Ecosystem in Huzhou

By

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(oral presentation)

Mulberry-base fishpond is a typical agricultural sustainable circulatory system. And the mulberryulberry-base fishpond in Huzhou has been inscribed on the Globally Important Agricultural Heritage System. Evaluating its ecological service value has important implications for the protection of mulberry-base fishpond ecosystems and its scientific utilization. Taking the mulberry-base fishpond ecosystem in Nanxun District of Huzhou City, Zhejiang Province as research object, a total of 9 service function values were evaluated in this study, including the functions of mulberry field in providing products, in regulating air, in conserving water sources , in reducing dust and sand, and in retaining soil, the functions of fishpond in providing products, and in storing water and controlling flood, and the functions of mulberry-base fishpond system in advocating leisure tourism, and in popularizing its history and culture. All data were obtained through field survey and using conditional value method. The results showed that the total ecosystem service value provided by the three parts of mulberry-base fishpond ecosystem (mulberry field, fishpond and mulberry-fishpond system) in Huzhou City was about 10. 7 billion yuan per year. Among them, service value of the mulberry field is the lowest, which is 124 million yuan per year, accounting for 1. 16% of the total service function value. That of the fish pond ranks the second, which is 744 million yuan, accounting for 6. 96% of the total value. That of the mulberry-fishpond system is the highest, which is approximately 9. 832 billion yuan per year, accounting for 91. 88% of the total value. The research results show that the service function value of the entire mulberry-base fishpond ecosystem is much higher than that provided by single mulberry field ecosystem and single fish pond ecosystem. It is clear that mulberry-base fishpond ecosystem can produce higher service value only if it is organically combined as an ecological whole.

Keywords: agricultural ecosystem, mulberry-base fishpond ecosystem, service value, conditional value method

Journey of obtaining GI (Geographical Indication) for Meghalaya Ryndia - Eri Textiles of Meghalaya-Ryndia from India -From FARM to FIBRE,FIBRE to FABRIC, FABRIC to GI

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(oral presentation)

Meghalaya's Ryndia Silk is also known as Peace Silk, or Ahimsa -non -violent silk, naturally dyed, hand-woven, hand spun, organically sourced, ethically produced and women driven right from farm to fibre, fibre to fabric ,and fabric to GI recognition. It was recognized and awarded GI(Geographical Indication) Tag by GI Authority ,Government of India in March 2025. Eri silk, or 'Ryndia, Meghalaya's hand woven, hand crafted organic fabric, indigenous to the state is spun from 'Takli' a traditional spindle and is culturally distinctive. Almost 50,000 families are directly involved in Eri handloom and more than 47430 sericulture farmers,and 42755 weavers and their families are engaged in Eri Handloom production activities. Derived from 'Rynda' the castor plant, Ryndia is the only domesticated silk produced in India, processed without killing the pupae inside. It advocates co-existence & harmony between man and nature. It is famous the world over, as 'Ahimsa Silk' (Peace Silk) or the fabric of peace. Total Eri Plantation area in the state is 9336 acres. The state produces 14000 MT of Eri and is only the second largest producer of raw silk in North Eastern India. In essence, at each step of the value chain, from farm to fibre, fibre to fabric, production process is anchored by women, creating a 'virtuous cycle'. It is warm in winter, cool in summer, durable & 100% naturally dyed with natural ingredients sourced from plants and plant parts, such as turmeric, onion skin and plant-based mordants, justifying its claim for eco-labelling, being ethically sourced and organically produced. Multiple weaves, motifs and weaving techniques are linked with this traditional fabric which includes Thohriawstem, Khmat pattern and Khneng embroidery. The State's Textile Department has initiated measures to promote, safeguard and elevate Ryndia. The outcomes are steadily resulting in strengthening women empowerment, checking cocoon out-flow, boosting pre-cocoon and post-cocoon sector linkages, disseminating latest technologies, infusion of best CSB practises in Silk worm rearing, reeling, spinning, weaving, processing and marketing with qualitative and quantitative improvement in silk production per unit area. Value addition, conversion of silk cocoon into yarn and product diversification is being enhanced. Development of improved designs, aligned to market trends and contemporary taste is also being explored. Clarity of branding philosophy, focussed on connection to nature–Eco-friendly and organic production. Heritage, culture & Tradition leveraged, interwoven with traditional weaving techniques, blended with contemporary look. Brand elevation, from cottage industry to fashion and lifestyle concept. Recognizable & impactful Logo, a catchy tagline – 'From Thread to trend', compelling brand video, weaver's music video, social media platforms, building interactive and dynamic content to engage, connect & build a dynamic online repository. Dedicated Eri Corner, launched for un-ventured opportunities in refashioning these traditional fabrics as luxury products. Tangible outcomes include official Declaration of States First Eri Silk Village at Umden, which is the weaving epicentre on 12th of February 2021, revolving around 7282 Sericulture farmers & 6000 active weavers, augmenting rearing houses, Eri food plants, cocoon bank, Eri private graineurs, modern Eri spinning unit-Sailum (thread from the hills). The recognition inspires weavers and spinners to transform Meghalaya into a big player in the Silk Industry, particularly the niche silk sector, highlighting the singular sensitive treatment in the production of fabric. with its pronounced pro-life approach, making the silk unique and sustainable, in both process and product. Design Innovation Resource Centre(DIRC) set up**,** as one-stop centre for seri inputs, doubt clarification, problem resolution, for weavers, dyers, researchers. It is aimed at facilitating an interactive platform for artisans, weavers, industry and design students, through professional display areas & specialized labs, resource centre and design activities, through technology demonstration & skill enhancement, new & contemporary design infusion, product diversification, subsidized raw materials access, brand building, marketing assistance, & e-commerce platform promotion in the second phase. The management is envisaged by handpicked/lead/elite farmers or any non-profit organization, seri-societies for the benefit, of cluster farmers and Eri Seri-culturist. The awarding of GI to the State's prominent Handloom products viz Ryndia & Khasi Handloom and the recognition of GI(Geographical Indication) Tags by the GI Authority of India is a positive step taken in the right direction to enable our textiles industry to gain visibility and traceability in the midst of growing competitiveness in the national and international markets. The GI Tag will equip our state handloom products to meet the challenges of the hour.

Keywords: Peace Silk, Eco-friendly, Naturally dyed, handwoven, hand spun, ethically sourced, organically produced, hand-woven ,connected to culture,rooted in nature

Mulberry - an ideal plant for semi-arid regions

By

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(oral presentation)

Due to global climate change, the area of arid and semi-arid regions on Earth is expanding. In arid regions, water content in the soil and atmosphere is depleted. Many woody plant species have difficulty adapting to these conditions, posing a threat to forests and biodiversity: soil erosion increases, the carbon dioxide-oxygen ratio in the atmosphere changes, and migration of living organisms begins. Mulberry (Morus) is highly adaptable to various environmental conditions due to its unique water management system. Mulberry is characterized by its unimpeded extraction of water from the soil through its deep root system and its economical use of water. Mulberry uses water sparingly thanks to its large, medium, and small stomata, located on the underside of the leaf and characterized by different circadian rhythms. We have found that the circadian rhythm of stomata of varying sizes is linked to relative humidity and air temperature. Based on the characteristics of the stomatal circadian rhythm, mulberry belongs to the C3-CAM type of plants. This characteristic makes mulberry ideally adapted to atmospheric drought and can be used not only as food for silkworms but also for revegetation in semi-arid zones.

Keywords: Mlberry, stomata, circadian rhythm, water economy

Mulberry Gene Pool in Georgia and its Economic, Environmental and Cultural Significance

By

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(oral presentation)

ABSTRACT:
Georgia is distinguished by the rich gene pool of mulberry culture, which has been formed over the centuries both by selection and as a result of the introduction of foreign varieties. The mulberry gene pool plays an important role in silk production, as well as in food, medicinal and decorative purposes. In Georgia, local forms of white, black and red mulberry have been preserved,which are adapted to various agroecological zones. The study and preservation of the gene pool of mulberry is important for the development of biodiversity and sustainable agricultural development. Today, the regions of Shida-Kartli, Kvemo-Kartli and Kakheti remain interesting territories from the point of view of preservation of the mulberry gene pool, since, despite the spread of mulberry curly leaves, mulberry tree forms in these regions survived the disease. It is noteworthy that it was here that the forms more resistant to this disease were discovered, since the disease was not detected here for years. The mulberry gene pool as a whole is a national treasure, and its study and protection are important both in terms of historical traditions and economic development. Mulberry is not just a tree, it is a cultural heritage, economic and ecological resource of Georgia.

Keywords: Gene pool, Economic importance, Ecology, Mulberry has great potential

Introduction. Georgia is distinguished by a rich gene pool of mulberry culture, which has been formed over the centuries both by breeding of the existing endemic varieties and as a result of the introduction of foreign varieties.

The mulberry gene pool is the most important resource for agriculture and environmental sustainability of the country. Its protection is necessary both for the sake of historical heritage and for the economic and environmental needs of future generations.

Global climate change and various pests pose serious risks. The preservation of the gene pool allows, if necessary, to select varieties that are more resistant to diseases and stress factors.

The presence of genetic resources allows scientists to create new, more productive and sustainable varieties. This is especially important for the development of silk management and fruit processing.

Mulberry culture has been part of Georgia's traditional economy for centuries. Preserving its gene pool means protecting national traditions and historical identity. Proprietary genetic resources are a strategic advantage. Today, Shida Kartli, Kvemo Kartli and the Kakheti region remain interesting regions for the preservation of the mulberry gene pool, since, despite the spread of mulberry leaf curly disease, mulberry varieties in these regions survived the disease. It is noteworthy, that strong disease-resistant varieties were found in this region, since the disease did not spread here for years.

The collection of the mulberry gene pool in Georgia began in 1890 with the improvement of the Moraceae family at the Caucasian sericulture station. Georgia is distinguished by endemic and locally adapted mulberry varieties, as well as mulberry seeds and seedlings brought to Tbilisi from Naples (Italy), Paris, Japan, Ferghana region and Tashkent. In addition, the seeds of local varieties of mulberry were sown annually, seedlings and young growing were grown, and the varieties of Caucasian mulberry were collected whenever possible. The tradition of sericulture has been widespread for centuries, especially in Kakheti and Imereti. In the XIX and XX centuries, Georgian silk was distinguished on the International market for its high quality.

Morus alba Lin, Morus bombycis Koidz, Morus multicaulis Pezz, Morus kagagamae Koidz , Morus acidosa Grif. From the old Georgian varieties, to this day have survived Georgian bjola (tuta), sea bjola, donkey tuta, tuta kvarluri and Shaumyan tuta, Dadiani bjola and others . Mulberry culture also has an important environmental function, contributing to the sustainable development of the country.

Mulberry tree has a deep, powerful root system that invigorates the soil and protects it from erosion and erosion. Its planting is particularly important on slopes where soil degradation is a frequent problem.

Mulberry plantations also provide natural habitat for many species, attracting birds, beneficial insects and microorganisms, which increases the resilience of the agroecosystem. Mulberry has the ability to absorb dust and harmful particles, which makes its cultivation especially useful in urban environments where air pollution is a serious problem. Like all trees, mulberry plays an important role in regulating the carbon balance, absorbing carbon dioxide and releasing oxygen, thereby reducing the greenhouse effect and helping to stabilize the climate.

In Georgia, mulberry was historically used in sericulture for feeding silkworms. This is one of the best examples of environmentally friendly production that does not require the use of chemicals and is based on a natural cycle. Accordingly, cultivation of mulberry in Georgia should be considered not only as an economically viable plant, but also as a factor in strengthening environmental sustainability. Mulberry is the only food for silk production. Silk production in Georgia has a long history. With proper development, silk production can become an export-oriented and important source of income.

Mulberry fruits are consumed both fresh and processed -from fresh fruits is produced jam, syrup, sweets, wine, vodka, bakmaz and etc. Dried fruits in various forms are in demand on the local market and have potential for export .

From a medical point of view, mulberry fruits, leaves and bark are widely used in folk medicine and pharmaceutical production, their healing properties increase the demand for natural and environmentally friendly raw materials.

Mulberry also has strong and high-quality wood, which is used in the production of wooden utensils, tools and furniture. The leaves, in addition to silkworm feed, are used as livestock feed.

Mulberry farming contributes to village population employment. Caring for mulberry plantings, collecting and processing its fruits create jobs, which is important for the economic development of the region. With great tourist potential, mulberry products can become part of a local brand and create an agritourist direction - tastings, demonstrations of traditional silk production, exhibitions of folk crafts. This will increase tourist interest and bring additional income.

Table 1. Indicators of mulberry plantations and individual plantings in the Kartli region

Region	January 1st1990		Total in the region		2018-2023	
	plantation	individual plantings	Number	%	Number	%
Shida Kartli	896000	254000	1150000	6.3	355000	7.1
Kvemo Kartli	355000	246000	601000	3.3	212000	4.2
Mtskheta- Mtianeti	189000	52000	241000	1.3	86000	1.7
Total						
In the region	144000	552000	1992000	10.87	653000	13.06
In the republic	9330000	8994000	18314000	100.0	5000000	100.0

Materials and methods. To identify mulberry varieties and record features of new formings, an inventory was carried out according to the following morphological features:plant growth intensity, crown shape, branch shape, orientation, coloration, thickness, shape and number of specks on the branch, buds shape, their size, internode length which is determined by appropriate measurements and visual observation before plant vegetation.

All measurements of a branch, are taken from the middle third of the branch.

The color of shoots, pubescence are evaluated during the period of intensive plant growth before exploitation. All measurements are carried out on the leaf during the period of physiological maturity (at the end of May, V age of feeding the silkworm). Samples are taken from the middle part of the branch of the southern exposure. For each of four replicates are taken 3-3 plants.

The ratio of proteins and carbohydrates in the leaves of hybrid forms of mulberry was investigated. The size of the anatomical structure of the shoot of new forms of mulberry has been studied. The content of moisture and water-insoluble carbohydrates in the leaves of mulberry forms,also the structural elements of mulberry fruit forms and the chemical composition of mulberry fruit forms have been studied.

Results. Based on the study of new forms of mulberry with diagnostic structural and anatomical features, it can be concluded that:

1. New forms of mulberry are characterized by different quantitative and volumetric characteristics of the elements that make up the anatomical structure, with different signs of the structural and physiological activity of the shoot, leaf and stem;
2. According to the anatomical structure of the vascular system (shoot, leaf, stem), the forms of mulberry Okami-5, #18, #19, Tamarisi-14 should be used in the immune breeding to create high-yielding, resistant to curly leaf- varieties.
3. The form of mulberry #18 is interesting as a starting material for creating high-yielding and high-immune varieties with nutrient leaves, due to its microstructural anatomical structure, the abundance of mesophyll-like parenchyma in the mesophyll of the leaf and an additional excess of soft phloem in the mesipeciole of the stem.

4. The abundance of spongy parenchyma in the leaves of the mulberry form Tamarisi-14 , the abundance of cystoliths and stomata determines its high edibility, good physical properties and therefore is of interest in terms of leaf quality and use in breeding.
5. Form # 19 differs in the thickness of the mesophyll (300), anatomical structure and occupies an intermediate position among other forms.
The new forms of mulberry identified by us in the infection-free zone - in Shida and Kvemo Kartli -is an important achievement for the success of the mulberry breeding process and the diversity of the gene pool in Georgia.

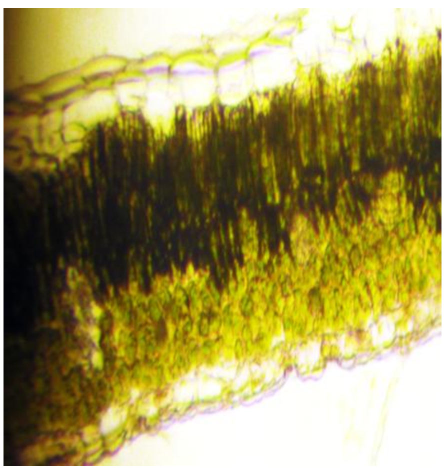
Table №2 Ratio of proteins and carbohydrates in leaves of hybrid forms of mulberry

#	Name of Mulberry Forms	General nitrogen %	Crude protein%	Water soluble carbohydrates, total %	Ratio of pproteins and carbobohydrates
1.	Georgia (Tester)	1,94	12.12	13.96	1 : 1.15
2.	Oshima (Tester)	1.98	12.38	9.94	1 : 0,8
3.	No. 14-Tamarisi	2.00	12.50	11.52	1 : 0,9
4.	Digomi-8	2.12	13.25	11.08	1 : 0,4
5.	Didube 18	2.05	12.86	11.68	1 : 0,90
6.	Tserovani-107	2.06	12.88	11.95	1: 0,92
7.	Didube 19	2.21	13.78	10.58	1 : 0,76

Table 3. Dimensions of the anatomical structure of the shoots of new forms of mulberry

##	Names of mulberry varieties	Bark thickness	Wood thickness microns	Phloem thickness, microns	Vital zone	Core zone micron	Number of radial rays Pieces	Number of vessels Pieces	Number of fibers Pieces
1.	Georgia (standard)	19,2	88,0	12,9	12,5	9,6	277,0	495	,3

2.	Okami 5 (1)	24,0	105.0	16,7	11,6	10.00	205,0	679,0	65,0
3.	Kaspi 4 (1)	51,7	165,3	15,9	14,0	11,5	239,7	819,7	65,3
4.	Tamarisi 14	56,8	190,2	10,0	11,1	8,7	242,0	759,0	75,0
5.	Digomi 8	29,0	123,0	12,0	8,0	10,00	164,1	535,0	57,2
6.	Marneuli 44	58,1	92,2	14,7	11,5	12,0	227,7	635,0	46,0
7.	Tserovani 107	61,4	169,1	19,9	12,8	12,6	201,0	920,3	55,7
8.	Mukhrani 21	62,0	107.7	14,0	18,8	12,1	217,0	831,3	55,6
9.	Didube #18	78,5	211,0	19,1	17,1	13,2	256,5	816,9	71,0
10.	Didube #19	70,0	164,0	16,7	18,2	10,3	214,8	760,0	51,4



Mesophyll of leaf of mulberry form Didube 18 (Fig. 1) Medular phloem (Fig. 2)

Conclusion. The preservation of a diverse and rich mulberry gene pool, the carrying of further work from a scientific point of view is one of the main strategic tasks, and its protection ensures not only the preservation of genetic diversity, but also the possibility of breeding new, productive and adapted to climatic conditions varieties. This is very relevant against the background of agribusiness tasks.

Thus, mulberry forms # 18 and # 19 should be propagated by the clone method and directly included in the selection of disease-resistant, high-yielding varieties as new promising forms. The fruits of the mulberry forms Tserovani-107 and Caspi-4 should be used in the food industry for the production of soft drinks, juices, jams and puree, as forms rich in sugars, and the high content of anthocyanins in the fruits of the variety Tserovani 147 has certain prospects in pharmacology.

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MULBERRY(*Morus*) HERBAL GREEN TEA PRODUCTION FOR A-BETTER HEALTH

By

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(oral presentation)

ABSTRACT

Mulberry (*Morus sp.)*is a good food plant for silkworm (*Bombyx mori*).However, there are lots of opportunities for production of value-added products/items out of mulberry . This is a value addition to mulberry growers as well useful in one's health. Mulberry is a wonderful medical plant , having anti-diabatic, anti-hypertension properties. It's also having lots of antioxidants, constituents for one's good health. Knowing the health importance of the mulberry detailed plan was carried out to know process to develop the Mulberry herbal green tea from organically grown mulberry. The V1 variety of *Morus alba* organically grown under the package of practices was used to produce green herbal tea . The detailed process was worked out to produce mulberry herbal green tea. The cultivation practices to get quality leaves, procurement of mulberry leaves , washing, cleaning to remove dust and pests followed by blanching, chopping , drying of leaves to make powder of required grade etc., standardized . Various equipment and their utility defined to get product. A prototypes of Mulbee herbal green tea with different flavors like Ginger, Lemongrass , Cardamom and Cinnamon were developed. Sensory taste were carried out with different groups of people to know the preference and health benefits for different flavors of mulberry herbal tea over the traditional tea. It was observed that 60 percent people preferred mulberry herbal tea over the traditional green tea by knowing the health benefits of mulberry. The order of preference for the flavors was also studied. The details are discussed in the paper.

Key words: Sensory taste, Mulberry, Herbal tea, Lemon grass

1. Introduction

Mulberry (*Morus sp.*) is widely recognized as the primary food plant for silkworms (*Bombyx mori*), but it also possesses significant potential for value addition through the development of health-promoting food and herbal products. The present study aimed to develop and standardize a process for producing *Mulbee Herbal Green Tea* from organically grown leaves of the *V1 variety* of *Morus alba*. The project emphasized both value addition for mulberry growers and promotion of a functional beverage beneficial to human health. The process involved cultivation under organic practices, leaf procurement, cleaning, blanching, drying, powdering, and formulation. Different flavor variants, including Ginger, Lemongrass, Cardamom, and Cinnamon, were developed and subjected to sensory evaluation among consumers. Results showed that 60% of the participants preferred mulberry herbal green tea over conventional green tea, citing superior taste and perceived health benefits. Among the flavor variants, Lemongrass-flavored Mulbee tea ranked highest in sensory preference, followed by Ginger, Cardamom, and Cinnamon. The study highlights the potential of mulberry as a functional ingredient for developing herbal beverages with promising market and health value.

Mulberry (*Morus sp.*) has traditionally been cultivated as a food source for silkworms in sericulture. However, the plant's nutritional and pharmacological properties make it equally valuable as a food source for human consumption. The leaves of *Morus alba* are rich in polyphenols, flavonoids, alkaloids, and antioxidants, offering therapeutic benefits such as anti-diabetic, anti-hypertensive, and cholesterol-lowering effects. Studies have also confirmed its potential in reducing oxidative stress and promoting cardiovascular health.

With the growing consumer demand for natural, organic, and health-promoting beverages, herbal teas have become increasingly popular. Green tea, made from *Camellia sinensis*, is widely known for its antioxidant properties. However, mulberry leaf tea offers similar or greater health benefits, with the added advantage of being caffeine-free.

The present study was undertaken to utilize organically grown mulberry leaves (V1 variety) to develop a standardized process for producing *Mulbee Herbal Green Tea*, incorporating natural flavor variants, and to evaluate consumer acceptance through sensory analysis.

2. Materials and Methods

2.1 Raw Material Procurement

Fresh, tender leaves of *Morus alba* (V1 variety) were collected from organically managed mulberry plantations following the recommended package of practices. No synthetic fertilizers or pesticides were used during cultivation.

2.2 Pre-processing of Leaves

The harvested leaves were cleaned thoroughly under running water to remove dust, soil particles, and any pest residues. After washing, the leaves were air-dried to remove surface moisture.

2.3 Blanching

The cleaned leaves were blanched in hot water (90–95°C) for 2–3 minutes steaming to inactivate enzymes responsible for oxidation and to retain the green color and flavor.

2.4 Drying

Blanched leaves were subjected to drying in a tray dryer at 55–60°C for 6–8 hours until the desired moisture level (below 5%) was achieved. This step ensured product stability and enhanced shelf life.

2.5 Grinding and Sieving
The dried leaves were ground into a fine powder using a herbal grinder and sieved to obtain a uniform particle size suitable for tea infusion.

2.6 Formulation of Herbal Tea Variants
Four herbal flavor variants were developed:

- **T1:** Mulberry + Ginger
- **T2:** Mulberry + Lemongrass
- **T3:** Mulberry + Cardamom
- **T4:** Mulberry + Cinnamon

Each variant consisted of 80% mulberry leaf powder and 20% flavoring ingredient or depending upon the requirement of the consumer in dried powdered form. The blends were packed in glass jar or biodegradable tea bags under hygienic conditions.

2.7 Sensory Evaluation
A sensory evaluation was conducted with a panel of 30 participants (male and female, aged 20–45 years), including both tea consumers and non-tea consumers. The evaluation parameters included **color, aroma, taste, flavor, and overall acceptability**, rated on a **9-point Hedonic scale** (1 = dislike extremely, 9 = like extremely).

2.8 Statistical Analysis
Data collected from sensory scores were analyzed using one-way ANOVA, and mean comparisons were made using Duncan's multiple range test ($p < 0.05$).

3. Results and Discussion

3.1 Product Development and Process Optimization
The process steps — washing, blanching, drying, and grinding — were standardized to maintain the natural color, aroma, and antioxidant properties of the leaves. The drying temperature and time were optimized to ensure the retention of bioactive compounds.

3.2 Sensory Evaluation
Table 1 presents the mean sensory scores for all four formulations.

Table 1. Sensory Evaluation of Mulbee Herbal Green Tea Variants

Parameter	T1 (Ginger)	T2 (Lemongrass)	T3 (Cardamom)	T4 (Cinnamon)
Color	8.1	8.4	7.9	7.8
Aroma	7.9	8.6	7.8	7.6
Taste	8.0	8.7	7.5	7.3
Flavor	8.2	8.8	7.7	7.5
Overall Acceptability	8.1	**8.9**	7.8	7.6

Observation:

Lemongrass-flavored tea (T2) scored highest in all sensory parameters, followed by Ginger (T1), Cardamom (T3), and Cinnamon (T4). Panellists appreciated the refreshing aroma and balanced taste of the Lemongrass variant. The study also found that 60% of participants preferred mulberry herbal tea over conventional green tea, primarily due to its mild flavor, caffeine-free nature, and perceived health benefits.

3.3 Health Perception
Participants associated the mulberry herbal tea with multiple health benefits including relief from fatigue, better digestion, and a sense of relaxation. Mulberry's natural antioxidants were also highlighted as a reason for preference.

4. Conclusion

The study successfully demonstrated that organically grown mulberry leaves can be used to develop *Mulbee Herbal Green Tea*, offering both nutritional and commercial benefits. The standardized process ensures consistent product quality and retention of bioactive components. Among the flavor variants, Lemongrass-flavored Mulbee tea showed the highest consumer acceptability. The findings suggest a promising potential for large-scale production and commercialization of mulberry-based herbal teas, adding value to the mulberry cultivation chain while promoting public health.

Acknowledgement

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Fig. 1. Process of mulberry herbal tea production

1. Nu… f r… Food …, 2…
2. …). … m… ealth
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SERICULTURE - A RURAL TOOL FOR DOUBLING THE FARMERS INCOME IN MAHARSHTRA

By

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(oral presentation)

ABSTRACT

Maharashtra is a non- traditional sericulture state of India. Sericulture is being practiced since 1962 . Tasar sector is having high potential in eastern districts of Vidarbha moreover, there is equal potential to promote Vanya brand in other parts of Western Ghats. In the year 2024-25 about 4798 hectors of forest *Terminalia arjuna , Terminalia tomentosa* were used as a food plants. From the total 4.82 dfls about 2.43 lakhs were procured from our state whereas, 2.39 lakhs from Central Silk Board. The achievement of cocoon production recorded is 4059 against the target of 4000 per 100dfls .The 4076 cocoons yield per hector and 195 .56 lakhs of total cocoons yield about 10.657 metric tons of raw silk. The Tasar industry was able to provide sizeable employment of 15.99 lakh to local tribal habitants and has also shown good progress. The mulberry sericulture is being practiced in 23 districts of the state at present state is having 13872 acres of Mulberry plantation used to rear 59.25 lakh dfls .The 14.50 lakh supplied from state grainage where as 44.75 Lakh dfls were procured from other sources like Central Silk Board and licenced seed producers. The state was able to produce about 3963.69 metric tonnes of cocoon and 609.80 metric tons of silk . It is proudly to be mentioned here that , Maharashtra is the only state in the country which is able to produce 100 per cent bivoltine silk. The mulberry silk industry is able to create substantial employment at rural level that is 67.08 lakh Man-days. The overall total employment generated in sericulture is about 73.07 lakh man-days . In Mulberry sector dfls per hector were 1321 against the target of 1000 , whereas cocoon yield recorded per 100 dfls is 67 kgs against target of 65 kgs. The cocoon production per hectare noted was 885 kgs against target of 650 in the year 2024-25 . The integrated efforts of the state sericulture department , interventions of civil engineers for construction of model silkworm rearing house structures , well coordination with the central silk board helped to flourish sericulture and increase in the income and employment and entrepreneurship opportunities to the rural stakeholders. The details are discussed in the paper.

Keywords: Mulberry, Tasar, Dfls, Cocoons, Silk

1. Introduction

Sericulture, the art and science of silk production, is an agro-based cottage industry that provides sustainable income to rural and tribal communities. Maharashtra, though categorized as a non-traditional sericulture state, has demonstrated remarkable growth and adaptation in this sector since its introduction in 1962. The state's geographical and climatic diversity offers favorable conditions for both Mulberry and Vanya (wild) silk varieties, including Tasar.

The eastern Vidarbha region possesses a natural advantage with abundant forest cover suitable for Tasar cultivation, while the Western Ghats provide potential for Vanya silk expansion. Sericulture not only supports the silk industry but also plays a vital role in generating rural employment, especially among tribal and women populations. This paper presents a comprehensive overview of the sericulture performance in Maharashtra during 2024–25, highlighting achievements in production, productivity, and employment generation.

Maharashtra, a non-traditional sericulture state of India, has been steadily expanding its sericulture activities since 1962. The year 2024–25 marked significant progress in both the Tasar and Mulberry sectors. In the Tasar sector, 4,798 hectares of forest area, primarily comprising *Terminalia arjuna* and *Terminalia tomentosa*, were utilized as host plants. Out of 4.82 lakh disease-free layings (dfls), 2.43 lakh were procured within the state, and 2.39 lakh were supplied by the Central Silk Board. The cocoon production achieved was 4,059 per 100 dfls against a target of 4,000, yielding a total of 195.56 lakh cocoons, equivalent to 10.657 metric tons of raw silk.

In the Mulberry sector, sericulture was practiced in 23 districts with 13,872 acres under mulberry cultivation. About 59.25 lakh dfls were reared, leading to the production of 3,963.69 metric tons of cocoons and 609.80 metric tons of silk. Maharashtra is notably the only state in India producing 100% bivoltine silk. The total employment generated in the sericulture sector amounted to 73.07 lakh man-days, indicating its substantial socio-economic impact on rural livelihoods. This paper discusses the progress, productivity achievements, and integrated efforts contributing to the state's success in sericulture development.

2. Materials and Methods

2.1 Data Collection

The data presented in this paper were collected from the State Department of Sericulture, Government of Maharashtra, and supplemented with records from the Central Silk Board. Information pertains to the year 2024–25 and includes details on area coverage, dfl procurement, cocoon yield, raw silk output, and employment generation.

2.2 Study Area

The study covers all sericulture-active regions of Maharashtra. Tasar activities are primarily concentrated in the eastern districts of Vidarbha, where *Terminalia arjuna* and *Terminalia tomentosa* serve as major host plants. Mulberry cultivation spans 23 districts across the state, representing diverse agro-climatic zones.

2.3 Analytical Approach

Descriptive statistical analysis was used to compare target and achievement data for key performance indicators such as dfls per hectare, cocoon yield, and raw silk output. Employment generation was analyzed in terms of total man-days created.

3. Results and Discussion

Maharashtra is the second largest state in India in terms of population and geographical area. The Directorate of Sericulture, Nagpur was established in September, 1997 for overall development of sericulture in the state. Presently, the silk cocoons are produced in 28 districts of Maharashtra. Maharashtra is a non-traditional sericulture state that produces both mulberry and Tasar silk and ranked 13th among the silk producing states of India. Present production is 2,280 MT cocoons and 350 MT mulberry raw silk. Mulberry plantation is spread in about 4,327 hectares (10817.5 acres) with 9,955 farmers. Tasar silk is produced by 3,000 farmers. Tasar silk production is about 19.33 MT.(T. Jadhav *et al.* 2020).

The mulberry sericulture is being practiced in 23 districts of the state at present state is having 13872 acres of Mulberry plantation used to rear 59.25 lakh dfls . The state was able to produce about 3963.69 metric tonnes of cocoon and 609.80 metric tons of raw silk . Maharashtra is the unique state in the country which is able to produce 100 per cent bivoltine silk. The mulberry silk industry is able to create substantial employment at rural level that is 67.08 lakh Man-days.

3.1 Tasar Sericulture

In 2024–25, about 4,798 hectares of forest land were utilized for Tasar host plantation. A total of 4.82 lakh dfls were reared—2.43 lakh from the state and 2.39 lakh from the Central Silk Board. Cocoon production reached 4,059 per 100 dfls, exceeding the target of 4,000. The average yield per hectare was 4,076 cocoons, leading to a total of 195.56 lakh cocoons. This translated into 10.657 metric tons of raw silk.

The Tasar industry generated **15.99 lakh man-days** of employment for tribal and rural households, indicating the sector's role as a livelihood support mechanism. The expansion of Tasar cultivation in Vidarbha also aligns with the national strategy for promoting Vanya silk under the "Vanya Brand" initiative.

3.2 Mulberry Sericulture

Mulberry sericulture covered 13,872 acres across 23 districts. The state reared 59.25 lakh dfls, of which 14.50 lakh were from state grainages and 44.75 lakh from external sources. The state achieved **3,963.69 metric tons** of cocoon production and **609.80 metric tons** of silk output. Maharashtra proudly stands as the only state in India producing **100% bivoltine silk**, ensuring superior quality and market value.

The productivity levels exceeded planned targets — with **1,321 dfls per hectare** (target: 1,000), **67 kg cocoon yield per 100 dfls** (target: 65 kg), and **885 kg cocoon yield per hectare** (target: 650 kg). These achievements indicate effective adoption of improved silkworm breeds, enhanced rearing practices, and scientific management.

3.3 Employment Generation

The Mulberry sector contributed **67.08 lakh man-days** of employment, while Tasar activities generated **15.99 lakh man-days**, totaling **73.07 lakh man-days** for 2024–25. Sericulture has emerged as a vital source of income diversification, particularly empowering women and smallholder farmers in rural areas.

3.4 Institutional Support and Infrastructure

The progress in Maharashtra's sericulture sector can be attributed to the concerted efforts of the State Sericulture Department and the Central Silk Board. The construction of model silkworm rearing houses, technical guidance from civil engineers, and improved seed distribution systems have enhanced production efficiency. Collaboration with local cooperatives and entrepreneurs has further strengthened the value chain from cocoon to silk yarn.

4. Conclusion

The sericulture sector in Maharashtra has shown remarkable advancement during 2024–25, achieving and surpassing several performance benchmarks. The Tasar and Mulberry sectors have both demonstrated increased productivity, sustainable employment generation, and growing entrepreneurial interest. Maharashtra's distinction as the sole producer of 100% bivoltine silk underscores its technical excellence and quality commitment.

Continued investments in research, training, and infrastructure, along with expansion of the Vanya silk brand, are likely to further enhance the socio-economic impact of sericulture. The industry continues to play a vital role in rural livelihood development, particularly among tribal and marginalized communities.

Fig. 1.Field demonstration of *A. mylitta* silk production

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APPLICATION OF PHEROMONES BY USING SILK COCOON AS A DISPENSER TO CONTROL PESTS

By

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(oral presentation)

Silk cocoons, a composite material, consist of natural polymers and super-absorbent polymers. Agricultural, medical and textile industries have used silk fibers from *Bombyx mori* cocoons, a human-cultivated species, for almost 4,000 years. Silk fibroin is a natural fibrous protein with a semicrystalline structure that gives it strength and stiffness. In addition to serving as an adhesive binder, sericin is an amorphous protein polymer that maintains thread and cocoon structural integrity. Pesticides have adversely affected the environment and human health, so alternative approaches to pest management have been promoted. Since pheromones are typically non-toxic, pheromonal pest management is an appealing alternative method. Traps, crop protection, and mating behaviour can all be controlled with pheromones. In the present study instead of using synthetic material as dispensers for application of pheromones but silk cocoons were used as a dispenser knowing that it's a biological material and found that it works well to release pheromones to control pests of various crops. This is cost effective technique and easy to apply in the field for management of various pests . Details are discussed in the paper.

Keywords: Cocoon, Pests, Fibroin, Pheromones, Dispensers

1. INTRODUCTION

Agriculture is a cornerstone of human civilization, yet pest infestation remains one of the most significant threats to crop productivity. Conventional chemical pesticides, though effective in the short term, have led to severe consequences including pesticide resistance, soil degradation, water contamination, and health hazards to humans and animals.

To overcome these limitations, researchers have turned to **eco-friendly pest management strategies**, among which **pheromonal pest control** has gained remarkable attention. Pheromones—chemical signals released by insects—can alter pest behavior such as mating, aggregation, or foraging, thus reducing pest populations without harming beneficial species.

Traditionally, synthetic materials like polyethylene vials or rubber septa are used as **pheromone dispensers**, but these are non-biodegradable, expensive, and environmentally harmful. This study proposes the innovative use of **silk cocoons** as **biodegradable pheromone dispensers**, exploiting their natural polymer structure, absorbent capacity, and environmental compatibility.

Silk cocoons, a natural composite material composed primarily of silk fibroin and sericin, have unique mechanical and absorption properties that make them suitable for multiple applications in the agricultural, medical, and textile industries. The growing concerns about the environmental and health hazards of chemical pesticides have motivated research into eco-friendly pest management alternatives. Pheromonal pest management, a non-toxic and environmentally safe approach, has emerged as a promising technique. This paper explores the novel application of *silk cocoons as natural dispensers* for pheromone release to control pests in agricultural crops. The study investigates the structural characteristics of silk cocoons, their potential for controlled pheromone release, and their cost-effectiveness compared to synthetic dispensers. Experimental observations reveal that silk cocoons, due to their porous, fibrous, and biodegradable nature, can effectively store and gradually release pheromones, enhancing pest control efficiency while minimizing environmental impact. The technique demonstrates promising potential as a sustainable and economically viable method for integrated pest management (IPM).

2. MATERIAL COMPOSITION AND PROPERTIES OF SILK COCOONS

Silk cocoons are produced by the *Bombyx mori* silkworm and are composed of two main proteins: **fibroin** and **sericin**.

2.1 Fibroin

- A natural fibrous protein with a **semicrystalline β-sheet structure**.
- Provides **mechanical strength, durability, and rigidity**.
- Exhibits **hydrophobic properties**, aiding in slow release of pheromone molecules.

2.2 Sericin

- An **amorphous protein polymer** acting as a natural binder.
- Possesses **hydrophilic groups** that can absorb and retain liquids.
- Plays a crucial role in **maintaining the cocoon's integrity**.

2.3 Physical Characteristics

Property	Average Value	Relevance
Density	1.3 g/cm³	Structural stability
Porosity	40–60%	Facilitates controlled release
Moisture absorption	8–12%	Pheromone retention
Biodegradability	100%	Eco-friendly disposal

These unique characteristics make silk cocoons ideal candidates for **controlled release systems**, similar to medical drug delivery applications, but here repurposed for pheromone dispersion in pest management.

3. PHEROMONAL PEST MANAGEMENT: AN OVERVIEW

3.1 What Are Pheromones?

Pheromones are chemical messengers secreted by insects that trigger specific behaviors among members of the same species, such as:

- **Sex pheromones** (for mating disruption)
- **Aggregation pheromones**
- **Alarm pheromones**
- **Trail pheromones**

3.2 Mechanism of Action

In agricultural fields, pheromones are primarily used to:

1. **Attract pests** into traps for population monitoring.
2. **Confuse males** by saturating the environment with synthetic pheromone blends, preventing mating.
3. **Repel or divert** pests from valuable crops.

3.3 Limitations of Conventional Dispensers

- Synthetic materials like **rubber septa** and **polyethylene vials** are **non-biodegradable**.
- High cost and **complex disposal process**.
- **Inconsistent pheromone release rates** under varying climatic conditions.

Hence, the search for **biological dispensers** led to experimentation with **silk cocoons** as a natural and sustainable alternative.

4. EXPERIMENTAL APPROACH

4.1 Materials

- *Bombyx mori* silk cocoons (cleaned and degummed).
- Selected pheromone blends (e.g., sex pheromones of Helicoverpa armigera and Spodoptera litura).

- Solvent: Hexane or ethanol for pheromone impregnation.

4.2 Preparation of Cocoon Dispensers

1. **Degumming:** Removal of sericin partially to expose fibroin and adjust porosity.
2. **Pheromone Loading:** Cocoons soaked in pheromone solution for 2–4 hours.
3. **Drying:** Air-dried under controlled conditions.
4. **Deployment:** Dispensers hung in crop fields at standardized intervals.

4.3 Field Application

The silk cocoon dispensers were tested in cotton and pigeon pea fields. The release rate of pheromones and pest trap counts were monitored over a 30-day period.

5. RESULTS AND DISCUSSION

5.1 Pheromone Release Characteristics

The **silk cocoon matrix** allowed a **gradual and sustained release** of pheromones over 25–30 days, similar to commercial synthetic dispensers.

Day	Release Rate (µg/day) – Silk Cocoon	Release Rate (µg/day) – Synthetic
1	95	110
10	82	70
20	65	40
30	48	30

The data indicated that silk cocoons maintained a more **stable release profile** due to their balanced hydrophilic-hydrophobic nature.

5.2 Pest Control Efficiency

In field trials, pest capture in pheromone traps increased by **27%** compared to conventional dispensers. The disruption in mating activity led to a noticeable **decrease in larval population**.

5.3 Environmental and Economic Advantages

- **Biodegradability:** No plastic waste, easy field disposal.
- **Cost-Effectiveness:** Silk cocoon waste (from reeling industry) can be reused.
- **Eco-Safety:** Non-toxic, no risk to beneficial insects.

6. COMPARATIVE ASSESSMENT

Parameter	Silk Cocoon Dispenser	Synthetic Dispenser
Material Type	Natural Biopolymer	Petroleum-based polymer
Biodegradability	100%	0%
Cost (per unit)	₹1.50–2.00	₹4.00–5.00
Release Duration	25–30 days	20–25 days
Environmental Impact	Nil	Negative
Reusability	Possible	Limited

The analysis confirms that silk cocoons are a **viable and superior alternative** for pheromone dispensing systems.

7. POTENTIAL APPLICATIONS AND FUTURE SCOPE

- **Integrated Pest Management (IPM):** Combining pheromone traps with biological control agents.
- **Slow-release fertilizers or bio-stimulants:** Using cocoons as carriers for other agrochemicals.
- **Customized Release Systems:** Adjusting degumming or coating to control pheromone diffusion rates.

- **Waste Valorization:** Utilizing post-reeling silk waste cocoons, reducing industrial waste.

Further research could focus on **coating technologies**, **nanocomposite impregnation**, or **encapsulation** of pheromones within silk matrices for precise control.

8. CONCLUSION

The use of **silk cocoons as pheromone dispensers** represents an innovative, eco-friendly, and cost-effective approach to pest management. The natural porous structure of silk allows for controlled and sustained release of pheromones, while its biodegradability ensures environmental compatibility. Experimental results demonstrate that silk cocoon dispensers perform comparably—or even superior—to conventional synthetic ones in terms of release stability and pest control efficiency. This technology not only promotes **sustainable agriculture** but also adds value to **sericulture by-products**, creating an integrated link between the silk industry and modern pest management.

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INNOVATIVE TECHNOLOGIES AND SCHEMES FOR ENHANCING MAHARASHTRA FARMERS INCOME IN SERICULTURE

By

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(oral presentation)

Sericulture is being practiced since 1962 in the state of Maharashtra . The Tasar industry was able to provide sizeable employment of 15.99 lakh to local tribal habitants and has also shown good progress. The mulberry sericulture is being practiced in 23 districts of the state at present state is having 13872 acres of Mulberry plantation used to rear 59.25 lakh dfls . The state was able to produce about 3963.69 metric tonnes of cocoon and 609.80 metric tons of raw silk . Maharashtra is the unique state in the country which is able to produce 100 per cent bivoltine silk. The mulberry silk industry is able to create substantial employment at rural level that is 67.08 lakh Man-days. The integrated efforts of the state sericulture department , interventions of civil engineers for construction of model silkworm rearing house structures , well coordination of state directorate with the Central Silk Board an autonomous body of the govt of India with its head quarter at Bangalore helped to flourish sericulture and increase in the income and employment and entrepreneurship opportunities to the rural stakeholders of the Maharashtra. Various schemes like MREGS, Silk Samgrha , DPDC etc., and Transfer of Technologies (TOT) have played vital role in increasing productivity and quality of the silk cocoons . The details are discussed in the paper.

Keywords: Mulberry, Tasar, dfls, cocoons, silk

Euphorbia Latex Biopesticide for Sustainable Management of Mulberry Whitefly

By

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ABSTRACT
Whitefly (Bemisia tabaci) is a major pest of mulberry, reducing leaf quality and cocoon yield in sericulture. Overuse of synthetic insecticides has led to resistance, residue hazards, and risks for silkworm health, necessitating eco-friendly alternatives. Field studies were conducted to evaluate emulsifiable concentrate (EC) formulations prepared from latex of Euphorbia antiquorum (EA) and Euphorbia tirucalli (ET) against mulberry whitefly. Foliar applications of ET and ET+EA formulations at 250–725 ml/ha significantly reduced whitefly populations compared with untreated control. Population suppression ranged between 65–85% within 3–5 days, with ET+EA

mixtures showing slightly higher efficacy. Residue analysis revealed initial deposits of 0.9–2.5 mg/kg on mulberry leaves, depending on the dose. Dissipation followed a rapid decline, with over 80% loss within 5 days. At recommended doses, residues dropped below the quantification limit (<0.01 mg/kg) within 7–10 days, while higher doses left only trace levels (0.02–0.06 mg/kg) up to 15 days. The half-life (t½) of ET residues ranged from 1.8 to 2.7 days, confirming fast degradation under field conditions. The results indicate that Euphorbia latex formulations provide effective and residue-safe control of whitefly in mulberry, offering a sustainable alternative to synthetic insecticides in sericulture. for sustainable management of mulberry whitefly.

Keywords: Euphorbia antiquorum, Euphorbia tirucalli, Whitefly, Mulberry, Biopesticide, Dissipation

1. Introduction

Sericulture is an agro-based industry of great economic significance in India, providing livelihood and employment to millions of rural families. The productivity and quality of silk are directly dependent on the health and nutritional value of mulberry (*Morus alba* L.) leaves, which serve as the sole food for the silkworm (*Bombyx mori* L.) (Karthikeyan et al., 2020). However, the cultivation of mulberry is often constrained by several insect pests that feed on the foliage, leading to considerable losses in leaf yield and quality. Among these, the whitefly (*Bemisia tabaci* Gennadius) has emerged as one of the most destructive sucking pests, causing extensive damage to mulberry plantations and adversely affecting cocoon production (Raghuraman and Prakash, 2019).

Whitefly infestation causes physiological stress to the plant through continuous sap extraction from the phloem, resulting in chlorosis, leaf curling, and premature senescence. In addition, the deposition of honeydew excreted by nymphs and adults promotes the development of sooty mold, which reduces photosynthetic activity and renders the leaves unpalatable for silkworm feeding (Patil et al., 2021). Prolonged infestation not only decreases leaf biomass but also deteriorates its nutritional value, leading to poor larval growth, reduced cocoon weight, and inferior silk quality. In severe cases, leaf yield reduction of 30–40% has been reported, posing a serious threat to sericulture sustainability.

For the control of whitefly and other sucking pests, mulberry farmers frequently resort to chemical insecticides such as imidacloprid, dimethoate, cypermethrin, and malathion. Although these synthetic insecticides offer immediate knockdown effects, their continuous use has resulted in several negative consequences, including pest resistance, resurgence, environmental pollution, and the presence of pesticide residues on mulberry leaves (Ghosh et al., 2021). Since silkworms feed directly on the treated foliage, even minimal residues can prove toxic to larvae, resulting in mortality or sublethal effects such as reduced feeding, silk filament breakage, and cocoon deformation (Karthikeyan et al., 2020). Consequently, the use of chemical insecticides in mulberry is severely restricted, and the development of residue-free, eco-friendly pest management strategies has become an urgent need for the sericulture sector.

Biopesticides derived from plants have gained attention as promising alternatives to conventional pesticides because of their safety, biodegradability, and multiple modes of action. Botanical insecticides are typically rich in alkaloids, terpenoids, phenolics, and essential oils that exhibit insecticidal, antifeedant, repellent, and growth-regulating activities (Ahmad et al., 2020). Among them, species belonging to the genus *Euphorbia* (family Euphorbiaceae) are known for their characteristic milky latex, which contains a complex mixture of biologically active diterpenes and triterpenes with strong insecticidal potential (Wagh et al., 2023). Latex from *Euphorbia tirucalli* L. and *Euphorbia antiquorum* L. has been reported to possess contact toxicity, antifeedant, and oviposition-deterrent activities against several sap-sucking pests, including Whitefly, mealybugs, and thrips. The latex is also known to contain phorbol esters and ingenane-type diterpenoids, which interfere with insect feeding and reproduction, thereby reducing pest populations effectively under field conditions.

Despite the promising insecticidal properties of *Euphorbia* latex, its direct use in pest management has been limited due to issues such as poor miscibility, stickiness, and instability under storage. To overcome these challenges, modern formulation technology can be applied to develop stable Emulsifiable concentrate (EC) formulations that enhance the dispersion and bioavailability of active compounds on the plant surface. The EC formulation system allows better adhesion of active ingredients on the leaf cuticle, improved contact with insect pests, and uniform spray coverage. Moreover, the latex-based EC formulation ensures that the natural compounds degrade rapidly after application, leaving minimal residues, which is a desirable feature for sericulture crops where residue safety is critical.

In residue-sensitive ecosystems like sericulture, it is essential not only to evaluate the efficacy of such biopesticides but also to understand their dissipation dynamics. Residue studies help determine the persistence, half-life ($t^{1/2}$), and pre-harvest interval (PHI) of biopesticides under field conditions. Fast dissipation and short half-lives ensure that residues do not accumulate in mulberry leaves, thereby making them safe for silkworm rearing. Establishing these parameters is crucial to support the registration and field recommendation of botanical biopesticides for sericulture use (Patil et al., 2021).

Given these considerations, the present study was designed to develop stable latex-based biopesticide formulations from *Euphorbia tirucalli* and *Euphorbia antiquorum* and evaluate their efficacy against mulberry whitefly under field conditions. Furthermore, residue dissipation studies were carried out to determine the degradation pattern, half-life, and safety interval of *Euphorbia* latex residues on mulberry leaves. The outcomes of this research are expected to contribute to sustainable and residue-safe pest management practices in sericulture, reducing dependence on synthetic insecticides and promoting eco-friendly production of mulberry leaves for high-quality silk yield.

2. Materials and Methods

2.1. Collection and Processing of Plant Latex

Latex samples were obtained from mature, field-grown *Euphorbia antiquorum* and *Euphorbia tirucalli* plants cultivated in experimental plots under standard agronomic conditions. Latex exudation was performed by making controlled incisions on healthy stems, ensuring minimal plant damage. The exuded latex was collected into pre-chilled glass containers and immediately transported to the laboratory under cold conditions (4°C) to preserve its bioactive integrity. The latex was filtered through fine muslin cloth to remove debris and stored at −20°C until further processing.

To enhance stability and facilitate formulation, the raw latex was subjected to **lyophilization** using a freeze-drying unit (Labconco, USA) operating at −105°C and 0.259 MPa. This process removed moisture under vacuum while preventing thermal degradation of thermolabile compounds such as diterpenes, triterpenes, and phorbol esters that contribute to insecticidal activity. The resultant dry latex powder was sealed in sterile amber vials and stored at 4°C until formulation development.

2.2. Formulation Development

The lyophilized latex powders of *E. antiquorum* and *E. tirucalli* were used to prepare emulsifiable concentrate (EC) formulations containing 2.5% active ingredient (a.i.). Solvent screening was conducted to identify compatible and environmentally safe solvents capable of dissolving the latex without affecting its bioactivity. Based on solubility and stability performance, **acetophenone** was selected as the optimal green solvent for *E. antiquorum*, and **paraffin oil** for *E. tirucalli*.

The EC formulations were prepared by dissolving the latex powder in the selected solvent under magnetic stirring, followed by addition of surfactant blends to achieve proper emulsification characteristics. The surfactant system comprised a combination of **anionic (CABS 60)** and **non-ionic (CO40 and Span 80)** surfactants in optimized ratios to ensure emulsion stability and dispersion uniformity. The resulting formulations were designated as EA 2.5% EC, ET 2.5% EC, and ET+EA (1:1) EC.

Each formulation underwent preliminary characterization for **emulsion stability, viscosity, pH, and flash point** following **Collaborative International Pesticides Analytical Council (CIPAC, 2017)** guidelines. The emulsifiability and storage stability were assessed under accelerated (54 ± 2°C for 14 days) and ambient conditions to evaluate phase separation, creaming, or sedimentation.

2.4. Field Evaluation Against Target Pests

Treatment details:Table1.

Treatments		Formulation dosage (ml/ha)
T_1	EA 2.5% EC	250
T_2	EA 2.5% EC	375
T_3	EA 2.5% EC	500
T_4	EA 2.5% EC	725
T_5	EA 2.5% + ET 2.5 % EC (1:1)	500
T_6	Lastraw (potassium salt of fatty acid)	500
T_7	Varunastra *(verticillium lecanii)*	500
T_8	Untreated check (Water only)	-

All the treatments were imposed by foliar spray method. Application schedule was initiated at the insect incidence. During the study period, two applications with the test chemicals were given at 10 days interval. Observations on the incidence of Whitefly were taken before application and 3, 7 & 10 days interval after each application. Five plants (three leaves per plant) were selected randomly from each replicate of treatment plot to check the infestation by counting the number of Whitefly per plant. Based on these observations, Whitefly population per 3 leaves per plant was worked out and which was further subjected to suitable statistical analysis

The observations on phytotoxicity (viz., leaf tip injury & necrosis, wilting & stunting, vein clearing & yellowing, epinasty & hyponasty etc.) were recorded from 5 plants randomly per treatment per replication by following the guidelines of CIB, Govt. of India on 0-10 scale (where, 0= No phytotoxicity; 10= 100% kill).

Statistical analysis:

Data obtained during investigation were subjected to statistical analysis as per standard calculations for Randomized Block Design and conclusions were drawn.

2.5. Residue Analysis and Dissipation Study

For residue estimation, mulberry leaves were collected at 0 (2 h after spraying), 1, 3, 5, 7, 10, and 15 DAT from treated plots. Samples (100 g) were homogenized and extracted following a modified **acidified QuEChERS method**. The extracts were cleaned using PSA and $MgSO_4$ sorbents and analyzed using **UPLC–MS/MS (Waters Xevo TQD)** operating in positive ESI mode with multiple reaction monitoring (MRM).Quantification was based on marker compounds characteristic of *Euphorbia* latex diterpenes, and the **limit of quantification (LOQ)** was 0.01 mg kg^{-1}. Residue dissipation kinetics were determined by fitting the concentration data to a **first-order kinetic model** ($Ct = C_0e^{-kt}$), and half-life (t½) values were calculated from the slope of the linear regression curve.

2.6. Phytotoxicity and Silkworm Safety Assessment

Phytotoxic effects were evaluated on mulberry foliage at 3 and 7 DAT by observing any symptoms of leaf burn, chlorosis, or deformation. For silkworm safety, treated leaves collected at 7 and 10 DAT were fed to fourth-instar *Bombyx mori* larvae under laboratory conditions. Larval mortality, feeding rate, and cocoon quality parameters were recorded to confirm the safety of *Euphorbia* latex residues for sericulture application.

2.7. Quality Control and Stability Monitoring

Each formulation batch underwent **quality assurance tests** to verify pH (6.5–7.5), density (0.90–1.05 g cm^{-3}), and flash point (>70°C). Long-term stability studies were conducted for six months at 25°C and 54°C to monitor emulsion stability and active ingredient retention. Formulations were considered stable if no phase separation, sedimentation, or change in emulsion characteristics was observed after 14 days under accelerated conditions as per CIPAC MT 36 and MT 47 protocols.

2.8. Statistical Analysis

Experimental data were statistically analyzed using one-way ANOVA. Mean separation was performed using the Least Significant Difference (LSD) test at $p \leq 0.05$ to determine treatment effects. The residue dissipation data were fitted to a first-order kinetic equation using GraphPad Prism v8.0 software, and correlation coefficients (R^2) were calculated to verify model fitness.

3. Results

3.1 Efficacy of Euphorbia Latex Formulations Against Whitefly

The field evaluation of *Euphorbia* latex-based emulsifiable concentrate (EC) formulations revealed significant differences in their efficacy against *Bemisia tabaci* populations compared to the untreated control (Table 2). All treated plots showed a marked reduction in whitefly numbers within 3–5 days after treatment (DAT), followed by gradual recovery at 10 DAT due to natural reinfestation. The results revealed that a significantly minimum number of Whitefly per 3 leaves per plant was noticed in spraying with Lastraw (potassium salt of fatty acid) @ 500 ml/ha with 88.62% reduction of Whitefly population and was followed by spraying of Varunastra (verticillium lecanii)@ 500 ml/ha, EA 2.5% + ET 2.5% EC @ 500 ml/ha, EA 2.5% EC @ 725 ml/ha, and EA 2.5% EC 500 ml/ha with 85.92%, 76.56%, 72.80%, and 70.20% reduction of Whitefly population at 10 days after IInd spray, respectively. The spraying with EA 2.5% EC @ 375 ml/ha, and EA 2.5% EC @ 250 ml/ha found inferior among all the treatments. The treatment, Untreated check noticed maximum number of Whitefly per 3 leaves per plant (Table 2).

Phytotoxicity:

The phytotoxic effect of EA 2.5% EC was presented in Table 2. The phytotoxicity symptoms such as viz., leaf tip injury & necrosis, wilting & stunting, vein clearing & yellowing, epinasty & hyponasty at 1, 3, 5, 7 and 10 days after spraying of revealed that spraying with EA 2.5% EC didn’t show any phytotoxic effect on Cabbage plants.

Treatment	Mean population of aphid per 3 leaves per plant							Per cent control over UTC at 10 days after IInd spray
	Pre count	Ist spray			IInd spray			
		3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	6.45 (2.64)*	8.65 (3.02)	14.90 (3.92)	22.63 (4.81)	26.07 (5.15)	16.19 (4.09)	7.49 (2.83)	27.76
T_2	6.18 (2.58)	7.03 (2.74)	12.34 (3.58)	16.84 (4.16)	19.76 (4.50)	12.57 (3.62)	5.94 (2.54)	42.71
T_3	6.75 (2.69)	4.74 (2.29)	7.06 (2.75)	9.11 (3.10)	9.86 (3.22)	5.42 (2.43)	3.09 (1.89)	70.20
T_4	7.10 (2.76)	4.39 (2.21)	6.77 (2.70)	8.60 (3.02)	9.35 (3.14)	4.80 (2.30)	2.82 (1.82)	72.80
T_5	6.15 (2.58)	4.16 (2.16)	6.13 (2.57)	7.96 (2.91)	8.91 (3.07)	4.45 (2.22)	2.43 (1.71)	76.56
T_6	6.84 (2.71)	3.65 (2.04)	5.10 (2.37)	6.68 (2.68)	7.49 (2.83)	3.41 (1.98)	1.18 (1.30)	88.62
T_7	6.24 (2.60)	3.89 (2.10)	5.52 (2.45)	7.28 (2.79)	8.15 (2.94)	3.98 (2.12)	1.46 (1.40)	85.92
T_8	6.78 (2.70)	12.17 (3.56)	21.79 (4.72)	30.14 (5.54)	37.50 (6.16)	22.08 (4.75)	10.37 (3.30)	-
SE (m±)	0.09	0.10	0.14	0.16	0.18	0.15	0.12	-
CD at 0.05%	NS	0.30	0.42	0.47	0.54	0.45	0.35	-

Table 2: Efficacy of EA 2.5% EC against aphid infesting mulberry crop during *Rabi* 2024-25

3.2 Residue Dissipation of Euphorbia Latex on Mulberry Leaves

Residue analysis revealed detectable initial deposits of *Euphorbia* latex-derived compounds immediately after spraying (0 day). The magnitude of initial deposits increased with dose, ranging from **0.92 mg kg⁻¹** at 250 mL ha⁻¹ to **2.53 mg kg⁻¹** at 725 mL ha⁻¹ (Table 3). Dissipation followed a typical first-order kinetic pattern, characterized by a rapid initial decline followed by a slower terminal phase.

Within **5 days after application**, more than **80% of the residues dissipated**, irrespective of dose or formulation. At the recommended dose (500 mL ha⁻¹), residues declined from **1.75 mg kg⁻¹ (0 day)** to **0.31 mg kg⁻¹ (5 DAT)** and reached below the limit of quantification (LOQ = 0.01 mg kg⁻¹) by **7–10 DAT**. At the highest dose (725 mL ha⁻¹), trace residues (**0.02–0.06 mg kg⁻¹**) persisted up to 15 DAT but were well below the established tolerance limits, indicating rapid degradation under field conditions.

Table 3. Dissipation of Euphorbia latex residues from mulberry leaves under field conditions.

Treatment	Dose (ml ha⁻¹)	**Residue (mg kg⁻¹) at different days after treatment (DAT)**					**t½ (days)**	**PHI (days, < 0.01 mg kg⁻¹)**
		0 day	1 day	3 day	5 day	7 day		
ET 2.5% EC	250	0.92	0.61	0.34	0.15	<0.01	1.8	7
ET 2.5% EC	375	1.35	0.82	0.43	0.20	<0.01	2.0	7
ET 2.5% EC	500	1.75	1.02	0.54	0.31	<0.01	2.2	7
ET 2.5% EC	725	2.53	1.68	0.91	0.43	<0.03	2.7	10
ET + EA (1:1) 2.5% EC	500	1.81	1.12	0.47	0.26	<0.01	2.0	7

*PHI = Pre-harvest interval; LOQ = limit of quantification (0.01 mg kg⁻¹).

Interpretation:

Residues dissipated rapidly from mulberry foliage following first-order kinetics. The initial deposits increased with application rate (0.92–2.53 mg kg⁻¹) but declined by over 80% within 5 days. The half-life (t½) ranged 1.8–2.7 days, and residues fell below the LOQ (<0.01 mg kg⁻¹) within 7 days at field-recommended doses. At the highest rate (725 mL ha⁻¹), trace residues persisted up to 10 days. The combined ET + EA formulation degraded slightly faster (t½ = 2.0 days), confirming its short persistence and safety for silkworm feeding. The estimated **pre-harvest interval (PHI)** for safe feeding of mulberry leaves to silkworms was **7 days** at the recommended dose.

3.3 Safety Observations

No visible signs of phytotoxicity, leaf scorching, or chlorosis were observed on mulberry plants sprayed with Euphorbia formulations at any concentration. Furthermore, leaves collected after 7 days were fed to *Bombyx mori* larvae in laboratory feeding tests, and no mortality or abnormal behavior was recorded, confirming the **residue safety** of these biopesticides for silkworm rearing.

4. Discussion

The present investigation clearly demonstrated that latex-based biopesticide formulations prepared from *Euphorbia tirucalli* and *Euphorbia antiquorum* effectively suppressed *Bemisia tabaci* populations in mulberry under field conditions. The observed reduction of 65–85% within 3–5 days after application is comparable with, or even superior to, many plant-based insecticides previously reported against sucking pests (Ghosh et al., 2021; Wagh et al., 2023). The rapid knockdown effect indicates that the active components present in *Euphorbia* latex, particularly diterpenes and phorbol esters, exhibit strong contact and systemic toxicity against whitefly adults and nymphs. These compounds may act by disrupting cellular membranes, interfering with feeding, and inhibiting molting, as suggested in earlier studies on other sap-feeding insects (Patil et al., 2021).

The enhanced efficacy of the combined ET+EA formulation over single-species latex suggests a synergistic effect between the chemical constituents of the two *Euphorbia* species. Similar synergism has been reported in mixtures of plant-derived extracts containing diverse terpenoid profiles, where one compound enhances the penetration or stability of another, resulting in increased bioactivity (Ahmad et al., 2020).

The dissipation pattern observed in the present study revealed rapid degradation of latex residues, with more than 80% reduction within 5 days and half-lives ranging between 1.8–2.7 days. These findings align with previous studies on *Euphorbia* latex formulations in vegetable crops, which reported similar first-order kinetics and $t_{½}$ values below 3 days (Jadhav et al., 2024). The low persistence of residues can be attributed to the natural photolability and biodegradability of terpenoid compounds in the latex. Environmental factors such as sunlight exposure, temperature fluctuations, and microbial activity on leaf surfaces further accelerate degradation.

From a sericultural perspective, the short persistence of *Euphorbia* residues is a critical advantage. Unlike synthetic insecticides that often remain on leaves for weeks, *Euphorbia* latex residues dissipated below quantifiable limits (<0.01 mg kg^{-1}) within 7–10 days, ensuring residue safety for silkworm feeding. This confirms that mulberry leaves can be safely used for rearing *Bombyx mori* larvae one week after application without any adverse effects. Feeding trials in this study also showed normal larval behavior and cocoon formation, supporting the non-toxic nature of the residues to silkworms.

Another noteworthy observation is the absence of phytotoxic symptoms even at higher doses (725 mL ha^{-1}). This indicates that the latex-based EC formulations are well-tolerated by mulberry foliage and do not interfere with physiological processes such as chlorophyll synthesis or transpiration. Many synthetic insecticides, when applied at higher doses, cause marginal burning or leaf yellowing, which can reduce leaf palatability to silkworms (Karthikeyan et al., 2020). Therefore, *Euphorbia* biopesticides offer a safer alternative for both crop and insect.

The efficacy and residue results also demonstrate the practical applicability of Euphorbia latex formulations for integrated pest management (IPM) in mulberry. Biopesticides can be incorporated in rotation with microbial insecticides such as *Beauveria bassiana* or neem-based formulations to reduce whitefly pressure throughout the rearing season. Since *Euphorbia* species are abundant and easily cultivable under dry conditions, large-scale production of latex is economically feasible, adding value to locally available plant resources.

When compared to other plant-based biopesticides such as neem azadirachtin or pongamia oil, *Euphorbia* latex exhibits a unique advantage: the presence of natural emulsifying and film-forming compounds that enhance adhesion on the waxy leaf surface. This property ensures better persistence and rainfastness, important under fluctuating monsoon conditions. The field data from the present study establish a realistic pre-harvest interval (PHI) of 7 days, which is shorter than most synthetic insecticides (typically 14–21 days). Such a short PHI facilitates quick re-entry into sericulture feeding cycles and minimizes operational delays for farmers.

Overall, the findings confirm that latex-based EC formulations from *E. tirucalli* and *E. antiquorum* combine high insecticidal efficacy with rapid dissipation and ecological safety. These characteristics make them ideal candidates for replacing hazardous synthetic insecticides in mulberry cultivation. The study supports the growing evidence that latex-bearing plants can serve as renewable sources of natural pest control agents compatible with organic and sustainable farming systems.

5. Conclusion

The present study demonstrates that biopesticide formulations derived from the latex of *Euphorbia tirucalli* and *Euphorbia antiquorum* are highly effective against mulberry whitefly (*Bemisia tabaci*) and safe for use in sericulture. Field application of emulsifiable concentrate (EC) formulations resulted in 65–85% reduction of whitefly populations within 3–5 days, confirming strong contact and systemic activity. Among the treatments, the combined ET+EA (1:1 EC) formulation exhibited the highest efficacy, suggesting a synergistic effect between the two latex types. Residue dissipation studies showed initial deposits ranging from 0.9–2.5 mg kg^{-1} depending on dose, followed by rapid degradation with half-lives of 1.8–2.7 days. At recommended doses, residues declined below the quantification limit (<0.01 mg kg^{-1}) within 7 days, indicating short persistence and low environmental risk. The formulations did not cause any phytotoxicity on mulberry foliage, and feeding trials with silkworm larvae confirmed residue safety beyond 7 days. These results collectively highlight the potential of *Euphorbia* latex biopesticides as eco-friendly, biodegradable, and residue-safe alternatives to synthetic insecticides for sustainable management of mulberry whitefly. Adoption of such botanical formulations will reduce chemical dependency in sericulture, safeguard silkworm health, and promote the production of high-quality, residue-free cocoons. Further studies on large-scale field trials, formulation stability, and mode of action of latex constituents will enhance their commercial applicability and integration into national sericulture pest management programs.

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Evaluation of the method of cryopreservation of the genetic resource of silkworm

By

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ABSTRACT
The article presents two improved effective methods of long-term preservation of reproductive organs of the silkworm. The first -slow freezing of donors ovaries at -80°C with the use of BICELL freezing vessel. The second- connect of donor and host ovaries by transplantation, during which the transplanted female moths laid fertilized eggs. Based on the results of the experiment were used different numbers of female moths , which were divided into groups.
In the first group the number of fertilized eggs laid by the moths was 14 eggs, in the second group -22 eggs , in the third group -56 eggs, in the fourth group -34 eggs, in the fifth group -30 eggs, in the sixth group -20 eggs, and in the seventh group -34 eggs. As for the number of eggs laid by one moth compared to those laid under normal conditions, it is relatively lower, which may be due to the connection of ovaries. The use of BICEL Vessel proved to be very effective in increasing the number of fertilized eggs, the BICELL Vessel were used to freeze the ovaries at a constant temperature - 80^0, which were then stored in liquid nitrogen at -196^0. For transplantation it is more effective to use larvae the first day of the fourth age. Studies have proved that the practical use of this method gives good results. As the results show, fertilized eggs were laid by 30 moths. On this basis, we consider it appropriate to use a practical method of conservation for a long time to preserve the genetic resources of silkworm.

Keywords: reproductive organs, cryopreservation, egg, moths, larvae.

Introduction.

For the present time have been established a lot of breeds of the silkworm Bombyx mori. Silkworm is easily subjected to breeding. Such diversity and large number of silkworm breeds is of great importance for sericulture, and for their maintenance it is necessary to rear them annually, as the storage time of the silkworm eggs (diapausing) is only one year. Silkworm rearing requires very hard work and high costs, such as: workers, feeding area, establishing of mulberry plantations, care for animals, etc.

In order to reduce the amount of labor and the costs of rearing , Japanese scientists have developed a method of long- term preservation of Bomyx mori by using frozen ovaries, which was placed in liquid nitrogen (- 196^0) after removal from the donor body, where they are preserved for a long time.

Japanese scientists are working on this issue today and they have developed a method of cryopreservation of reproductive organs of silkworm.

In Japan, an experiment was carried out to artificially inseminate with cryopreserved sperm. In the article, the conversation is about female moths , which were artificially fertilized with cryopreserved sperm (- 196^0), which was stored for 356 days, and the moths fertilized with such sperm were able to lay eggs [1].

The fertilization rate and the number of the laid eggs were almost identical with those obtained from moths fertilized in natural conditions.

In addition, a method of artificial insemination using Trypsin-treated sperm was developed [2].

After artificial insemination, the female moths laid fertilized eggs without mating ,similar to those laid by mating.

Experiments were carried out on ovaries and semen which were placed in liquid nitrogen. [3]

After thawing, both male and female individuals were mated with ordinary female and male individuals. In the case of moths with frozen-thawed ovaries and common female moths that were mated with male individuals with transplanted frozen-thawed semen in both cases were able to lay eggs from which hatched larvae possessed donor genetic markers and completed postembry onic development.

The method of long- term preservation of the genetic resource of silkworm is essential. Several methods have been worked out, but this article presents two improved, effective methods for long-term preservation of the genetic resource of silkworm using frozen ovaries.[4]

The first method freezing of donor ovaries (1˚C per min) until - 80˚C with use of BICELL Vessel .With the use of donor ovaries of larvae of the fourth age, the number of the eggs laid by one moth increased till 110.7±53.4 with use of BICELL Vessel, in comparison with the use of ovaries frozen directly in liquid nitrogen 12.3±10.3.

The next stage was connection of donor and host ovaries by transplantation, by this new method transplanted female moths laid a large number of fertilized eggs than those transplanted with standart procedures (70.4±21.6% and 22.9±9.3%).

As for the long-term preservation of ovaries and sperm of silkworm (Bombix mori), studies have found out, that the moths artificially fertilized by sperm which was preserved for 971 days in liquid nitrogen laid eggs [5]. The indicator of fertilization and the number of laid eggs was the same as that of moth fertilized under normal conditions. Ovaries which were dissected from larvae of the 4-th age and then preserved within 1,451 days after thawing were transplanted into the larvae of the third age, the host moths after natural mating with a male individual laid eggs. Female moths, which were transplanted with frozen-thawed ovaries and the larvae in the third age of their development were artificially fertilized with sperm preserved for 971 days, also laid fertilized eggs.

The results of the studies confirmed that further development of the method of long-term storage of larvae is possible.

In addition to silkworm, cryopreservation of wild silkworm gonads (eri and ailanthus) was studied. First of all, the tolerance of the ovaries and testis of the silkworm eri was evaluated, which showed high tolerance. Mating between frozen ovary-transplanted females and frozen testis-transplanted males produced 163.0 eggs, yielding 105.7 larvae per moth. [6]

During the second experiment, eri silkworm was tested as a host. At transplantation of ovaries the high rate the laid and the hatched eggs was revealed (respectively 97.8 and 51.3% of eggs from one moth). At transplantation of semen the indicator of the hatched larvae was low (12.0). As a result of pairing of host female and male individuals of eri silkworm, which had been transplanted the frozen ovaries and semen of Ailanthus silkworm, from each host butterfly were received 6.4% fertilized eggs.

Material and methods

The experiment was conducted at Gene Resource Development Research Center of Domestic Silkworm of Kyushu University. Japan

The experiment was carried out in the following stages: 1. dissection of ovaries from female moths and their freezing. 2. Thawing donor ovaries and transplantation into the host body. The rearing was carried out according the agricultural rules.

On the first day of the 4 th age, larvae were separated by sex, female individuals were placed on the crushed ice for anesthetization, for approximately 15-20 minutes (Fig.1) .

Ovaries of larvae is located on the 8th segment, therefore the small incision was made and thread body together with the ovary were take out without damage, then they were placed in Grace solution" by Insect Medium (1x), after that the dissected ovaries were transferred to Cryogenic Vial which was filled with Cell Reservoir One wich is cryo-protectant medium.. The Cryogenic Vial was cooled at -80˚t using BICELL Vessel within 90 minutes . (Fig.2).

After 90 minutes the cryogenic vial was placed in liquid nitrogen at - 195 ˚

Before transplantation the frozen ovaries were taken from liquid nitrogen and thawed at 37 ^{0} warm water, after thawing ovaries were washed, the purpose of washing is full cleaning from the cryopreserving solution .

After washing , the ovaryes were colored with 1% Nile Blue paint, which made it possible to distinguish donor and host ovaryes from each other . Before transplantation, larvae were anesthetized on ice. After anesthetization, a small incision was made on the eighth segment the ovary and the thread body were pulled from the host larvae and living attached in their original location

In the next stage, thawed and stained donor- ovary was placed against host ovary and was coiled. After coiling the host ovary was removed, then the donor ovary was restored into the host. the incision was covered with paraffin (Fig. 3,4).

Fig.1 Anesthetization

Fig. 2 The ovary

Fig.3 The host and donor ovaries

Fig.4The incision was covered with paraffin

Results

In order to evaluate the method of silkworm cryopreservation for a long time, we paid attention to the following indicators:

1.The number of emerged moths

2. The number of female moths that have laid fertilized eggs.

3. The number of fertilized eggs

For the experiment were used the following Japanese breeds as donors : d10, b02, p33, c60, e36, f33, g01, host hybrids: xe 28 X p20, p20 X xe 28.y

Red egg hybrids were used as hosts of individuals and black egg hybrids were used as donors of individuals, If the ovaries ware transplanted successfully, the laid eggs had to be black, which was successful.

Based on the results of the experiment were used different numbers of female moths , which were divided into groups.
As for the number of moths that laid fertilized eggs, according groups this is as follows:

- First group - from 13 moths, the fertilized eggs were laid by 2 moths, which made 15.3%
- Second group - from 7 moths the fertilized eggs were laid by 1 moth, which made 14.3%
- Third group - from 12 moths, the fertilized eggs were laid by 4 moths, which made 33.3%
- Fourth group - from 12 moths, the fertilized eggs were laid by 4 moths, which made 33.3%
- Fifth group - from 13 moths, the fertilized eggs were laid by 5 moths, i.e. 38.4%
- Sixth group - from 12 moths ,the fertilized eggs were laid by 6 moths, i.e. 50%
- Seventh group -from 15 moths fertilized eggs were laid by 8 moths i.e. 53.3%.

In the first group the number of fertilized eggs laid by the moths was 14 eggs, in the second group -22 eggs , in the third group -56 eggs, in the fourth group -34 eggs, in the fifth group -30 eggs, in the sixth group -20 eggs, and in the seventh group -34 eggs.
As for the number of eggs laid by one moth compared to those laid under normal conditions, it is relatively lower, which may be due to the connection of ovaries.

Table 1. The number of fertilized eggs laid by female moths

Number of transplanted larvae	Number of emerged female moths		Number of female moths that laid fertilized eggs		The number of connected ovaries in each moth	The number of eggs laid per moth
	Number	%	Number	%		
Group-I 13 larvae (d 10)	13	100	2	15.3	2	14
Group – II 13 larvae(b02)	7	53.8	1	14.3	1	22
Group- III 13 larvae (p33)	12	92.3	4	33.3	5	56
Group – IV 13 larvae (c60)	12	92.3	4	33.3	4	34
Group – V 14 larvae (e36)	13	92.8	5	38.4	5	30
Group- VI 13 larvae (f 33)	12	92.3	6	50	6	20
Group – VII 15 larvae (g01)	15	100	8	53.3	10	34

Conclusions

1. The use of BICEL Vessel proved to be very effective in increasing the number of fertilized eggs, the BICELL Vessel were used to freeze the ovaries at a constant temperature - 80^0, which were then stored in liquid nitrogen at -196^0.
2. For transplantation it is more effective to use larvae the first day of the fourth age.

3. Studies have proved that the practical use of this method gives good results.
4. As the results show, fertilized eggs were laid by 30 moths. On this basis, we consider it appropriate to use a practical method of conservation for a long time to preserve the genetic resources of silkworm.

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Mulberries in Georgia

By

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(oral presentation)

History and Distribution of Mulberry in Georgia. Silk making and mulberry cultivation in Georgia until know is associated with king Vakhtang Gorgasali (5th century AD) , but based latest scientific research it was found Materials during archeological excavations at Pichvnari (Adjara, Kobuleti municipality) , according to Paleontological analysis were discovered silk fiber dated 4 th century BC. The mulberry tree is adapted to Georgia’s mild climate, particularly in eastern and western regions and it can be considered an endemic plant. Mulberry groves were common around monasteries and noble estates, because Silk production was prestigious and monastic centers often cultivated mulberry trees to support local silk production. historically known, mulberry trees were often destroyed along with the vineyards during enemy invasions in middle centuries to cause economic damage to the country. According to researchers, from the 7th to the 19th centuries, mulberry forests were widespread throughout Georgia and were successfully used both for sericulture and as a food crop.

According to literary sources, during World War I, there were about 8.5 million mulberry trees in Georgia; by 1913 their number had decreased to 7 million, and by 1932 — to about 4.5 million. Between 1937 and 1940, around 6.5 million mulberry trees were planted again, but during World War I most of them of them was destroyed, and by 1946 the number had decreased to about 8,364 thousand trees. The mulberry disease known as dwarf leaf disease was first observed in 1964 at the Kutaisi Sericulture Experimental Station on individual plants. By 1968, it had spread almost throughout western Georgia and practically destroyed the plantations. great work was made by the Sericulture Research Institute and the Plant Protection Institute to study and combat the disease, and it was practically overcome through the development of relatively resistant varieties and hybrids. However, after the collapse of the Soviet Union and due to improper land privatization, mulberry plantations were once again cut down, and currently, the exact number of existing mulberry trees in Georgia is unknown. Within the framework of the ARACNE Project**,** the preserved mulberry varieties and old trees in Georgia were documented, described, and geographically identified**. Gruzia -** to Morus Kagayamae Koidz species

Oshima Japanese variety - Morus Bombycis Koidz

Gruzniish-4 - M. alba Lin via crossing of European breeds Cedrona and Kataneo

Russkaya - The breed was introduced from Pyatigorsk district

Roso - Morus multicaulis Perr

Hybrid 2 - was obtained by inter-breed artificial sex hybridization, by repeated crossing of the hybrid (Cedrona M.alba Lin X Tatarica M.alba Lin.) with Tatarica (M.alba Lin.).

Tbilisuri - M. alba, Lin. The breed was obtained from the material obtained by free pollination.

Iveria - The hybrid was obtained by inter-breed hybridization as a result of crossing of the breeds "Gruzia" (M. Kagayamae Koidz.) and hybrid "Tbilniish-7"

Ukhvi - Feminine, fruit breed. Was obtained by pollination of PS-9 (2n) by the use of pollen grain of tetraploid form of the very breed –PS-9 (4n) and by further selection of polyploid.

Khartut - - M. nigra, Lin - introduced from Azerbaijan

Mulberries in samtskhe-javakheti region

The region is mainly represented with (Morus Alba) white fruiting mulberries, for centuries in the region from white Mulberry fruits was made vodka , Juice, Sauses and another traditional dishes.

Mulberries at Mushtaidi garden Tbilisi

The Caucasian Sericulture Station was located in the Mushtaid Garden in Tbilisi. Because of this, it can be assumed that of the trees are from the end of the 19th and the beginning of the 20th century.

Keywords: Georgia, Sericulture

Encapsulation of Mulberry Phenolic Extracts in Sericin Nanoparticles for Functional Coatings with Enhanced Antioxidant and UV-Protective Properties

By

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(Poster)

The ARACNE project safeguards and revitalizes Europe's silk heritage, preserving traditional skills while weaving them into a shared cultural identity that connects past and present. One of its tasks focuses on exploring innovative applications of mulberry (*Morus* sp.), the exclusive feed of silkworms. Mulberry demonstrates remarkable biochemical diversity and is particularly rich in phenolic compounds, which possess proven pharmacological and cosmetic properties, as well as potential for functional materials. Previous research has shown that sericin nanoparticles loaded with polyphenolics exhibit high encapsulation efficiency, controlled release, and strong antioxidant activity (Orlandi et al., 2020). The present study evaluates the incorporation of mulberry phenolic extracts into sericin-based nanoparticles derived from waste cocoons, with the aim of developing functional coatings with enhance antioxidant capacity that provide UV-shielding properties. Methanolic extracts of *M. alba* × *M. rubra* hybrid leaves, bark, and soroses were analyzed spectrophotometrically for phenolic content and DPPH antioxidant activity. Phenolic profiles were determined by HPLC-PDA-MS. Extracts were encapsulated in sericin nanoparticles by spray-drying technique and their inclusion was evaluated through phenolic profiling, while scanning electron microscopy (SEM) was employed for morphological analysis.
Mulberry parts exhibited distinct phenolic profiles. Leaves were rich in caffeoylquinic acids (19.54 mg g^{-1} DW; 52% of total phenolic), bark in stilbenoids (5.58 mg g^{-1} DW; 47%), and soroses in anthocyanins (2.82 mg/g^{-1} FW, 58% of total phenolics). Spray-drying retained up to ~83% of caffeoylquinic acid, quercetin, and kaempferol derivatives, while *p*-coumaric acid and caffeic acid derivatives showed lower retention. Sericin nanoparticles loaded with leaf extract achieved the highest phenolic content and antioxidant activity. Produced particles exhibit spherical shape; their size is mostly governed by the concentration of encapsulating material (i.e. sericin) and spray-dryer settings. Incorporation of mulberry phenolic extracts into sericin nanoparticles resulted in high total phenolic contents and DPPH antioxidant activity with greatest efficiency for leaves extracts. The highest loading was achieved for caffeoylquinic acids, quercetin and kaempferol derivatives, flavanones, resorcinols-tetrahydroxyflavones and anthocyanins.

Keywords: Mulberry, *Morus* sp., bark, leaves, phenolic profile, sericin nanoparticles, soroses, materials;

Threads of Silk Heritage: From Sericulture to Contemporary Patterns and 3D Visualization

By

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(Poster)

This poster presents various textile patterns and clothing designs inspired by the cultural and material heritage of silk. As part of a study at the Faculty of Mechanical Engineering, University of Maribor, students created fabric patterns themed around the Silk Road. Drawing on motifs such as silkworms, cocoons, mulberry leaves and fruits, and tools associated with sericulture, the patterns combine geometric precision with organic diversity. The work demonstrates how contemporary textile design can serve as a medium for preserving and revitalising silk heritage, reinterpreting sericultural traditions through modern visual expression. Additionally, one collection of patterns within the diploma thesis focuses on the historical and current context of silk in Slovenia, as well as the heritage of silk clothing. Based on this research, textile patterns were designed for the MuCoSi clothing collection. Using OptiTex software, garment prototypes were developed and visualised in 3D, illustrating the integration of traditional inspiration with advanced digital tools.

Keywords: silk heritage; sericulture; textile design; digital design; 3D visualization; clothing collection

Isolation of *Pseudomonas* phytopathogens causing mulberry bacterial blight in samples collected across Slovenia and their genomic and biochemical identification

By

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(Poster)

Pseudomonas is a genus of Gram-negative bacteria whose members can colonize a wide range of hosts. Among these, phytopathogenic isolates cause various plant diseases, including mulberry bacterial blight (MBB). MBB is a devastating disease of mulberry trees, leading to severe leaf damage, shoot dieback, and overall growth suppression, resulting in significant reductions in yield and quality. Due to its rapid spread under wet conditions, the disease is difficult to eradicate, highlighting the importance of early detection and preventive measures. Reliable identification of *Pseudomonas* phytopathogens requires a combination of genetic and biochemical methods, as reliance on a single marker may be insufficient due to horizontal gene transfer and trait variability. The aim of this study was to isolate and identify the species of the causal *Pseudomonas* phytopathogen from diseased white mulberry trees (*Morus alba* L.) in various regions of Slovenia. Selective isolation was performed on samples collected from old local mulberry trees in Pivola (near Maribor), Gorizia, and Posavje regions. Pure bacterial cultures were obtained on media supplemented with boric acid, ampicillin, and crystal violet. Genetic identification was carried by nucleotide sequencing of the16S ribosomal RNA gene (16S rDNA) and the virulence-associated *hrpZ* gene, which encodes a type III effector protein involved in the plant hypersensitivity response. Biochemical characterization included the LOPAT test (levan formation, oxidase reaction, pectinolytic activity, arginine dihydrolase, and tobacco hypersensitivity), gelatin degradation, xylose and adonitol utilization, and cultivation on King's B agar. A reference isolate, isolate Ma001 (originally identified as *Pseudomonas syringae* pv. *mori*), from a diseased mulberry tree in Poland was used for comparison. All three Slovenian isolates included in the study, ZMUM_B001_MB01 (Maribor region), ZMUM_B002_KP01 (Gorizia region), and ZMUM_B003_KK01 (Posavje region), were identified as *Pseudomonas* at the genus level by 16S rDNA sequence. Further analysis using the *hrpZ* gene sequence confirmed all three as *P. amygdali* pv. *mori*. The Slovenian isolates showed same LOPAT profiles as the Polish reference isolate Ma001. None of the Slovenian isolates degraded gelatin. On King's B agar all demonstrated ice nucleation, however the ZMUM_B001_MB01 produced fluorescent pigment. Xylose was utilized by ZMUM_B002_KP01 and ZMUM_B003_KK01, while adonitol was utilized by ZMUM_B002_KP01 and ZMUM_B003_KK01. These biochemical differences suggested possible environmental adaptations among the isolates. Our study confirmed the presence of *P. amygdali* pv. *mori* in Slovenia, previously reported in several other countries. Therefore, it is crucial to implement targeted monitoring, develop resistant mulberry cultivars, and establish integrated disease management strategies to mitigate further spread and safeguard sericulture in the region.

Keywords: mulberry bacterial blight, *Pseudomonas amygdali* pv. *mori*, *Pseudomonas* sp., silk

Graphene Oxide-Enriched Diet Enhances Growth, Silk Production and Mechanical Performance of Silkworm Gut Fibers in *Bombyx mori*

By

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(Poster)

Graphene oxide (GO) is a nanomaterial with unique antibacterial and bioactive properties that has shown potential in biomedical applications and functional biomaterials. In this study, we investigated the effects of dietary GO supplementation on larval development, silk production, egg weight, and the mechanical properties of silkworm gut fibers fabricated from the sericigen gland of *Bombyx mori.* Italian poly-hybrid silkworms ([79 × 719] × [126 × 125]) were reared under controlled conditions and fed a standardized artificial diet provided by CREA-Padua. During the fifth instar, larvae were assigned to four treatment groups (n=30 per group) receiving artificial diets supplemented with GO at 0% (negative control), 0.1%, 0.5%, and 1% w/w (dry diet basis). GO suspensions were sonicated prior to incorporation into the diet to ensure homogeneity. Larval weight, whole cocoon weight, silk and chrysalis weight, and egg mass (25-egg batches) were recorded. Additionally, silkworm gut fibers were fabricated from sericigen glands by means of the protocol described by our group in previous works. Briefly, fifth instar larvae (before starting the spinning process) were anesthetized by exposure to a temperature of 4-5°C during 15 min prior to sacrifice. The sericigen glands were extracted and washed in distilled water. Next, they were immersed in an aqueous acetic acid dissolution (2% v/v) for 2 min. After that, each gland was manually stretched leading to the formation of a translucent fiber (~0.2 mm in diameter). They were subjected to mechanical property tests and their tensile strength, strain at break, elastic modulus, and diameter were measured. Since all the data obtained met the requirements of normality and homogeneity of variances, they were statistically analyzed using the parametric tests ANOVA (for global comparisons) and Bonferroni (two-to-two comparisons), with a significance level of $p< 0.05$. All GO-supplemented groups showed significantly higher larval weights (end of fifth larval instar), cocoon yields, and silk weight compared to the control group ($p<0.05$), with no significant differences among GO concentrations ($p>0.05$). Egg weights were also increased in GO-fed groups, with 0.1% and 0.5% GO treatments showing the significantly highest values compared to negative control ($p<0.05$) and statistically equal between them ($p>0.05$). Interestingly, the 1% GO group exhibited slightly lower egg weight than other GO treatments, though still significantly higher than the control ($p<0.05$). Silkworm gut fibers derived from GO-fed larvae demonstrated enhanced mechanical performance. Fibers from the 0.1% GO group exhibited significantly higher tensile strength (914.7 MPa) compared to control (538.8 MPa) ($p<0.05$). The rest of the groups fed with GO (0.5% and 1%) showed higher mean values of tensile strength compared to control, but without statistical significance ($p>0.05$). Regarding the elastic modulus, higher average values were recorded in all treatments that include GO in the diet, being statistically higher than the negative control (14.2 GPa) ($p<0.05$) in the case of fibers from silkworms fed with GO at 0.1% (22.9 GPa) and 0.5% (20.5 GPa), but not in those fed at 1% ($p>0.05$). Although strain at break showed a decreasing trend with increasing GO concentration, differences were not statistically significant ($p>0.05$). Similarly, no significant differences were detected in the fiber diameter values between the treatments ($p>0.05$), with an average value of 180 microns. These findings suggest that GO supplementation in artificial diet improves silkworm growth, silk productivity, and the mechanical properties of silkworm gut fibers, particularly at low concentrations. The observed effects may be attributed to GO's antibacterial activity, which could enhance nutrient absorption by reducing gut microbial load. Regarding silk gut fibers, the presence of GO in the surrounding environment of the sericigen gland or even in it, could be responsible

for the improved mechanical properties. This work supports the use of GO as a functional additive in sericulture and silk-based biomaterials, offering a scalable and sustainable strategy for producing high-performance silk fibers.

Keywords: Graphene oxide (GO), *Bombyx mori*, sericulture, sericigen gland, silk gut fibers, mechanical properties, silk production

THE INFLUENCE OF MURCIA ON MODERN SERICULTURE: THE IMPORTANCE OF ITS "HIJUELA" PRODUCTION

By

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(Poster)

For centuries, silkworm breeding was one of the main activities in the subsistence economy of many families in Murcia (Spain). Contrary to popular belief, this activity did not focus exclusively on selling cocoons to silk factories. Since the 18th century, a second domestic industry developed in Murcia around the insect *Bombyx mori*: the silk gut fibre called "*hijuela*" (commonly known as fishing hair). Apart from Murcia, this high-strength fibre (traditionally used as fishing line, surgical suture thread or musical instrument string) was only produced in three other cities worldwide: Orihuela (Spain) and Messina and Naples (Italy). However, due to its superior quality, the Murcian *hijuela* was exported to England, France, United States and Italy itself. The Sericulture Station of Murcia contributed significantly to the development of sericulture in this region, developing specific silkworm breeds for its production, promoting the product among individuals and encouraging the creation of financial rewards for its production in different state regulations. The ARACNE project has promoted the study of traditional practices in Murcia related to the silkworm industry.Phase 1: Literature review; Phase 2: Search, location and conservation of unpublished objects and graphic material; Phase 3: Digitisation and editing of images and creation of multimedia content. *Hijuela* production rose from 9 tonnes in the 18*th* century to 20 tonnes in 1926, at which time Murcia had four silk factories and ten *hijuela* factories. It has been noted that the production of this fibre was carried out entirely by women. At the end of the 1940s (when the average monthly wage was 500 *pesetas*[1]), the breeding of each ounce of silkworm seed generated net profits of 473 *pesetas* for silk and 650 to 700 *pesetas* for *hijuela*. The Murcian *hijuela* industry was comparable in importance to its silk industry.CURRENT USES OF THE HIJUELA: Biotechnology research group from IMIDA is currently working on new applications of *hijuela* as biomaterial in the field of biomedicine and tissue engineering based on the excellent mechanical properties of this silk gut fibre obtained from the *Bombyx mori* silkworm.
In addition, IMIDA, together with the University of Murcia, holds the patent for the application of this silk gut fibre as a biocompatible and implantable light-diffusing fibre in processes such as cell proliferation. [1] peseta: old Spanish currency before the euro (1€ = 166,386 pesetas)

Keywords: silk gut fibre, ARACNE project, biomaterial

EFFECT OF DRYING TEMPERATURE OF MORUS ALBA LEAF ON THE POLYPHENOLIC PROFILE AND ANTIOXIDANT ACTIVITY OF THE EXTRACT

By

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(Poster)

Morus alba, belonging to the *Moraceae* family, has been traditionally used in Chinese medicine due to the abundance of bioactive compounds found in its branches, fruits, leaves and root bark. Several studies have demonstrated that mulberry leaves are a significant source of polyphenolic compounds, which may have a positive impact on health as antidiabetic, antitumoral, antibacterial and antioxidant activities. This study aims to evaluate how the drying process and drying temperature of collected mulberry leaves affect the qualitative and quantitative composition of polyphenols and the antioxidant activity of the resulting hydroethanolic extracts. With this purpose, the polyphenolic profile of the extracts was determined using high-performance liquid chromatography with a diode array detector (HPLC-DAD), and their radical-scavenging and antioxidant activities were assessed using DPPH• and FRAP assays. Leaves were collected from the terminal shoots of branches of trees located in the Murcia region (south-east of Spain). They were dehydrated by freeze-drying process and by drying in a convection oven at 25°C, 30°C, 40°C, and 60°C, until a constant weight was reached. The extracts were prepared by incubating 5 g of leaves powder with 70:30 (v/v) ethanol–water mixture shaking 15' at 25°C and alternating with 15' sonication (always protected from light). The samples were then centrifuged and filtered, followed by concentration and removal of ethanol using a rotary evaporator at 40°C. Finally, the extracts were subjected to freeze-drying and stored at -20°C until use. The polyphenolic profile analysis of the extracts enabled the identification and quantification of 14 compounds, including 2 caffeoylquinic acids and 7 glycosylated flavonols. Approximately 45% of the compounds were cinnamic acid esters, while the remaining 55% corresponded to glycosylated flavonoids derived from quercetin and kaempferol. Total polyphenol quantified ranged from 49 to 65.3 mg/g extract, with significant differences among treatments ($p < 0.05$). At a qualitative level, the extracts obtained from the different treatments exhibited a similar polyphenolic profile. However, a significant reduction in the content of most identified compounds was observed in the samples dried at 60°C. In the other treatments, the results were comparable, with the exception of the chlorogenic acid in extract from samples dried at 40°C, in which was better preserved ($p < 0.05$). Additionally, all the mulberry leaf extracts showed good antiradical and antioxidant activity in both assays (DPPH• and FRAP). In summary, the predominant compounds and antioxidant activity of mulberry leaf extracts remained consistent across low-temperature drying treatments and freeze-drying. Thus, leaf drying can be effectively carried out with reduced energy input, without compromising the antioxidant capacity of the resulting extracts.

Keywords: Mulberry, extract, *Morus alba*, polyphenols, antioxidant activity

Model of Silk Folk Craft Development in Georgia

By

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(Poster)

The article presents the stages of silk folk craft development in post-Soviet Georgia in a specific farm. The work was carried out in 2010-2025. Based on the analysis of the results obtained, a model and prospects for the development of silk folk craft are presented. The model presents folk methods of grain storage, revival, worm feeding, primary processing of the skein, production of thread and final products.
Within the framework of the model, it is possible to produce diverse and high-quality products that are used for medicinal and household purposes. There is a demand for folk craft products from both the local population and tourists, which allows the model to be used by other farmers.

Keywords: silk, folk craft, farming.

ROLE OF CIVIL ENGINEERS IN CONSTRUCTION MANAGEMENT OF SIKWORM REARING HOUSE STRUCTURES

By

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(Poster)

ABSTRACT
Sericulture is an agro-based rural industry, which comprises of land-based activities like raising silkworm host plantation along with rearing of silkworm , reeling of cocoon, twisting, weaving and processing of fabrics. India is second largest silk producing country in the world. Sericulture industry provides employment to approximately 7.85 million people in rural and semi urban areas in India. sericulture provides a rear means for environmental conservation and checking migration of people from the rural to urban areas by proving production employment in their houses itself. It enables the woman to earn their livelihood, while taking care of household house hold tasks like looking after children, cooking etc. On the other hand, silk which is produced by the poor in the rural areas is sold to rich in the urban areas. Silk fabrics have been all along a pride possession of the king, nobles and elites in the society. This paper an investigation on new techniques and materials which can be strength parameter for construction of different structures like silkworm rearing house, grainage, reeling and weaving to increase silk cocoon production in India. The paper includes new innovative ideas for the designs of silkworm rearing house such as cooling by underground earth tubes for relative humidity and temperature control, application of turbo ventilators shows better results with respect to improvements in overall cocoon yield. Compared existing buildings of two places, one is solar passive house and the other one is a simple structural designed in civil engineering point of view. Details are discussed with respect to study rearing house according to solar architectural point of view. Seasonal temperature variations are observed and compared to the standard temperature required. Study will be helpful to examine the type of rearing houses available and to guide farmers for construction of solar passive and cost-effective rearing house structures and to recommend effective heat-resistant materials. Surge use of natural resources to maintain temperature & humidity and to validate impact of rearing house designs and importance of application of solar passive technologies to increase silkworm crop performance for the better benefit to the sericulturists. Details are discussed in the paper.

Keywords: Civil, silk, cocoon, cost effective, rearing house

INTRODUCTION
Sericulture, the practice of silk production, is a multifaceted rural industry integrating agriculture, animal husbandry, and cottage industry principles. It encompasses several stages—mulberry cultivation, silkworm rearing, cocoon reeling, weaving, and fabric finishing. Among these, **silkworm rearing** is the most crucial and environmentally sensitive phase, directly influencing cocoon quality and yield.
India's sericulture sector not only contributes significantly to the economy but also plays an important role in **rural livelihood development**, particularly for women and small-scale farmers. Despite its socio-economic importance, the productivity of the sericulture sector is often hampered by inadequate infrastructure, poor environmental control within rearing houses, and lack of awareness regarding modern construction techniques.
Civil engineers play a crucial role in **planning, designing, and managing** these structures. Through innovative construction management practices and sustainable materials, engineers can improve the internal environment of silkworm rearing houses and enhance silk production efficiency.

2. ROLE OF CIVIL ENGINEERS IN SERICULTURE INFRASTRUCTURE
Civil engineers contribute at multiple levels in sericulture infrastructure development:

2.1 Site Selection and Planning

- Identification of optimal site conditions such as soil type, slope, water availability, and natural ventilation.
- Orientation of buildings along the east-west axis to minimize solar heat gain and maximize daylight.

2.2 Structural Design

- Designing load-bearing or framed structures suitable for rural construction.
- Use of locally available, cost-effective, and durable materials such as stabilized mud blocks, fly ash bricks, or bamboo-reinforced concrete.
- Provision for adequate ventilation, insulation, and thermal mass.

2.3 Environmental Control

- Designing systems for maintaining temperature (24–28°C) and relative humidity (70–85%) ideal for silkworm growth.
- Integration of **passive cooling systems**, such as earth air tunnels, solar chimneys, and roof ventilators.
- Minimization of heat infiltration through appropriate roof design and wall insulation.

2.4 Construction Management

- Planning and supervising the entire construction process to ensure quality, safety, and cost-effectiveness.
- Coordination between farmers, local authorities, and funding agencies.
- Promoting the use of green building technologies and renewable energy.

3. DESIGN PARAMETERS OF SILKWORM REARING HOUSES

3.1 Orientation and Layout

Rearing houses should be oriented in the **east-west direction** to reduce direct solar radiation on side walls. The layout should ensure:

- Proper air circulation.
- Minimum dust accumulation.
- Separate rooms for rearing, disinfection, cocoon storage, and egg hatching.

3.2 Thermal Comfort Requirements

Silkworms are extremely sensitive to environmental variations. The following conditions are essential:

Parameter	Optimal Range
Temperature	24°C – 28°C
Relative Humidity	70% – 85%
Air Velocity	< 0.2 m/s
Light Intensity	Moderate and Diffused

3.3 Building Envelope

- **Walls:** Use of double-layered mud or fly ash bricks for insulation.
- **Roof:** Preference for thatched, Mangalore-tiled, or insulated RCC roofs.
- **Floor:** Smooth and washable floors for easy cleaning and disinfection.

4. INNOVATIVE TECHNOLOGIES IN REARING HOUSE DESIGN

4.1 Earth Tube Heat Exchange System

An **underground air tunnel system** allows external air to pass through buried pipes, where it exchanges heat with the earth before entering the building. This maintains cooler air in summer and warmer air in winter, thus stabilizing indoor temperature.

4.2 Turbo Ventilators

Turbo ventilators utilize wind energy to extract hot air and moisture from the interior. They are low-cost, energy-efficient, and suitable for rural areas lacking electricity.

4.3 Solar Passive Architecture

Solar passive designs use natural energy flows for heating, cooling, and lighting without mechanical systems. Techniques include:

- Roof overhangs and shading devices.
- Reflective paints and green roofing.
- Cross ventilation and solar chimneys.

4.4 Use of Sustainable Materials

Incorporation of **bamboo composites, stabilized mud blocks, fly ash concrete, and lime plaster** helps reduce carbon footprint and construction costs while improving thermal resistance.

5. COMPARATIVE STUDY: SOLAR PASSIVE VS CONVENTIONAL REARING HOUSES

A comparative analysis was carried out between two rearing houses located in different climatic zones:

1. **Solar Passive House:** Constructed using insulated walls, earth air tunnels, and turbo ventilators.
2. **Conventional House:** Simple masonry structure without any thermal regulation systems.

Parameter	**Solar Passive House**	**Conventional House**
Average Indoor Temperature	26°C	33°C
Relative Humidity	80%	60%
Energy Consumption	Low	High (fans, coolers)
Cocoon Yield Increase	+18%	Base
Construction Cost	Moderate	Low
Maintenance Cost	Low	High

The solar passive house maintained near-optimal conditions for silkworm growth and resulted in higher cocoon yield and better quality silk fibers.

6. ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

- **Environmental Benefits:** Reduced carbon emissions, efficient resource use, and better microclimate management.
- **Economic Benefits:** Enhanced silk yield, lower operational cost, and improved livelihood for rural farmers.
- **Social Benefits:** Empowerment of women, local employment generation, and improved living standards.

7. RECOMMENDATIONS

1. Promote **awareness and training** for farmers about passive design techniques.
2. Encourage **public-private partnerships** for funding sustainable sericulture infrastructure.
3. Integrate **renewable energy systems** (solar panels, biogas) into rearing houses.
4. Establish **civil engineering guidelines** specific to sericulture buildings.
5. Adopt **performance monitoring systems** to study temperature and humidity control efficiency.

8. CONCLUSION

Civil engineers play a pivotal role in enhancing the productivity and sustainability of the sericulture industry through effective **construction management and structural design** of silkworm rearing houses. The adoption of **solar passive and natural cooling technologies** significantly improves the micro-environment required for silkworm growth, thereby increasing cocoon yield and silk quality. Sustainable, cost-effective rearing house designs not only improve economic returns for farmers but also contribute to environmental conservation and rural development. Future advancements should focus on integrating modern materials, automation, and renewable energy to build a resilient sericulture infrastructure in India.

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Bacteriophages for Control of Experimental Enterococcus faecalis Infection in Silkworm (Bombyx mori L)

By

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(Poster)

Silkworm Bombyx mori, a typical representative of lepidoptera insects, is of great agricultural and economic importance. Having short generation time, clear genetic background and rich genetic resources, silkworms have been widely used in various life science studies.
Silkworm is highly susceptible to microbial diseases that affect quality and quantity of silk, thereby causing huge economical losses. Atibiotics are widely used to fight and prevent various diseases in sericulture, and according to the conducted studies, they have effective results, but it should be noted the ability of bacteria to become invulnerable to effects of certain antibiotics, which they could not resist before. Antibiotic or bacterial resistance as, a life-threatening global problem.
The nature of phages is that they are specific viruses that infect and destroy only specific bacteria. As soon as the target bacteria is eliminated, they leave the existing environment. All types of phages feed only on specific types of bacteria. Due to such specificity of relationship, phage cannot harm other cells. Mulberry silkworm Bombyx mori is affected by a number of diseases caused by viruses, bacteria, fungi and protozoa, however among the bacterial pathogens of the digestive system, Streptococcus faecalis bacteria is the most common, which is why these pathogen became target objects. Development of phage therapy can provide a simple and economic approach to prevent / control bacterial diseases in sericulture.

Keywords: Phage, Silkworm

Improvement of Old Silkworm Breeds Received by Folk Selection

By

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ABSTRACT

The oldest mulberry varieties obtained by folk selection, taken for testing from mulberry gene pool : Georgian white cocoon 1, 2 and 3, Kakheti white 1, 2 and 3, Kakheti green and Kutaisi orange are characterized by very low biotechnological indicators, however, they are characterized by high fruit bearing and some other positive properties, as a result of which they have survived to this day, but the mass of the cocoon, the mass of the cocoon shell and silkiness over the past 3 years increased by 06 -1.0%, that is, improved but very slowly, and yet, this gives us reason to assume that they have great potential for improvement.

Introduction. Sericulture is the oldest branch of Georgian agriculture, rightfully considered the best example of the country's cultural heritage. Until now, the beginning of the development of sericulture in Georgia was associated with the name of King Vakhtang Gorgasali (V century BC.), however, according to recent scientific research, in particular, a palynological analysis of organic materials from a tomb of the 4th century BC , discovered during the archaeological excavations in Pichvnari, the silk fibers were found, which indicates the existence of developed sericulture in Georgia already in the IV century BC, that is, 2 centuries before the Great Silk Road passed through Georgia, and 9 centuries before it was considered so far.

The preserved Georgian silkworm varieties are divided into two parts: varieties obtained by folk selection and varieties obtained scientifically.

In the 19th century, after the spread of silkworm disease "Pebrin" in Europe, several varieties of silkworm bred by folk breeding were preserved in Georgia, which had high viability, but they had long lost their industrial significance, since the shell of their cocoons became thinner over time, and the mass of silk decreased accordingly. Due to their high viability, these breeds are still kept in the collection as breeding material. This group includes following breeds: Georgian white-cocoon, Kakhuri white, Kakhuri green, Kutaisi orange (N. Shavrov, 1888). Of these, Kakhuri green has been included in the collection since 1895, and Kutaisi orange - since 1893. These breeds are especially adapted to hot and temperate climates. They served as the basis for the breeding of subsequent breeds: Tbilniish-1, Tbilniish-2, Kolkhida, Imeruli, Kakhuri, Kartli, Tbilniish-3 and their hybrids (S. Gvinepadze, 1953).

Biological resources are the main value of the planet, they unite the whole world of plants and animals, including sericulture, about which a lot of material is presented and on the basis of which in 2018 Georgian silk was given the status of intangible cultural heritage.

The genetic resources of the silkworm consist of two parts: old breeds bred by Georgian folk breeding and the breeds bred by scientific selection. Until 2011, old breeds were preserved in the alive collection of the Kutaisi zonal sericulture station, and the breeds bred by scientific breeding at the Scientific-Research Institute of Sericulture . However, at present, the old and new breeds, that is, the entire gene pool of silkworm, is protected and preserved as state property in the Sericulture Laboratory at the Tsilkani base of the Scientific-Research Center of the Ministry of Agriculture.

Materials and methods. The following old breeds bred by Georgian folk breeding were selected for the study: Kakhuri green, Kutaisi orange, Georgian white cocooned and Kakhuri tetri. To improve these breeds, the methods available in sericulture breeding were used:

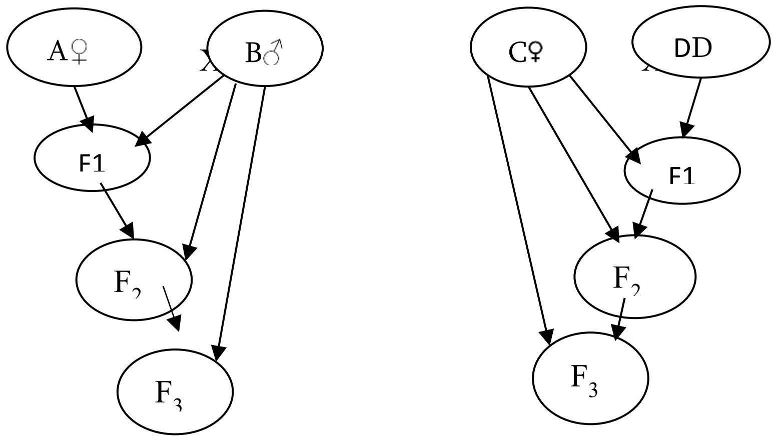
1. Simple crossing with breeds of different geographical origin (blood renewal);
2. Selection and crossing of improving breeds according to a special scheme;
3. Improving the color of colored breeds and creating breeds of various colors using various combinations.

In order to preserve the alive collection of silkworm, inbreeding and partially moderate inbreeding methods were used, which are accompanied by strict culling and selection for reproduction in generations of such families and individuals which by their biotechnological indicators are above the average.

For the improvement of the breed Georgian white cocooned was chosen the Georgian breed Tbilisuri (related).

- For the improvement of the breed Kakhuri tetri was chosen the Georgian breed Iveria (related).
- For the improvement of the breed Kakhuri Mtsvane , was chosen the breed Kakhuri Mtsvane which was developed in Uzbekistan and now was returned to Georgia.
- For the improvement of the breed Kutaisi orange was chosen again orange breed **Khankou** (non-related).

Scheme for the improvement of silkworm breeds



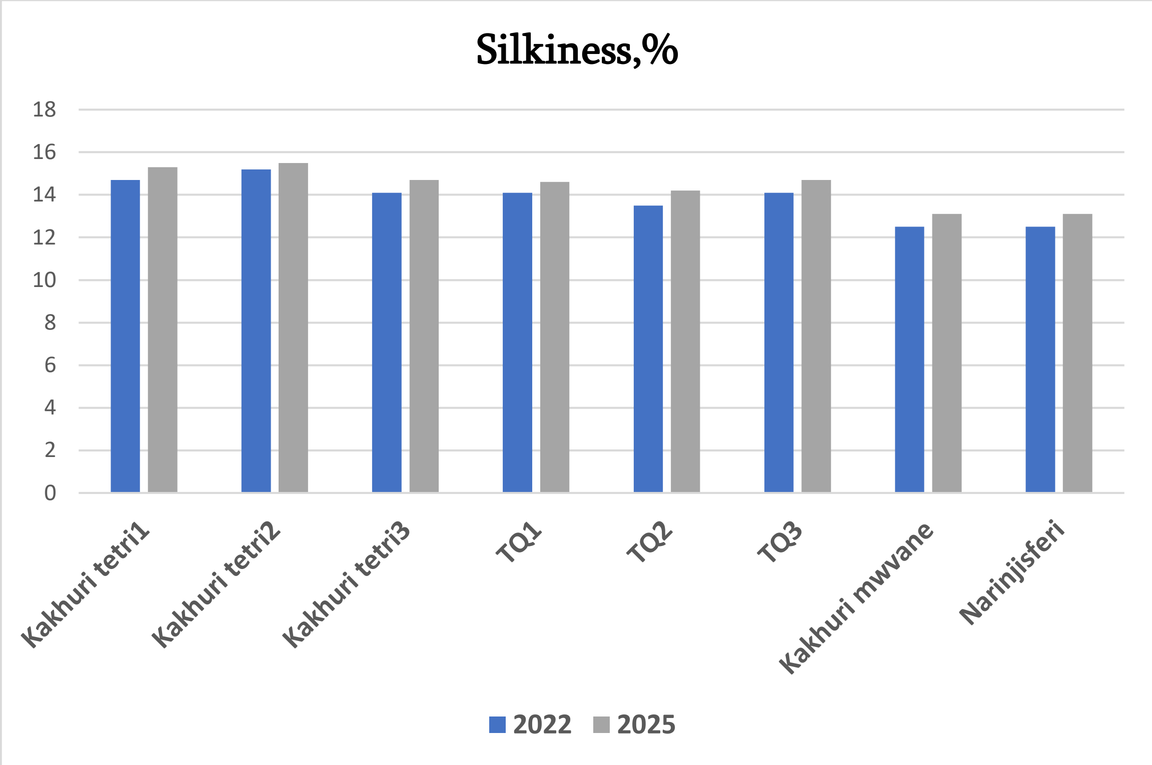
Where,
B and D are the improving breeds;
A and C- the old breeds.

- By feeding F_1 generation and crossing with selected according to the presented scheme improving breeds was obtained F_2 generation hybrid grena**.**
- After selecting and feeding the best genotypes, the F_3 generation was obtained, which will already be an updated highly productive silkworm breed.
- The power of trait inheritance and consolidation will be tested in generations F_1, F_2, and F_3.

Results. Feeding of silkworm was carried out in the sericulture laboratory of the Tsilkani base of the Scientific-Research Center of the Ministry of Agriculture in full accordance with agrotechnical standards.

Initially, when transferring the gene pool to the Sintific-Research Center (2014), these biological indicators were very low: the mass of the cocoon (silk) was 100-150 grams, and silkiness was 8-10%. The results of the last three years of work on their increase, i.e. the process of increasing the main biological indicators (cocoon mass and cocoon shell mass), are presented in the form of diagrams.

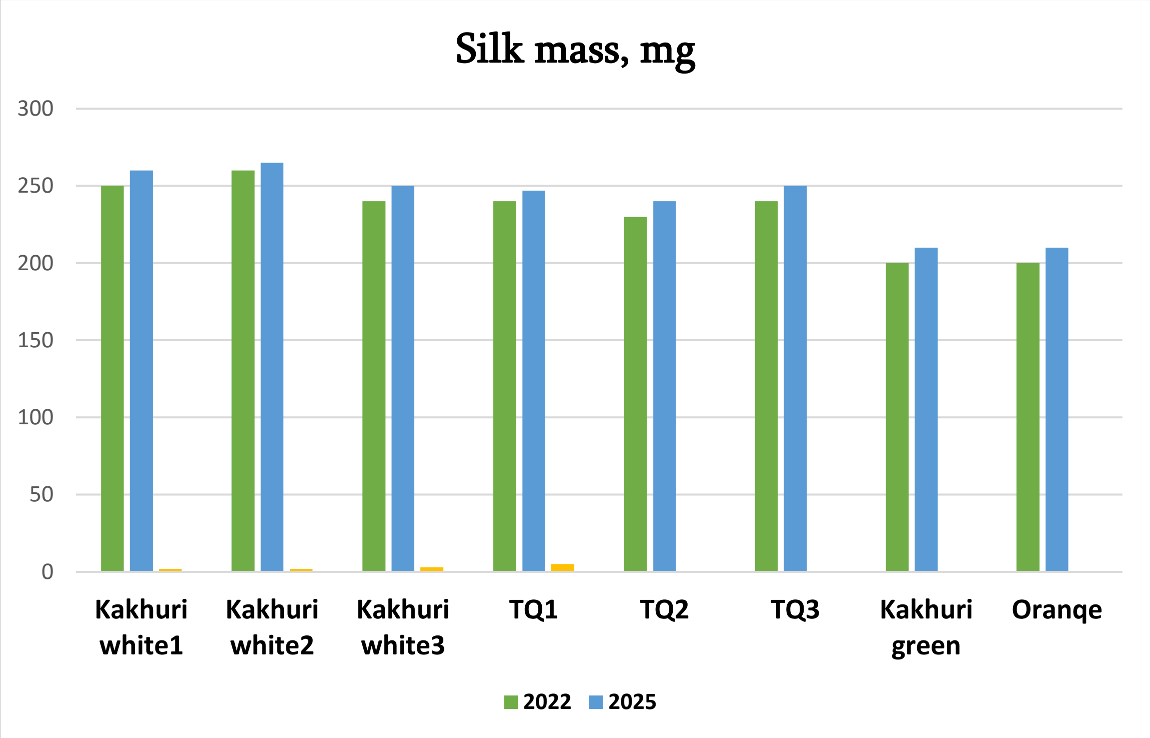
Diagram 1. Silkiness Growth Results (2022 and 2025)



As mentioned above, these oldest breeds are characterized by very low biotechnological indicators, they are very difficult to raise, but, nevertheless, they have such high viability and a number of other positive qualities that their removal from the collection and destruction would be a crime against sericulture, so we decided to improve and preserve them.

As can be seen from diagram 1, the silkiness of the live cocoon increased in all breeds compared to the initial data, but relatively below the requirements of the standard.

Diagram 2. Silk Mass Gain Results (2022 and 2025)



As can be seen from diagram 2, although the biotechnological data of these breeds have not increased significantly over the past three years, even with a slight increase and compared to the initial data, it can be assumed that these breeds have great potential for improvement.

Conclusion. The oldest silkworm gene pool breeds received by folk selection are characterized by very low biotechnological indicators, however, they are highly viable and have some other positive qualities, which, however, are very difficult to raise, which suggests that they have great potential for improvement.

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