

SERITECH

The New Concepts in Sericulture



The 26th INTERNATIONAL SERICULTURAL COMMISSION CONGRESS



INTERNATIONAL
SERICULTURAL
COMMISSION

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FINAL REPORT

07th - 11th September 2022, Cluj-Napoca, Romania

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Table of contents

Foreword	3
 The 26th International Sericulture Commission Congress	
About the Congress.....	4
Organizing Committee and Volunteers.....	5
General Agenda	
Day 1	6
Day 2	8
Day 3	22
Day 4	22
Day 5	28
 Section Reports	
Section List.....	29
Section 1: Mulberry.....	30
Section 2: <i>Bombyx mori</i>	32
Section 3: Non-mulberry silkworms.....	34
Section 4: Bacology of silkworms / silkworms in research.....	37
Section 5: Post-cocoon technology.....	40
Section 6: Economy, management, and marketing.....	41
Section 7: Sericulture in non-textile industry.....	45
Section 8: Silk processing.....	47
 List of participants	 49

Foreword

@SERITECH 2022. Cluj Napoca, România: The 26th ISC Congress – became history now. It took "The New Concepts in Sericulture" as its logo since it was proposed, as a challenge for sericulture of the third millennium.

Those of us who love this field have given our best to have the number one global sericultural event. New solutions or research results were shared with all participants worldwide for having state-of-the-art sericulture. With great hope, SERITECH 2022 has managed to pass on to all participants the ideas and the need to implement new concepts for a developed global Sericulture. We hope to see our work, the results and the progress, come to life in the next ISC event, in 2025.

The New Concepts in Sericulture are a must-have for all the countries and the people who believe that The Chronicles of Silk should continue in the new era.

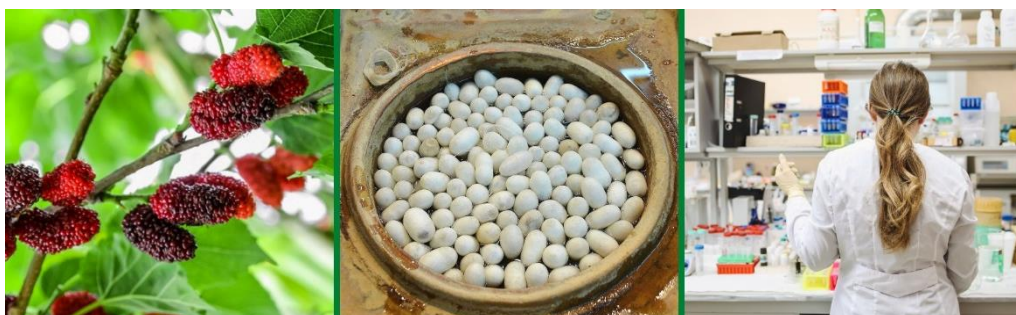
Let's make this field shine again!

Daniel S. Dezmirean,
Cluj-Napoca, 2022

The 26th International Sericulture Commission Congress

The ISC Congress, which is a triennial event, is the only international forum committed exclusively to sericulture and silk industry that provides access to progress made in sericulture science and technology, current knowledge of the field, and the prevailing global business environment for silk. It offers an exclusive opportunity for international scientists, universities, faculty & students of research Institutions in mulberry and non-mulberry silkworms, host plants, post-cocoon technology, biotechnology, sericulture management & economies, post-yarn sectors, the silk trade, processing, promotion, marketing, etc., including those in silk and silk related businesses to interact, share and exchange the most recent advancements in their fields.

This year's theme of the Congress was **SERITECH- the New Concepts in Sericulture**. In the past thousand years, human civilization has been practicing sericulture in order to obtain several benefits from it. Sericulture, on the other hand, managed to leave its mark on the development of humankind and to imprint in researchers' conception and economic development its perfection when it comes to the transformation of raw plant material into noble silk fibers. Today's challenges and the science dynamic from the last decades offer an unprecedented chance for diversified sericulture activities, by defining new profitable concepts such as biotechnology, pharma-farming, bioeconomy, organic sericulture, bio/nanomaterials. In order to keep up with the new opportunities, all the specialists from these areas have to cooperate so as to give a restart to sericulture at international level. The future of sericulture is extremely promising given the new opportunities that come with the dynamic research and economy of the 21st century.



LOCAL ORGANIZING COMMITTEE

Chair:

Prof. Dr. Daniel S. DEZMIREAN

Vice-Chair:

Dr. Eng. Adela-Ramona MOISE

Secretary:

Eng. Ecaterina-Daniela BACIU

Members:

Dr. Alexandru-Ioan GIURGIU

Eng. Gabriela-Maria BACI

Eng. Antonia-Maria CUCU

Dr. Claudia PAȘCA

CS Dr. Otilia BOBIȘ



VOLUNTEERS

Adela Pihotovschi, undergraduate

Alexandra Criste, undergraduate

Alexandru Deac, PhD candidate

Andrei Tătaru, undergraduate

Cristinel Popanton, undergraduate

Daria Bandula, undergraduate

Andreea Mocian, undergraduate

Mădălina Nedeluș, undergraduate

Mara Dezmirean, Msc. student

Ovidiu Hudusan, undergraduate

Raluca Lazăr, undergraduate

Sara Botezan, PhD candidate

Ștefania Meseșan, Msc. student

Valentin Condurache, undergrad.

General Agenda

Day 1 (Wednesday, 07.09.2022)

The Executive Committee of International Sericulture Commission start the day being invited for a field visit at **ITALTEXTIL Sărata**, one of the largest Silk Processing Unit in Europe. On this occasion, the Organizing Committee expresses its gratitude to ITALTEXTIL Sărata, for supporting our conference through a modest sponsorship.



Later that day, the **Executive Committee Meeting** was held in the Council Room of the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca.



The 26th International Sericulture Commission Congress, Cluj-Napoca, Romania

All the Executive Committee Meeting conclusions will be reported to the national delegates by the ISC Secretariat.



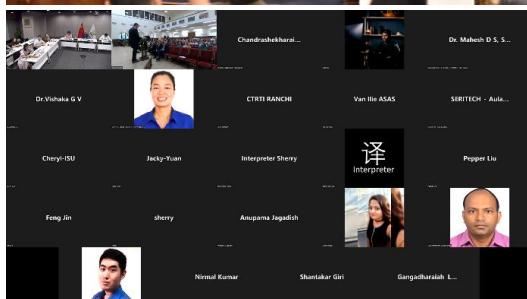
Also, in the first day of the event, two main activities have been conducted: on one hand, the participants were warmly welcomed in Cluj-Napoca, by being picked up from the airport and conducted to their accommodation places while the **registration desk** was open.



Day 2 (Thursday, 08.09.2022)

Opening Ceremony

The Ceremony started with a mesmerizing traditional Romanian instruments demonstration, followed by a welcoming speech addressed by The Rector of the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, **Professor Dr. Cornel Cătoi**. Delegates from **16 countries** were attending the conference either **physically or online**, as the event was organized to be in a **hybrid system**. Later, The Chairman of the Organizing Committee of the Congress, **Professor Dr. Daniel Severus Dezmirean**, national delegate of Romania and Dean of the Faculty of Animal Sciences and Biotechnologies had also addressed kind welcoming words to the participants and announced the **National Awards in Sericulture**.



The 26th International Sericulture Commission Congress, Cluj-Napoca, Romania

The Executive Director, **Mr. Dileep Kumar R.**, together with The General Secretary, **Mr. Rajit R. Okhandiar** had also insightful speeches on behalf of the **International Sericulture Commission** and led the official launch of the volume **Chronicles of Silk**. Mr. Dan Dezmiorean was also invited on the stage together with **Mr. Barabasi Antal**, State Secretary in the Ministry of Agriculture and Rural Development in Romania, to receive the Book.



Welcoming words from the President of Animal Husbandry Section in the Academy of Agricultural Sciences and Forestry in Romania, **Profesor Dr. Ilie VAN** have been addressed via online. Also, among the invited speakers that attended online, top representatives of the **International Silk Union** (China) addressed their greetings through the General Secretary and included some presentations.



ISC Awards

During the 26th International Sericultural Commission Congress, two important categories have been awarded: Louis Pasteur Awards & Excellence in Sericulture awards.



For the first category, **Louis Pasteur Award**, the winners are:

Mr. Yasushi TAMADA



Present Address

Faculty of Textile Science and Technology,
Shinshu University, 3-15-1 Tokida, Ueda,
Nagano 386-8567, Japan
E- mail: ytamada@shinshu-u.ac.jp

Position	Faculty of Textile Science and Technology, Shinshu University
Educational Qualifications	M.Sc. (Engineering) at Kyoto University Ph.D. (Engineering) at Kyoto University
Major Contributions	<p>Dr. Tamada undertaken research on chemical and genetical modifications of silk proteins, new fabrication methods using silk protein aqueous solution, analyses of cell behaviour on silk protein substrate, and evaluation of silk materials for cartilage regeneration scaffolds. These works are expected to accelerate the use of silk in pharmaceutical sector.</p> <p>The sulfated silk proteins developed by Dr. Tamada has the potential to commercialize as a preventive agent for HIV infection. Initial works for an industrial collaboration with a Japanese chemical company is currently underway. The silk protein resin developed have excellent dielectric properties and thermal conductivity which are being disseminated to field. The silk fibroin sponge materials developed by him is used in cosmetics, aesthetic, and medical fields through collaboration with a reputed chemical company. Dr. Tamada's research work on interactions between cells and silk materials provides crucial information for developing medically applied products such as wound dressings and cell scaffolds for regenerative medicine.</p>
Sericulture Experience	18 years of experience in silk related fields

Mrs. Somying CHUPRAYOON



Present Address

24/23 Phahonyothin 56, Yaek 2-1 (Kamkoon),
Phahonyothin street, Saimai sub-district,
Saimai District, Bangkok 10220 Thailand
E- mail: csomying@hotmail.com

Position

Expert on Sericulture Production
Promotion and Management,
Queen Sirikit Department of Sericulture and
the Director of PASAYA BIOTECH Co.,
Ltd., Thailand.

Educational Qualifications

Master of Science (Plant Pathology)

Major Contributions

Mrs. Somying Chuprayoon has involved in the development of quality standards for Thai silk, which culminated in developing industrial utilization of hand reeled Thai silk. She was also involved in developing testing and reeling equipment in collaboration with Kasetsart University and National Bureau of Agricultural Commodity and Food Standards. These equipments have been readily accepted and popularized in the field. In 2017, she

developed a prototype of a silk producer according to TAS 8000-2012 standard to enable farmers to set up a silk production system to meet quality and certified according to standard, receiving “Q” mark. She was instrumental in introducing contract farming system which helped the farmers to increase their income for more than 30% consistently throughout the year.

Sericulture Experience

38 years of experience in Silk Industry

Dr. Subhas Venkappa Naik**Present Address**

No.32, 15th Main, Sarakki, NHBCS,
J.P.Nagar, 5th Phase, Bangalore, INDIA
E- mail: svnaik.cstri@gmail.com

Position

Director (Retired), Central Silk Board,India

Educational Qualifications

M.Tech in Textile Technology
Ph.D. in Raw Silk Reeling Technology,
Bangalore University

Major Contributions

Dr. Naik was involved in indigenously developing multi-end reeling machine and automatic reeling machine along with the package of practices suitable to the cocoons produced for the Indian conditions. He has also been involved in popularizing 650 MRMs and 127 ARMs all across the country. These efforts have significantly enhancing the production, productivity and quality of Indian silk. India is now in a position to produce internationally graded silk for local consumption and resultantly the import of silk to the country has significantly reduced.

**Sericulture Experience
Technology**

31 years of experience in Post Cocoon

The 26th International Sericulture Commission Congress, Cluj-Napoca, Romania

For the **Excellence in Sericulture Science**, the winners are:

Mr. Somchai LUEMUNKONG for Mulberry Development



Present Address

13/9 Moo 7 Klongyai Subdistrict,
Ongkharak District,
Nakhon Nayok Province 26120
Thailand

Position

Agricultural Research Officer, Senior
Professional Level at the Queen Sirikit
Sericulture Center (Sisaket), Thailand

Educational Qualifications

Master of Science, Field Crop Breeding

Achievement for Award

Developed three high yielding varieties which
are very popular in the field.

Sericulture Experience

31 years in Mulberry development.

Dr. S. Mathira Moorthy for Silkworm Development



Present Address

Central Silk Board, CSB Complex,
BTM Layout, Madiwala, Bangalore, India
Email: moorthysm68@gmail.com

Position

Scientist-D

Educational Qualifications

M.Sc. in Zoology
PhD in Zoology

Achievement for Award

Dr. Moorthy has developed a promising bivoltine hybrid for the eastern and central regions of India. Historically, these regions were known to practice multivoltine races as the climatic conditions are not suitable for bivoltine rearing. However, the Hybrid developed by Dr. Moorthy has broken this myth and become so popular in the region. Resultantly the bivoltine production in the region has significantly increased from 38 MT in 2010 to 2386 MT in 2020.

Sericulture Experience

28 years

Mr. Meechai TAESUJARIYA for Post Cocoon Technology



Present Address

131 Khampun Museum, Srisaket Road,
Khamnamsab, Warinchamrab,
Ubonratchathani, Thailand

Position

Founder & the owner of Ban Khampun; Ubon Weaving Center and Khampun; Museum of Weaving Culture, UbonRatchathani, Thailand

Educational Qualifications

Bachelor of Art (Political Science;
International Relations)

Achievement for Award

Mr. Meechai Taesujariya has been involved in developing a new textile design called “Pa Kaab Bua” with the combination of techniques like Mudmee, Khit and Mubmai on stripped warp. This has become so popular in Thailand and other part of the world. Mr. Meechai has got several awards for the “Pa Kaab Bua” design in the field.

Sericulture Experience

40 years in traditional silk weaving

Dr. Somchai JOMDUANG for Silkworm and Silk in Non-Textile Industry



Present Address

353 Moo.9, T. Sanklang, A. Sanpatong,
Chaing Mai Province, 50120, Thailand
Email: admin@bio-c.co.th

Position

Managing Director of BIO CRENOVATION
CO, LTD, Thailand

Educational Qualifications

M.S. (Food Science and Technology).
Kasetsart University Thailand

Ph.D. (Food Technology), University Putra
Malaysia (UPM), Serdang, Malaysia

Achievement for Award

He has been involved in developing many by-products from sericulture with the concept of “Zero Waste”. One of the major breakthrough research of Dr. Somchai was identification of pupae extract as a viable agent for vasodilation. This knowledge has the potential to develop medicines for sclerosis and high blood pressure.

Sericulture Experience

20 years in silk industry

Romanian Sericulture Awards

In total, 3 Awards has been given by Dr. Daniel Dezmirean, as it follows:

- Best entrepreneur in Romania, awarded to SC Ital Textil Sărata SRL



- Best results in sericulture, awarded to Dr. Matei Alexandra
- The Award for the entire professional activity in sericulture field in Romania given to Prof. Dr. Ioan Pașca



The organizers ensured the **media coverage** of the event.



Also, during all 4 days, participants had the opportunity to showcase their work, whether it was in the textile or in the non-textile industry. As such, Mr. Kumar S. Gopal had arranged a stand with **silk products**: scarves, suits and other accessories, while the delegates from Thailand brought samples of different products developed by them: **teas, food supplements, masks**, etc. **Romanian products** made by local artisans and crafters were also available for showcasing and purchasing in the University campus.



After the completion of the formalities, the scientific presentations begun for 3 sections simultaneously:

- Economy, management and marketing in sericulture, chaired by Dr. Alina S. Rusu
- Sericulture in non-textile industry section, chaired by Dr. Tsunenori Kameda
- Silk processing section, chaired by Dr. Subhas V. Naik

After lunch break, the silk processing section was over and was replaced by the Bacology of silkworms section, chaired by Dr. Shuichiro Tomita.

In the afternoon, the participants were invited to the **Welcome dinner**, where they enjoyed delicious food and traditional Romanian dances, songs and costumes presentation.



Day 3 (Friday, 09.09.2022)

This day was full of scientific content, meaning the scientific presentation of papers belonging to the sections:

- Mulberry, chaired by Dr. K. Vijayan
- *Bombyx mori*, chaired by prof. Daniel Dezmirean, PhD
- Non-mulberry silkworms, chaired by Dr. K. Sathyanarayana
- Post-cocoon technology Dr. Sukunya Chumchuen

At the end of the programme, the participants had free time in order to explore the city of Cluj-Napoca or other desired activities.

Day 4 (Saturday, 10.09.2022)

The first activity of the day has been the **poster session**. All the posters have been presented and discussed in the Aula Magna lobby.



In the meantime, the ISC delegates were taken for a **tour** to the **Department of Apiculture and Sericulture** and were presented the facilities: the APHIS-DIA laboratory, the Global Centre of Excellence and Advanced Research in Sericulture and Promotion of Silk Production (GCEARS-PSP), mulberry greenhouse and silkworms rearing house.



Afterwards, the closing ceremony has begun. Firstly, the **Chairperson** of each section presented their **report** one by one. The reports can be found in the next section of the present document. The participants were also awarded with **certificates**.



Kind words to mark the closing of the event have been addressed on behalf of the Organizing Committee through Mr. Daniel Dezmarean, International Sericulture Committee by Mr. Rajit R. Okhandiar, and various participants and stakeholders. Among them, Mrs. **Somying Chuprayon** honored the audience with insightful speech about the prospects of sericulture, expresses her gratitude for being awarded with Louis Pasteur Prize and launched an invitation for closer collaborations between Thailand participant countries.



Also, Mr. **Jose Hott** has been awarded by Mr. Dileep Kumar R, for his unwavering devotion to sericulture and the interest given to all activities under the auspices of the International Sericulture Commission.



Nonetheless, the Organizing Committee and volunteers involved in preparation of the event had the most pleasant surprise by being, one by one, awarded by the ISC representatives.



Based on the official program, participants were taken to a guided tour of **Turda Salt Mine**, one of the most spectacular tourist destinations in the world. It is the underground formation that people created in a special natural environment, in the depths of Transylvania, digging into the salt deposited after the evaporation of the sea that covered the entire region millions of years ago. followed by a **private quartet concert** performed in the amphitheater of the salt mine, having a great acoustic.



International evening was the last event of the day. It took place at Salina Wine yard and participants were encouraged to wear traditional clothing items as well as to perform and got engaged into traditional dances, music and intercultural experiences.





Day 5 (Sunday, 10.09.2022)

One day trip to the historical city of Alba-Iulia took place. Participants had the chance to explore the magnificent citadel in a guided tour, witness the changing of the guards and taste local cuisine.



Section Reports

During The 26th International Sericultural Commission Congress, a total number of 109 research papers were presented through the 8 sections that we had. The Congress has been held in hybrid format; therefore 53 papers were orally presented online, 50 papers were presented orally onsite, and 6 papers has been presented onsite as posters.

Section	Chairperson	Domaine
Mulberry	Dr. K. Vijayan, International Sericultural Commission, E-mail: kunjuvijayan@gmail.com	All aspects and areas concerning mulberry
Bombyx mori	Dr. Daniel S. DEZMIREAN, PhD, University of Agricultural Science and Veterinary Medicine of Cluj-Napoca, ROMANIA Email: bombyxmorisecion@usamvcluj.ro	Rearing, feeding, pathology and breeding aspects of <i>Bombyx mori</i> (mulberry silkworms)
Non-mulberry silkworms	Dr. K. Sathyanarayana, Director, Central Tasar Research and Training Institute, CSB, Ranchi, Jharkhand, INDIA Email: ctrticsb@gmail.com	Rearing, feeding, pathology, breeding, host-plants
Bacology of silkworms / Silkworms in Research	Dr. Shuichiro TOMITA Institute of Agrobiological Sciences National Agriculture and Food Research Organization (NARO), Tsukuba, JAPAN Email: tomita@affrc.go.jp	Silkworms as a biological model, genetics, physiology, biochemistry, genetic-engineering, molecular biology, developmental biology and genomics
Post-cocoon technology	Dr. Sukanya Chumchuen, The Queen Sirikit Sericulture Center (Sisaket), THAILAND E-mail: scsrinin7870@gmail.com	Reeling, cocoon preservation, silk quality, gradation, weaving, products diversification.
Economy, management and marketing in sericulture	Dr. Alina S. Rusu, University of Agricultural Sciences at Veterinary Medicine E-mail: alina.rusu@usamvcluj.ro	Silk markets, prices, trading, economic analysis, situation and statistics in silk producing countries; marketing and silk promotion; import/exports.
Sericulture in non-textile industry	Dr. Tsunenori KAMEDA Silk Materials Research Group Institute of Agrobiological Sciences, NARO, University of Tsukuba, Tsukuba, JAPAN email: kamedat@affrc.go.jp	The silkworms and mulberries for medicals, pharmaceuticals, food, biotechnology, biomaterials.
Silk processing	Dr. Subhas V Naik, Central Silk Technological Research Institute, CSB, Bangalore, INDIA Email: cstriban.csb@nic.in	All the activities in silk processing, import, export, silk consumption, global demand, marketing and promotion.

Section 1: Mulberry

Chair: Dr. K. Vijayan

Vice-chair: Ms. Daniela Baciu

In this session 16 papers were presented 9 papers were presented onsite and 7 were done online. The session started with the presentation of the lead paper on Genomics for higher productivity of mulberry. It briefed the current status of mulberry genomics and its potential use in mulberry crop improvement to sustain higher productivity under the changing climatic conditions and soil fertility. With the ongoing rapid industrialization and urbanization, available fertile land is becoming less and less and the climatic changes caused by global warming and pollutants lead to drought and unseasonal rain, and unprecedented emergence of new pests and diseases.

These changes in the growing condition of mulberry significantly impacted the leaf productivity of the mulberry. Thus, it is imperative to develop new robust mulberry through breeding integrating both traditional and modern breeding. The completion of the whole genome sequencing of three important species of mulberry opened up a new avenue to identify new sets of molecular markers and genes to select new parents with desired traits and screen the progenies for complex traits with less time and cost. Pangenomics helps *de novo* domestication and the gene editing with CRISPR/Cas to synthesis tailor made varieties.



A paper on transgenesis highlighted the benefits of simultaneous over expressing on of AtDREB2A and AtSHN1 genes in mulberry (*Morus spp.*) by providing enhanced tolerance to drought and salinity stresses. Another paper which needs special mention is the development of an Ayurvedic formulation from mulberry leaf called 'Toodasava' which is found effective in treating diabetic mellitus. Root rot caused by *Fusarium*

solani, *F. oxysporum*, *Lasiodiplodia theobromae* *Macrophomina phaseolina* and *Rhizopus oryzae* make devastating crop loss in India and using molecular markers associated with the resistance, new varieties can be developed rapidly to cultivate and sustain healthy leaf production. Role of mulberry in phytoremediation of heavy metals was also demonstrated. Using the Mulberry Growth and Yield, in Phare province of Thailand, a simulation model, namely PLANTGRO, was developed to predict the annual leaf yield. Mulberry propagation in the Global Centre of Excellence for advanced research and promotion of silk production of Cluj-Napoca was also presented along with the efforts being made to popularize mulberry in this region to revive mulberry cultivation in Romania. The benefits of triploids mulberry cultivation were demonstrated with the leaf of 6 triploid mulberry genotypes under optimal and suboptimal conditions. Using 2 candidate Mildew resistance Locus O (MLO) in mulberry the role of these genes in conferring powdery mildew resistance in *Morus* spp was explained. It was demonstrated that fertigation in mulberry could reduce application of chemical fertilization by 20-25% without affecting the leaf yield and leaf quality.



Overall, the session focused mostly on crop development using modern technologies. A few presentations demonstrated that improving some of the current agronomic practices can enhance leaf yield and quality while reducing the production cost. The potential use of mulberry in the preparation of medicine and materials useful for human consumption was also highlighted.

Section 2: *Bombyx mori*

Chair: Dr. Daniel Dezmarean

Vice-chair: Dr. Adela Moise

Bombyx mori, which give the name of this section, represents for all of us an important useful insect and a specie which was studied for long periods of time by researchers from all over the world. Still today, this wonderful specie, provide sources of inspiration and research for valuable researchers, as demonstrated by your presence at this conference and the topics presented.



This section registered a number of 18 presentations, and the main topics presented regarded the **different breeds reared** in India, Romania and Vietnam, **their biological and technological parameters, pathology aspects** regarding the main diseases of silkworms, as well as important **studies regarding genetics aspects**.

The Section started with a valuable Lead paper presented by Dr. Sashindran Nair, which presented us the role of seed organization in shaping the future of mulberry multi- and bivoltine silkworm seed production in India. It was a useful presentation for the participants, especially for those which are not familiarized with the economical parameters of cocoons obtained in India.



The presence of Indian researcher improved the scientific value of this Conference; As a proof of this fact, I want to mention the importance of presented aspects such as the conservation and characterization of silkworm germplasm for biodiversity and posterity, as well as the effect of organic manures on larval and cocoon traits of silkworms. Important information regarding

the Chawki rearing concepts and the correct application of the technologies for these young larvae were clearly offered on line by Dr. Muthulakshmi and her team collaborators.

As we all know, the silkworm's pathogens are very dangerous, they can affect entire growing series if the pathogen attack and if we did not take the correctly hygienically prevention measurements. Unfortunately, the silkworm is a specie of insect that doesn't always respond quickly and efficiently to the traditional medicines and treatments. That's why, it was gratifying for me to see in this section important researches developed in this direction.

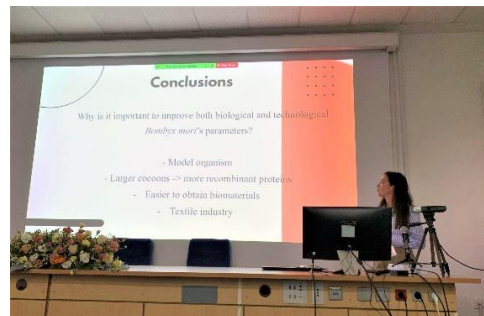
So well, in this direction, I want to mention the good results presented by Dr. Dar, Dr. Jagadish and Miss Pooja regarding the main pathogens (*Nosema*, , etc) and diseases provoked by those which can affect the silkworms.



I want to mention as well, that I was happy to present in this Section the main results obtained by me and my researchers team regarding the alternative nutrition method of silkworms. As you know, being in a continental area, in Romania, the rearing of silkworms is not possible all over the year. So why, the artificial diet improved with different natural supplements, can be a valuable instrument

for obtaining good biological material for sericulture research. So on, we obtained good results in adding linden honey in the artificial diet of silkworms, which were presented by my PhD student Gabriela Baci.

In the end, but not the least, the **engineering genetics** has to be mentioned, as an important part of this section presentations. As we all know, the biotechnologies and the genetic methods are in continuous development. This create in the research world the possibility to make new and important discovering, and the silkworms represent a valuable instrument for the genetic engineering. Evaluation of genetic variability, heritability and genetic parameters, development and optimization of TaqMan assay based on the β -tubuline gene, molecular marker assisted breeding for the development and the evaluation of BmBDV resistant silkworms breeding are all aspect studied by the researcher presented in this section and their results deserves all our attention and interest.



Section 3: Non-mulberry silkworms

Chair: Dr. Sathyanarayana Kutala

Vice-chair: Ms. Lelia Pop

In total 47 papers were accepted for oral (30) and poster (17) of which 21 papers were presented (Onsite: 07, Online: 14 and Poster: 1), besides one lead paper.

The presentations covered all the sectors with 13 in tasar, 3 each in Oak Tasar & Mug and 2 in eri, besides the major specialized areas like host plant improvement (2), Silkworm improvement (9), Silkworm protection (3), Silkworm seed and by product (5) and general issues (2).

The lead paper on ‘Unleashing Stakeholder base: A Paradigm Shift in Indian Silk Tasar Promotion’ covered status and contribution of Vanya to overall Indian silks, CSB’s role, areas of intervention and research-collaboration, convergence to increase the stakeholder base. Role of tasar in tribal and women empowerment, continuous engagement and income generation, socio-economic and environmental benefits besides addressing various SDGs were also covered in lead paper.

Major areas of research (ongoing and in pipeline) in host plant improvement- faster propagation, bio-fertilizers, carbon sequestration, ectomycorrhizal bioinoculants, focus on emerging pests, pest control through semio-chemicals and botanical formulations, disease monitoring- control of virosis, pebrine, bacteriosis, Eco race conservation, seri-by product utilization, technology dissemination, roping in other line departments/ research organizations, community led seed production/ extension services and overall impact on sustainable livelihood creation.

Presentations in Tasar sector included research work on phosphate solubilizing bacterial strains of tasar silkworm food plants to bring out nitrogen and phosphate fixing nitrogen fertilizers, botanical extracts against predatory bugs of tasar silkworm,



impact of leaf consumption on the voltinism of *Antheraea mylitta* D, management of gall fly, *Trioza fletcheri* minor on tasar host plants. Similarly, presentation on seed multiplication covered various problems and prospects of seed areas, seed cocoon preservation loss with seasonal shifts and use of green shade nets for better recovery of eggs,

analysis of grainage performance in relation to cocoon number to optimize seed cocoons to be processed in different seasons and unique technique for Tasar silkworm, *Antheraea mylitta* cellular seed production on paper sheet.

Various research initiatives in frontier areas viz., *De novo* Genome sequencing and comparative genomics of tasar silkworm *Antheraea mylitta* for its utilization in future breeding programmes like marker assisted selection, studies on genetic diversity of *Antheraea mylitta* ecoraces using SNP Markers to exploit wild ecoraces, comparative mitochondrial genome analysis of *Antheraea* silkworms and differential expression of heat shock protein *Antheraea proylei*.

Presentation on By-products included commercial utilization of *Cordyceps militaris* fruiting bodies grown on Tasar silkworm and Oak Tasar Culture based significant livelihood and its Impact on Carbon Mitigation. Besides the above research works on molecular landscape of AnprNPV infecting oak tasar silkworm, issues related to breeding in muga silkworm, *Antheraea assamensis* due to inbreeding and exploring option to overcome the issues, microbiome of Golden silk moth, characterization of the pathogen causing virosis in Muga silkworm, Chawki Rearing Technology in Ericulture and Eri silkworm rearing for addressing youth unemployment of Ethiopia. During the event, a poster on Wild silks traces in Europe.

Recommendations:

1. In view of the advantages of tasar culture in its role in tribal and women empowerment, focused approach to address the gaps to be taken up with required policy support.
2. Research work shall be taken up for eco-friendly control like botanicals, semio-chemicals etc., against existing and emerging pests and predatory wasps in tasar culture in changing climate scenario.
3. Genetic Analysis data available on the NCIBI databases should be used to enhance the productivity of the tasar silkworm *A. milita*. Similarly, the work on muga should focus to address susceptibility to disease and reduced reproductive capacities.
4. Works to minimize the tasar grainage operation, synchronized emergence, mitigation of low egg hatching and cost reduction due to variability in egg laying materials should be takne up.
5. Wild Tasar silkworm eco-race population diversity should be genetically mapped, conserved to increase their population in scientific lines.

6. In view of the detoxifying role of the digestive gut microbiota, studies using different host plants should be explored to increase the disease resistance in Vanya silkworms.
7. Chawki rearing in ericulture should be explored on the lines of mulberry, besides breeding studies to overcome heat shock in tasar silkworm.
8. Possibilities of exploiting seri-by products like *Cordyceps militaries* should be explored for its medicinal values (substrates for medical fungus) and as fish fodder.
9. Strategies to support group/ community-based enterprises, capacity building, improving the market access and financial support are very essential for sustainability of Vanya sericulture.
10. Available Whole Genome Sequence database of *A. mylitta* to be utilized for the development of SSR markers specific to genes involved in the expression various productive traits and their utilisation in Marker Assisted Selection breeding programme in tropical tasar silkworm should be explored.



Section 4: Bacology of silkworms / silkworms in research

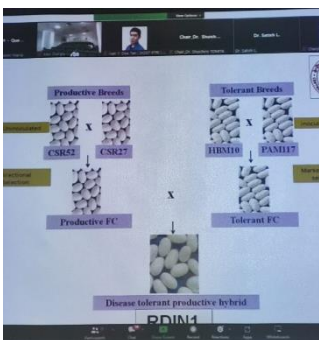
Chair: Shuichiro Tomita

Vice-chair: Ms. Gabriela Baci

Every technology applied for the agricultural field had been built up with a combination of basic research achievements and the application study of its own. To this end this section covers all the aspects of silkworm research. We had six oral presentations, three as onsite and three as online.



It was striking that four out of six papers employed Next Generation Sequencing technology (NGS). It has been more than a decade since the advent of NGS and it has become inevitable when you conduct vast basic studies on biology.



Likewise, the authors of these papers stated background information specific to each research as clear so that the purpose of study be easily understandable. The rest two papers are more or less conversional physiology/molecular biology studies; that does not mean they are outdated, rather I see they can easily employ omics approaches to expand their research on the basis they had established here. The other notable point was most of the research were motivated by climate change either directly or indirectly.

Lead Paper

SNP Genotyping and Genome-Wide Association Mapping for economic traits of silkworm, *Bombyx mori* L

S. Manthira Moorthy¹, V. Sivaprasad¹, L. Kusuma², R. Sumathy², Rukhumangda², Bindya², Mary Josepha² and Vidya Niranjana³

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³RV College of Engineering, Bangalore

The authors collected genome-wide SNPs from 100 silkworm breeds by means of GBS and subjected them for phenotyping with five qualitative and ten quantitative traits. Followed by standard procedures such as minor allele frequency distribution analyses, QQ plot, Manhattan analyses etc., preliminary results of association analysis were

exhibited, and possibility and feasibility of marker assisted selection (MAS) was presented.

Oral presentations

Genetic strategies for the development of thermotolerant bivoltine silkworm breeds of *Bombyx mori* L.

Raju P.J¹, Lakshmi H¹, Khedkar G.D², Mamatha D.M³, Vidya. N⁴, Seetharamulu J¹ and Prashant B¹

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⁴RV college of Engineering, Bangalore

In this presentation the authors clearly stated that the climate change was the issue by which the study was motivated. RNA-Seq was employed to find out differently expressed genes (DEGs) between normal and high temperature + high humidity conditions and also among 14 bivoltine breeds. Initial effort was concentrated to heat shock proteins (HSPs) and several heat-shock related genes are picked up as DEG and relationship between their expression profiles and thermotolerance phenotypes were examined.

Expression profiling of TRP genes for determination of thermo sensitivity and humidity tolerance in silkworm

Raviraj V Suresh, Pooja Makwana, Nalavadi Chandrakanth, Lakshmanan V, A. R. Pradeep, Kishor kumar C.M, V Sivaprasad
Central Sericultural Research and Training Institute, Berhampore

This study was also directly dealing with temperature and humidity. Expression profile and SNPs of TRP genes are examined by comparing high temperature / humidity condition with optimum rearing condition. Possible role of TRP genes in perceiving heat and humid sensation was hypothesized and involvement of other abiotic factors was suggested.

Exploration of role of polyamines in growth and development of *Bombyx mori*

Anitha Mamillapalli

Seribiotechnology lab, Department of Biotechnology, Institute of Science, GITAM

Role of polyamine in silkworm growth and development was examined by feeding several molecular species of polyamine to the silkworm. Spermidine feeding affected

gut microbiome and application of ornithine decarboxylase inhibitor resulted in significant reduction of putrescine and spermidine levels with developmental defects in pupae and adult. Continuous effort is strongly expected to reveal the role of polyamine in silkworm physiology.

Molecular Markers from Philippine-Reared *Bombyx mori* L. through Genotyping by Sequencing (GBS)

Ma. Anita M. Bautista^{1*}, Ma. Neda A. Catalma², Ivan Y. Dee Tan^{1,2}, Ma. Ysabella Elaine D. Conde^{1,2}, Cheryl G. Lopez², Alfrieta B. Olayo², Juliet A. Abuan³ and Sarah Mae U. Penir⁴

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Philippine-reared silkworm were collected and subjected to GBS and genome-wide SNPs were recovered. Among these SNPs, the polymorphic loci among Philippine strains were identified. Suggested use of these SNPs for discriminating silkworm strains in Philippine was validated by sequencing additional individuals.

Transcriptome analysis of Silkworm, *Bombyx mori*, during BmDENV1, BmIFV and BmNPV infection

Satish L., Kusuma L., Moorthy S. M., Josepha M., Sivaprasad V and Babulal
Central Sericultural Research and Training Institute, Mysuru

Demand for silkworm breeds resistant to viral diseases is continuously high and climate change makes it even more. Towards the identification of genes that control tolerance against BmNPV and BmIFV, transcriptomic analysis was executed with RNAs collected from midgut of BmDENV, BmIFV, and BmNPV infected silkworm larvae as well as uninoculated control. Numbers of genes were found up/down regulated with each viral infection. Toll and IMD pathway genes were upregulated, and endocytosis and Hippo pathway genes were downregulated in the samples inoculated with BmDENV, whereas DNA replication pathway genes are upregulated and Toll and IMD pathway genes are downregulated in BmIFV inoculated samples.

Section 5: Post-cocoon technology

Chair: Dr. Sukanya Chumchuen

Vice-chair: Dr. Otilia Bobiş

The presentation in the Post Cocoon Technology Section were very useful for silk industry and healthy for human. In total 7 oral presentations, but only online 4 papers were completed while 3 papers onsite the speaker absent.



1) Development of silk yoga mats from recycled silk yarn and their evaluation by Dr. Nivedita. The details can conclude that Yoga mat develop from silk waste had a good feedback form consumers and have many benefits of recycling and environment friendly.

2) Studies on morphology and structure of long passage in silk reeling and developments of gadgets for retrofitting in reeling machines by Dr. Mathiazhagan conclude that study on the morphology of back and reeling silk compare with Multi end reeling silk is a new study its better and sheen and quality and use the Scanning Electron Microscope the back end reeling better uniformity less filament serration

3) Study on Improving the Crease Recovery of Soft Silk Fabrics by Fabric Geometry by H.H. Shambulingappa. concluded that changing in fabric geometry can leads to achieve better crease recovery in soft silk fabrics. The optimum results have been to provide to the industry which will aid the silk fabric manufacturers in producing better engineered /designed fabrics. The garment manufacturers would be benefited by the way of being empowered to make a better choice of fabrics for garments and consumer will benefit in terms of availability of a variety of fabric with improved properties and value of their money.

4) Development of an apparatus to estimate the reliability of mulberry cocoons, by Sangappa N Shilin conclude that the development of integrated weighing system for cocoon shell and required water quantity display, development of liquid dispensing unit, development of RO membrane based demineralize unit and development of thermostatic water bath percentage of reel ability determines the productivity and quality of raw silk to a great extent.

Section 6: Economy, management and marketing in sericulture

Chair: Dr. Alina Rusu

Vice-chair: Ms. Lelia Pop

Presentations:

On site: 14

Online: 4

Guest Presentation: 1 (online)



The **lead paper** of the section has been written and presented by Mr. Dileep Kumar S., who is Programme coordinator, at International Sericulture Commission.

His paper covered the subject of the use of a sustainability index, named HIGG index, in the analysis of services of goods and products. The index has been created Sustainable Apparel Coalition (SAC), established in the USA.

The HIGG index, originally created for internal analysis within the company, has been applied to the silk industry as well. Mr. Dileep Kumar, though his research has highlighted its main drawbacks: it is biased towards synthetic fibers, it uses outdated and fabricated data, and overlooks the bioeconomy aspects

International sericulture commission in undertaking actions to suspend the use of the HIGG Index in impact analysis related to natural fibers, including silk. In collaboration with other national and international agencies, International Sericulture Commission focuses on initiating similar actions against SAC and focuses on creating sustainable standards for the silk industry, that are meant to be distributed globally. Other areas for future action will be: LCA standardized analysis, research and innovation and financial assistance

ISC is the only international inter-governmental institution, focused on the development of silk industry at a global level. Its main activities focus on the following key areas:

- Protection of the industry
- Referral agency and periodical analysis of the silk industry
- Technical support and financial assistance
- Research and development: international collaboration with countries or other global organizations (from FAO to World Bank), international trainings and exchange programs, technical meetings, scientific publications, and support of research through congresses and prestigious awards.

The section continued with Country Reports, presenting their silk industries

1. India



India is the second largest silk producer, with an incredibly rich culture and history in the domain, in the world, but in the same time, it is also a large consumer of silk (imports come from China). Its silk industry is predominated by mulberry, tasar, eri and muga silks.

Although the industry has registered significant growth in the last decades, it also faces challenges at workforce and meccanization level.

Despite this aspect, the industry continues to present many advantages, from biodiversity, work stability all the way to economic growth and women empowerment.

In order to further develop the industry and address its current challenges, the focus is orientated towards creating highly productive silkworm breeds (such as bivoltine), production will be destined for internal consumption, on training and consultancy programs and on export of seeds and machinery.

International sericulture Commission plays an important role in the industry facilitates the research processes and international partnerships with institutions such as FAO and World Bank, and facilitates the protection of the silk industry and its culture

2. Thailand

Is a country that also has a rich tradition in sericulture. The predominant type is the mulberry silkworm. Research is focused on creating improved silkworm strands and mulberry varieties.

One of the main national organizations, The Queen Sirikit Department of Sericulture (QSDS), focuses on silkworm and mulberry varieties conservation, technology development and transfer and on creating an eco-friendly industry.



The research articles presented in the session have covered many important aspects in the sericulture industry:

1. The importance of economic and/or institutional partnerships

For India, collaboration between institutes, such as Central Silk Board have as main focus growth in production, achieved through highly productive hybrids, cawky rearing systems and developing funding schemes focused on wild silk (vanya) and mulberry silk). Such partnerships address also the seed (silkworm egg) sector. Addressing the support policies in more depth, it can be seen the variety of support mechanism such as:

- Catalytic Development Programme (CDP)
 - Technology transfer and distribution of governmental financial support
- CDP – Support Mechanism
 - Addresses in optimization of value chain segments through: programs, trainings, and marketing services.

Though the services of ISC, countries may enquire more details about the sericulture industry model,

For Latin America, the sericulture is divided in 2: artisanal products and commercialization of the cocoons. We have Project SEDA (11 institutions from 6 countries were involved), focused on developing sustainable rearing technologies and high-quality inputs (silkworm eggs and mulberry saplings), thematic workshops, trainings from farmers, access to financial support and providing access for farmers to better resources through specialized agents.

2. The importance of value chains: highlighted in the Thailand Country report.

The example of Thailand, where through research focused on productive strains and development of new facilities (such as reeling centers), the sericulture production greatly increased after 2017.

3. New trends in the silk industry, focusing on more green and sustainable production, as well as social aspects, such as women Empowerment

The case of Meghalaya, and its Ethnic fashion under international recognition:

- Peace silk (where the moths are set free). It has 2 main aspects: ethnic fashion (cruelty free) and sustainable processing. With support from government, this branch of sericulture continues to develop more and more (from silkworm rearing, to weaving and dyeing).
- One important aspect is fully ecological nature throughout the entire chain.

4. Importance of family farms in the sericulture industry

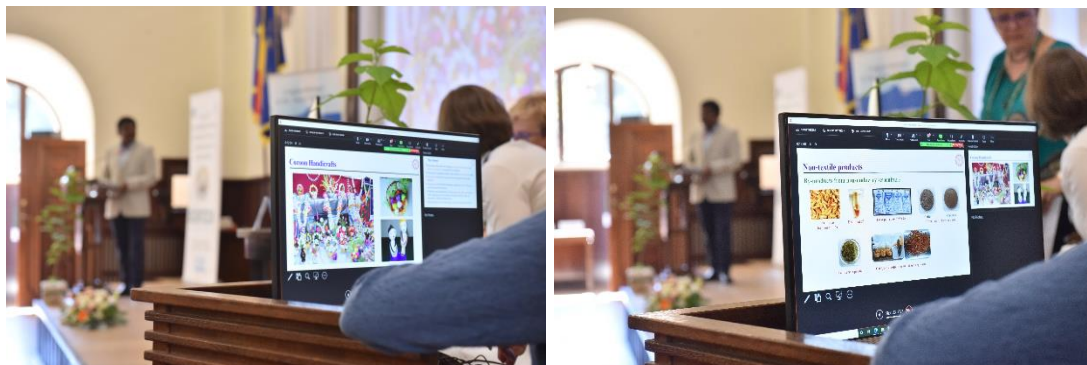
- The Case of Egypt: Carpet production has become sustainable through collaboration with bigger farms that will offer the services such as weaving

5. Technological aspects

- Input sector:
 - Seed production. India is highly focused on the production of quality silkworm eggs with a high cocoon yield. Large numbers of farmers and enterprises are implicated in this sector, that are being supported by financial government incentives (establishment of the farm infrastructure).
 - Integration of the mulberry with other cultures: the Case of Cuba

We had a guest presentation of a large company from China, Babei Group Company, that has addressed the situation of silk and sericulture industry, and its activity as company as well.

In conclusion, we can state that our section has focused greatly on developing strategies meant to help the silk industry (from farm to company level) and on strategies that protect its culture and heritage.



Section 7: Sericulture in non-textile industry

Chair: Tsunenori Kameda

Vice-chair: Dr. Vlaic Bogdan

This section was set up with intriguing expectation on silkworms and mulberry presentations for medicals, pharmaceuticals, food, biotechnology, and biomaterials applications. A wide range of discussions were anticipated on the



possibilities of sericulture beyond silk textiles. Six speakers gave onsite presentations, and three more online presentations. The actual content of the presentation was roughly divided into two directions: (1) silk materials, and (2) mulberries for medicinal and food use.

In papers on silk materials, "sericin" was the trend. Many studies on sericin were presented, including sericin extraction methods, extract component analysis, and sericin processing. Also, in some papers, consideration was given to the molecular weight of sericin. At the beginning of the section, the section chair did an opening lead paper presentation that was particularly focused on silk materials. In the presentation, the usefulness of using sericin that maintains its original molecular weight, using nanoparticles as an example, was demonstrated.

In addition, the lead presentation also mentioned adding functionality to fibroin by transgenic technology, genome editing technology, or conjugation with peptides or other polymers. In the presentation following the lead presentation, a specific successful example of functional addition to fibroin, and its success in immobilizing a functional peptide to fibroin via the GAGAGS peptide was described.

For the other category, mulberries for medicals and food, it was suggested that mulberry leaves may help prevent COVID-19 infection. It was strongly argued that improving the quality of the human life could be achieved by mulberry leaf. Regarding the use of mulberry fruit, a new way of making mulberry juice was proposed and the results of nutritional component analysis were reported.

Lead paper: Silk as non-textile materials

Tsunenori KAMEDA

Silk Materials Research Group, Institute of Agrobiological Sciences, National Agriculture and Food Research Organization (NARO), Tsukuba, JAPAN

Oral Presentations

Oral 1 (on site): Immobilization and visualization of functional peptides on silk fibroin-based biomaterials

Presenter: Dr. Tomoko Hashimoto

Faculty of Textile Science and Technology, Shinshu University, Ueda, JAPAN

Oral 2 (on site): Potential of Sericin Peptides from *Bombyx mori* (Nistari) as Drug Delivery Molecules: A Computational Analysis

Presenter: Dr. Pooja Makwana

Central Sericultural Research & Training Institute, CSB, Berhampore, INDIA

Oral 3 (online): Sericin is a gift of nature: its valorization

Presenter: Dr. Karmabeer Jena

Central Tasar Research and Training Institute, Central Silk Board, Jharkhand, INDIA

Oral 4 (online): Studies & Experimental trials on Carbonization of Silk fibroin and its use for electronic textile and manufacturing of composite materials

Presenter: Dr. Ponnusamy MathiAzhagan

Central Silk Technological Research Institute, Bangalore, INDIA

Oral 5 (online): Green Synthesis of Silver nanoparticles in aqueous medium by reduction of Silver nitrate by using excreta of *Bombyx mori* for medical applications in wound, dentistry healing and disease control during silkworm rearing

Presenter: Dr. Ponnusamy MathiAzhagan

Central Silk Technological Research Institute, Bangalore, INDIA

Oral 6 (on site): Product Development from Mulberry Fruit Juice into Fruit Instant by Foam-mat Drying

Presenter: Dr. Tanakij Thamee

Queen Sirikit Sericulture Center)Phrae(, Phrae, THAILAND

Oral 7 (on site): Mulberry leaves as practical alternative for improving the quality of the human life

Presenter: Dr. Dayron Martín Prieto

Sericulture group. Experimental Station for Pastures and Forages Indio Hatuey, CUBA

Oral 8 (on site): A Physico-Chemical Study on Soap and Cosmetics Enriched with Sericin Extracted from Mulberry Silk Cocoons *Bombyx mori* / *L.*

Presenter: Dr. Abhilasha Rangi

Central Silk Technological Research Institute, Central Silk Board, Bengaluru, INDIA

Section 8: Silk processing

Chair: Dr. Subhas V Naik,

Vice-chair: Dr. Alexandru Giurgiu

Total number of 10 research papers were presented on different aspects of Silk processing, import, export, silk consumption, global demand, marketing, and promotion.



Lead paper on Advanced developments in silk processing highlighted the latest developments in silk processing like High Pressure and High Temperature Degumming without chemicals, Arm dyeing etc. Further latest technologies like application of plasma technology, Super critical carbon dioxide dyeing process, Foam dyeing technology were also presented. Author also emphasized the need of Product development and diversification, Ensuring purity of silk by non-destructive method and uniform raw silk grading system for the silk industry.

Paper on Degumming of Eri silk without chemical using newly developed high temperature and high pressure degumming machine highlighted the advantages of eco-friendly process.

Paper on Silk Melange yarns highlighted the importance of characterising the Melange effect and accordingly newly developed image processing technique for the same was presented.

Paper on Enzymatic finishing of Tasar silk fabrics highlighted the advantages of finishing process in enhancing the handle properties of Tasar fabrics woven with Indian Tasar silk and there by value addition.

Paper on extraction technique on the properties of Mulberry Sericin extracted reveal that sericin extraction process plays an important role on the characteristics of Sericin and thus should be chosen based on the area of sericin application.

Paper on Cocoon finger puppets explores and envisages the potential of the silkworm cocoon in edification.

Paper on Yarn finishing emphasized the importance of yarn finishing process and highlighted the advantages of new finishing treatment developed and given at yarn stage itself to impart desirable functional properties such as oil and water repellence and anti-microbial finish for loom finished fabrics,

Paper on Impact of wet processing on quality of Mulberry silk fabrics explained the changes in the properties that occur during various stages of chemical processing of silk fabrics and highlighted how the certain required fabric properties are enhanced/improved by wet processing.

Paper on Eri silk and Wool blended yarn emphasized that best intimate blending can be achieved by blending Eri silk with wool due to their similarity in fiber fineness and hence this combination is exploited for manufacturing suiting fabrics,

One more paper highlighted the importance of generic promotion and product diversification for growth of global silk industry. Paper also emphasized the importance of silk mark labelling of products.



Recommendations

1. Adoption of new technologies which gives better quality, productivity with less labor/water/energy requirements.
2. Product diversification and development is essential in order to broad base the usage and increase the silk consumption.
3. Silk being valued fiber robust branding and purity assurance system is essential to enhance the confidence of stake holders as well as consumers.
4. Huge scope exists for silk for non-textile applications.

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