From President's Desk……

Biomedical Applications of Natural Gums

The Natural resins and gums are well known for their widespread use in the food and pharmaceutical industries. The prospective uses of tree gum polysaccharides and their nanostructures in various aspects of food, water, energy, biotechnology, environment and medicine industries have garnered a great deal of attention recently. Tree gum polysaccharides or gum hydrocolloids are versatile green materials encompassing diverse functional and structural properties to assemble varied nanostructures. Depending on their major industrial applications, plant gums may be broadly classified as 'food' and 'non-food' or 'technological grade' gums. Natural gum hydrocolloids are classified into various groups depending on their origin, structural - functional properties, and applications namely botanicals (locust bean gum, guar gum, and pectin), tree gums (arabic, karaya, tragacanth, ghatti, etc.), seaweed polysaccharides (alginate, carrageenan and agar), and bacterial polysaccharides (xanthan, dextran and gellan gum).

In addition to food, substantial non-food applications of gums have gained widespread attention due to their structural diversity and remarkable properties as 'green' bio-based renewable materials. Tree gums possess exceptional properties like biocompatibility, biodegradability, cyto-compatibility, with no eliciting of immune response and their ability to undergo easy chemical modifications. The surface properties of tree gums are unique due to their ability to decrease interfacial tension between different systems such as gas-liquid, liquid-liquid, and solid-liquid, which imparts stability via steric, electrostatic interaction and hydration forces. Non-food applications of several important commercially available gums include greener synthesis and stabilization of metal/metal oxide NPs, production of electrospun fibers, environmental bioremediation, bio-catalysis, biosensors, coordination complexes of metal–hydrogels, and for antimicrobial and biomedical applications. Cell bio-imaging, drug delivery, tissue regeneration, water treatment, radio-sensitizers in radiation, photodynamic therapy, biosensor, biomaterials for implantation and sutures are among the most common biomedical application of gum bio-based nano-materials and nano-composites.

Though the current advancement has made a significant improvement in the pharmaceutical sector, however, several engineered constructs are still at their fantasy and facing challenges due to poor pharmacokinetics and inefficient mode of action. The current limitations of synthetic counterparts can be tackled by imparting the inherited bioactive features and functional attributes of gums polysaccharides-based bio-nanostructures. The natural gums have an ability to become excellent biopolymer and can improve the composite properties when combined with various other biomaterials and can show superior results by additive effect. With their unique structure and functionality, they have opened up a new area of nanostructured material creation.

Lac production scenario in India ….

According to the Census of India 2011, there are 248.4 million households with an average family size of 4.8 in India (Government of India, 2015). Out of these households, less than one percent is involved in lac production and processing activities, but almost every household and each government departments of the country have a regular demand for lac-based products. The environment including living (parasites and predators) and non-living factors plays a major role in lac cultivation. Climate resilient practices have become an important researchable issue and their adoption by the lac growers at the field level is a necessity due to the changing climate. In the second stage of lac production, transportation, and processing of harvested crop (sticklac) are the major activities.

Table 1. Quinquennial average lac production in India

Plan Period		*Baisakhi*	*Katki*	*Jethwi*	*Aghani*	*Rangeeni*	*Kusmi*
V Ave.	1974-1978	14449	3312	1452	2064	17761	3516
Rolling Plan Ave.	1978-1980	7985	3330	883	1157	11315	2039
VI Ave.	1980-1985	10776	3001	730	1478	13777	2208
VII Ave.	1985-1990	9268	4339	1009	2476	13607	3485
AN Ave.	1990-1992	7545	3320	895	1039	10864	1934
VIII Ave.	1992-1997	10516	5357	958	2086	15872	3045
IX Ave.	1997-2002	7934	3573	2015	2319	11507	4334
X Ave.	2002-2007	7915	6452	2528	3123	14367	5650
XI Ave.	2007-2012	5211	3326	4362	3351	8537	7712
XII plan	2012-2017	4432	3111	5761	5229	7543	10990
AN Ave.	2017-2020	2896	2704	4792	6035	5600	10827

All the production figures represent tonnes

Role of the host plant and machinery come into the value chain at lac production stage. Policy issues, infrastructure, applied research and market factors become major factors influencing lac processing. As soon as the final product comes out of the machinery, lac reaches the market where applied research, price, demand, supply, trade agreements, and policies become major factors influencing lac consumption. Thus, in the value chain the lac insect from the ecosystem produces sticklac (natural resin) and finished/value added products reach to consumers. In this process host plants, machinery and the market play a key role (Fig. 1)

Strain-wise analysis of time series data: Jharkhand state alone contributes around 50% of the total lac production of the country. About 45 years back the share of the state was 65% and was recorded highest (about 70%) during the sixth five year plan (1980-85); in which the major share was from *baisakhi* and *katki* crop of *rangeeni* strain. During 1974-97, *rangeeni* strain contributed about 80% of the total lac produced in the country.

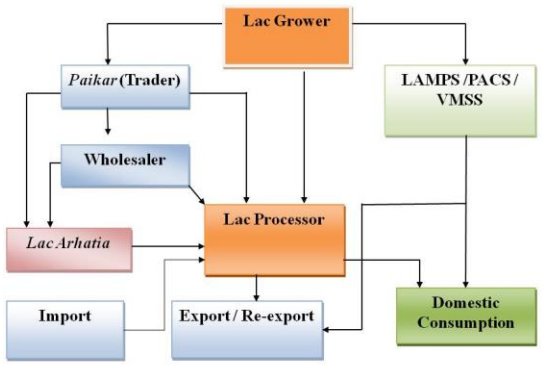

Fig. 1. Channels of lac marketing

Similar trends over this period were also observed in the state of Jharkhand, and it is interesting to note that Jharkhand had been contributing more than 60% of the lac produced in the country. The production level of *jethwi* and *aghani* crop of *kusmi* strain was doubled from 1997 onward while the production of *rangeeni* strain was observed to be in a declining trend both at the national and state level. The transition period of the paradigm shift in lac cultivation pattern was observed from 1997 to 2007. Further, it completely flipped the scenario. During this period, production curve of *kusmi* strain touched the level of average annual lac production of 2000 and 4000 tonnes in Jharkhand and India, respectively (Fig. 2).

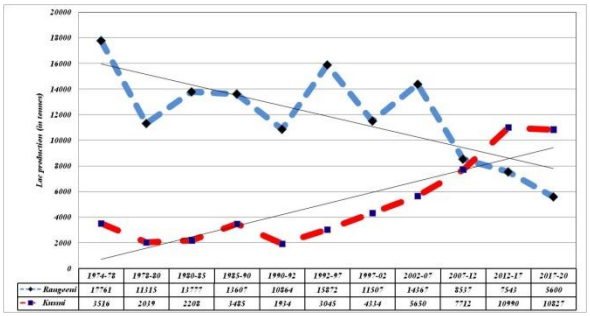

Fig. 2. Crop-wise share in total lac production in India

During the sixth five-year plan period, an '*overlapping stage*' was observed after which the major share of lac production was contributed by *kusmi* strain. Since last few years, Jharkhand state has witnessed failure of *rangeeni* strain in several districts and simultaneously has been compensated by *kusmi* strain. Consequently, the production level of *rangeeni* strain inclined downwards at the state level. The scenario was not similar at the national level, as production belts for *rangeeni* strain in the states of Madhya Pradesh, Maharashtra and West Bengal were the major contributors in lac production. Utilization pattern of lac host trees in

Jharkhand showed that only 51, 70 and 62% of the *palas, ber* and *kusum* trees are exploited, respectively.

Kusmi lac in terms of quality and quantity is superior to *rangeeni* lac. Lac growers fetch a greater price for *kusmi* lac in comparison to *rangeeni* lac. Moreover, both crops of the *kusmi* strain, namely *aghani* and *jethwi,* mature in six months and the lac growers get their income at a half yearly interval. On the other hand, the major crop of *rangeeni* strain, i.e. *baisakhi,* matures in eight months so lac growers have to wait for eight to nine months for income. Among lac growers, the level of awareness through various training programmes has also increased, providing more profitable options for them. Consequently, a paradigm shift of lac growers from *rangeeni* to *kusmi* lac production in Jharkhand state as well as at national level was observed.

Production of lac from *jethwi* crop of *kusmi* strain had shown the highest instability comparatively to all other crops. As seen in the pictorial illustration, *aghani* crop of *kusmi* strain seems to be a relatively more stable crop. Out of five years, this crop had touched the level of about 4000 tonnes of lac production thrice. Thus, it can be inferred that the winter and rainy season crops of both the strains have shown stable production over the period. On the other hand, summer crops of both the strains were relatively less stable in production due to mortality of the lac insect. Mortality of the lac insect may occur due to several factors including high temperature, traditional method of lac cultivation, water scarcity, and pest attack. Negative growth trends in the production of rainy and summer season crop of *rangeeni* strain have been reported. During the previous five years, the insect mortality of the rainy season crop of *rangeeni* strain was detected as the major cause of decline in production. Subsequently, a shift in utilization of the *ber* host trees for *kusmi* strain was observed and relative contribution of *kusmi* lac has gained a momentum of positive growth in the state (ICAR-IINRG, 2014).

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Export and import performance of natural resins and gums

According to ITC calculations based on UN COMTRADE statistics, the world trade aggregation of lac, natural gums, resins, gum-resins and balsams during 2019 was 1435.02 million US dollars. Out of this, the world export aggregation of lac, natural gums, resins, gum-resins and balsams during 2019 was 519.25 million US dollars. Share of NRGs in India's total import of ₹ 35946.74 billion in 2018-19 & ₹ 33609.54 billion in 2019-20 has been increased slightly at 0.04% (₹ 15.33 billion) in 2018-19 and 0.05% (₹ 16.65 billion) in 2019-20.

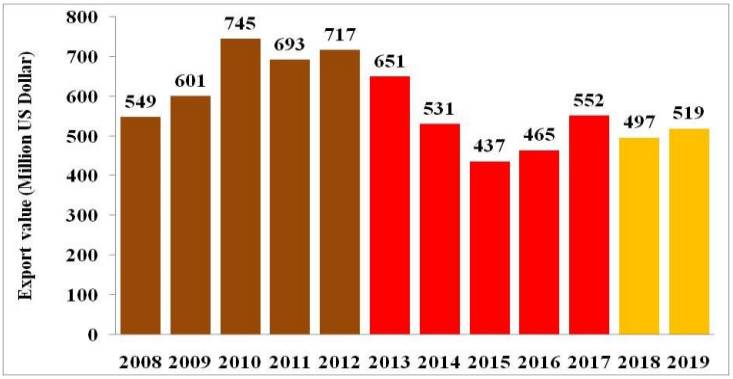

Fig. 3. World export flow of lac, natural gums, resins, gum-resins and balsams

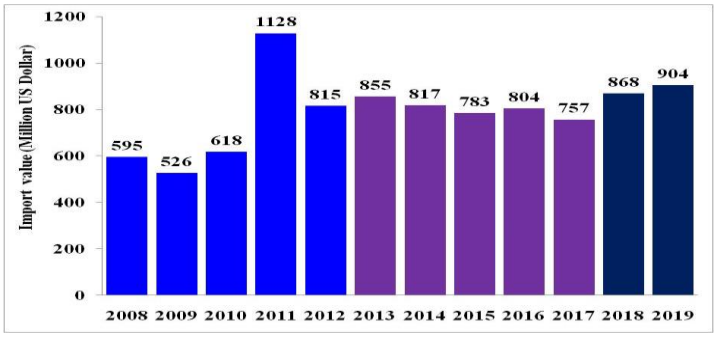

Fig. 4. World import flow of lac, natural gums, resins, gum-resins and balsams

Similarly, share of NRGs in India's total agri import increased from 0.84% in 2016-17 to 1.13% in 2019-20. Share of NRGs in India's total export (₹ 23077.26 billion in 2018-19 & ₹ 22198.54 billion in 2019-20) has been decreased from 0.20% (₹ 45.63 billion) in 2018-19 to 0.15% (₹ 32.83 billion) in 2019-20 with an annual deceleration of 28.05% (Department of Commerce, 2020). Similarly, share of NRGs in India's total agri export has also been decreased from 1.42% in 2016-17 to 1.30 % in 2019-20. A decadal data (2008-2019) on world EXIM aggregation of lac, natural gums, resins, gum-resins and balsams were analyzed and presented in Figure 3 and Figure 4. Since 2012, deceleration in the value of world export aggregation was observed, but it increased in 2017. Stagnation was found in the value of world import aggregation during the similar period.

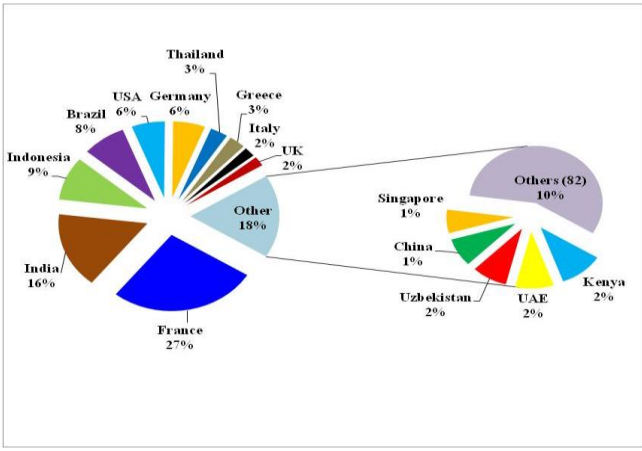

Fig. 5. Breakup of the World export aggregation of NRGs

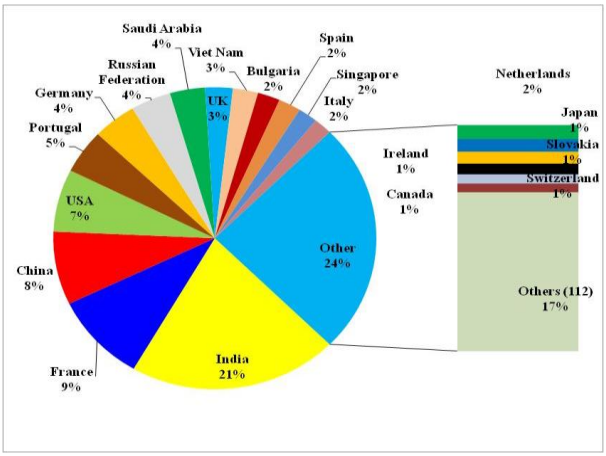

Fig. 6. Breakup of the World import aggregation of NRGs

Major suppliers of NRGs contributing about 90% share in international market are France (26.9%), India (16.1%), Indonesia (9.3%), Brazil (7.9%), USA (6.0%), Germany (5.8%), Thailand (3.2%), Greece (3.0%), Italy (2.0%), UK (2.0%), Kenya (1.9%), UAE (1.7%), Uzbekistan (1.5%), China (1.4%) and Singapur (1.2%). Rest of the 10% NRGs are supplied from 82 countries across the world (Fig. 5). Similarly, the world import aggregation of lac, natural gums, resins, gum-resins and balsams during 2019 was 904.00 million US dollars.

Major importers of NRGs comprising about 82% share in the international market are India (21.0%), France (9.5%), United States of America (7.8%), Portugal (4.7%), Germany (4.4%), Russian Federation (4.0%), Saudi Arabia (3.5%), United Kingdom (2.8%), Viet Nam (2.5%), Bulgaria (2.2%), Spain (2.2%), Singapore (2.0%), Italy (1.8 %), Netherlands (1.5 %), Japan (1.4%), Ireland (1.3%), Slovakia (1.1 %), Switzerland (1.0%) and Canada (1.0%). During 2019, rest of the 17.6% demand of NRGs arose from 112 countries across the world (Fig. 6). NRG production level during 2019-20 was estimated to be comparatively lower than previous year (Table 2). Other resins and gums production have increased during the current year

Table 2. World EXIM trade aggregation of lac, natural gums, resins, gum-resins and balsams *(Value in Million US$)*

Year	Export	Import	Re-Export	Re-Import	Total Trade
2006	669.12	559.72	11.77	0.75	1241.35
2007	470.47	575.00	11.82	1.50	1058.79
2008	548.82	594.65	13.26	0.12	1156.86
2009	601.20	526.39	19.94	0.24	1147.76
2010	745.48	617.75	15.46	0.20	1378.89
2011	693.28	1127.70	15.12	0.55	1836.64
2012	716.89	814.98	17.88	0.24	1550.00
2013	650.94	854.70	17.06	0.31	1523.02
2014	530.78	816.86	10.43	0.37	1358.44
2015	436.70	783.45	5.87	0.58	1226.60
2016	465.03	804.37	9.06	0.20	1278.67
2017	552.39	756.63	5.42	0.19	1314.63
2018	496.60	868.27	15.83	0.42	1381.13
2019	519.25	904.00	11.60	0.18	1435.02

Source: ITC calculations based on UN COMTRADE statistics.

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Technological innovations in Entomology displayed at various Fairs by SKUAST-Jammu

1. Northern India Regional Agriculture Fair 2021

The entomological innovations and interventions were displayed in the five-day fair. The foremost point of attraction was insect museum depicting biodiversity of Jammu region, showcasing world of insect in the form of bees, butterflies, beetles, grasshoppers, dragonflies etc. Another focal spot was eco-friendly interventions to manage harmful insects through available Bio resources, Botanicals and Microbes while conserving and enhancing beneficial insects through bioengineering and seed mixtures (Fig. 7).

Many farmers and children were imparted awareness on these aspects. Further insects have aesthetic value because of their ubiquity and variety, which could inspire for creative art and products in daily life. Therefore, a separate sale counter was displayed for insect-based crafts like true butterflies in photo frames which can be used as decorative wall arts in the houses, painting and the products that are derived from insects especially Honeybee and lac insect. For

instance Bee venom for apitherapy, Bee Pollens as a source of protein and management of seasonal allergies and building resistance in the body, Bee Propolis which has anti fungal properties and also treat cold sores and Bee Wax that is meant for usage in beauty products, organic candles like Papaya candles made up of papaya stems and bee wax without chemicals. Other products were based upon the use of resins of lac insects for value addition of ornamentals, decorative items, etc

In order to create awareness about the positive role of insect in human life, the students were involved to play with insects to get acquainted with their behaviour and role in the ecosystem. The insect games developed and designed by the Entomological Club for the first time in India under the leadership of Dr. R. K. Gupta and his team Dr. R. S. Bandral, Dr. Magdeshwar Sharma, Dr. Uma Shankar, Dr. Amit Kumar and Dr. Devinder Sharma were played in this event. Many visitors, school and college children enjoyed these games. The first one was Entomo Tambola which was like conventional tambola. The main objective of the game is to promote awareness about insects besides entertaining the participants with the motive of playing while learning. Entomological Club that was formed to conserve and promote insects in the Jammu region, believe that these kind of activities and games will help to promote interest among common man regarding insects that will help in conservation of insects. Another game was the insect acoustic games. The game was like musical chair but based on the various kinds of sounds of insect. The objective was to develop interest in children and with the insect sounds they will be able to recognize them. In another event, live caterpillar race was organized and played. Participants chose their pawns according to their will and the caterpillars were allowed to run and the quicker in a transparent polytube.

Dr. R. K. Gupta informed that as per the instruction of Dr J. P. Sharma, Vice Chancellor to reorient entomological education as per National Education Policy, Entomology Division under the banner of Entomological Club organized an innovative stall on Entomo mimmetics: an emerging field of Entomology to inspire engineers to develop and design machinery, arms, Defence warfare and robots etc. This stall of Entomological Club was applauded with appreciation by all kind of visitors while having a look at Stealth Bombers which were designed mimicking the flight ability of insects called hawk moth. Small scale models based on hawk moths was depicted and deliberated. Another feature of this stall was Excavator machines that were inspired by the front digging legs of mole cricket and praying mantis. Robots based on the movement of cockroaches were also displayed and its use in urban warfare to counter terrorists was explained. Similarly, use of a front faced video camera and 360 degrees camera and bullet camera inspired from the eye of dragonfly was deliberated. Solar cells based on the wings of butterflies that are covered in randomly spaced holes that allow butterfly to absorb more of the sun's heat offer a way to improve the efficiency of thin-film solar cells.

In a clinical stall named, we the Urban Pest Managers, the Entomological Club scholars extended consultancy services to the visitors who were amazed to experience detailed knowledge on household insects that are known to occur frequently in our dwellings, damage our food materials and transmit various kinds of diseases and cause annoyance to us. These insects are known as household insect pests.

These include cockroaches, bed bugs, houseflies, ants, mosquitos, termites. The visitors were amazed to utilize free consultancy service in urban pest management and sought our future services on a no profit no loss basis. The dignitaries who visited and appreciated the stall were Sh. Narender Tomar Union Cabinet Minister, Sh. Kailash Choudhary Union Minister for State, Dr. Jatindra Singh Union Minister of State for Prime Minister's Office, Sh. Farooq Khan, Advisor to Hon'ble LG UT of J&K, Shri Navin Kumar Choudhary (IAS) Principal Secretary to Government, Former DG DRDO, a team of scientists from IIT, Jammu and others.

Fig. 7. Technological innovations in Entomology displayed at SKAUST-Jammu

2. Deepawali Fair at SKUAST-Jammu

Under the initiatives of Network Project on Conservation of Lac Insect Genetic Resources lac items were displayed in the one-day Deepawali fair. Many farmers and children were imparted awareness on the importance of lac insect and its conservation. Visitors were amazed to know about the economic importance of the lac insect and in particular the children were amazed to see the different types of articles made up of lac. Dignitaries who visited and appreciated the stall were Dr. J. P. Sharma Hon'ble VC, SKUAST-Jammu, Dr. Sanjay Kumar, Director CSIR-IHBT, Palampur, Sh. Sham Lal Sharma Former Minister, Government of J&K, Former Director Research and Registrar SKUAST-J and others (Fig. 8).

Fig. 8. Lac Items Display in Deepawali Mela at SKUAST-Jammu

Biston suppressaria* (Guen.) & *Hyposidra talaca* (Walk.): recorded as insect pests of *Flemingia spp.

Tea looper, *Biston suppressaria* and black looper or back inch worm, *Hyposidra talaca,* a major insect pest of tea crop belonging to the family Geometridae were recently recorded in lac ecosystem at regional lac insect field gene bank, AAU, Jorhat (Fig. 9 and 10). Literature reveals that five looper pests *Biston bengaliaria* Guen., *B. suppressaria* Guen, *H. talaca* Walk., *H. infixaria* Walk. *Eproctis* sp. are reported and well adapted in tea ecosystem of Assam. Continuous observation on lac host plants shows that these two insect pests feed vigorously and defoliate the leaves of *Flemingia semialata* and *Flemingia macrophylla*.

The pests were recorded from January to July, 2021 and highest infestation was recorded in the month of May, 2021. The early instar larvae cut small holes along the margin whereas the full grown larvae fed voraciously on matured leaves, initially from the margin towards the mid rib, leaving the mid rib uneaten. Hence, looking at the severity of infestation, certain aspects of *B. suppressaria*'s biology were studied at lac laboratory, Department of Entomology, Assam Agricultural University, Jorhat under laboratory conditions at temperature 27 ± 1°C, and RH 80 to 85%. The looper caterpillar shows complete metamorphosis. There are four stages in their life cycle *i.e.* egg, larva, pupa and adult. The study reveals that the insect completed its life cycle within 50 to 60 days. The incubation period ranged from 10 to 15 days. The larval period is about 3 weeks and passed through five instars. The pupal period is about 3-4 weeks. The total fecundity of *B. suppresarria* ranges from 250-350 eggs. The adult lives for 5-7 days. These two pests cause about 80-90% damage of the plant both in field and laboratory conditions. Thus, the key pest of tea crop might be a major pest of *Flemingia* spp. in near future.

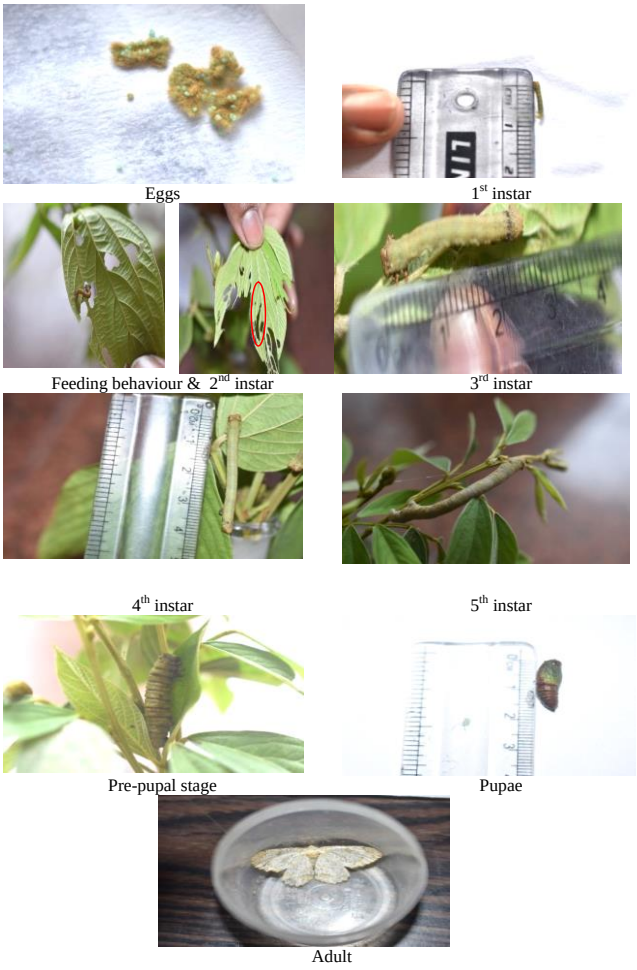

Fig. 9. Biology of *Biston suppressaria*

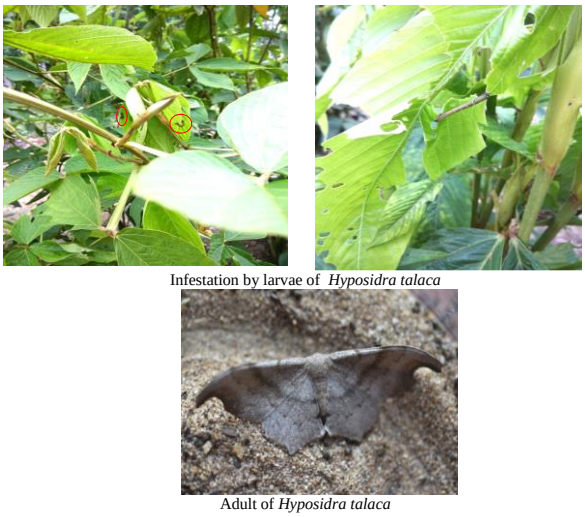

Fig. 10. Symptoms, larvae and adult of *Hyposidra talaca*

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AAU, Jorhat

Value addition of NTFPs: production of decorative forest products

Most of the products in day today activity depend directly or indirectly on forest and NTFPs. Presently, there is a vast scope for value addition and income generation through the sale of value-added products. Normally, if we sell the NTFP products in the raw state, it fetches less value (e.g., bamboo, canes, cinnamon leaves, medicinal plant parts, beedi leaves, muttuga leaves, garcinia, nelli, jack fruits, etc); hence value addition is very essential to gain more income to the farmers, to provide employment to rural people and avoid post harvesting losses. Now a days there is a huge demand at the international markets also for value added products of NTFPs (e.g., Nutmeg, Pepper, Cinnamon quills, Kokum juice, Shigekayi, Bamboo and Cane products, etc.). They are eco-friendly as well as sustainable in nature.

Studying B.Sc. Forestry, at College of Forestry, Sirsi, Uttara Kannada, under UAS, Dharwad, we came across many different forest produces which by value addition can be an additional source of income to the people living in and around forest areas of Uttara Kannada district, Karnataka. During the final year of our graduation, we were exposed to many different experiential learning programs, where we execute the learning from past years of under graduation and develop entrepreneur skills. We produced different decorative value added products from NTFP species such as bamboo (Burma bamboo, Yellow bamboo, Budha bamboo, Hallow bamboo, etc.) and decorative seeds/beads (*Entada scandens*, *Adenanthera pavonina*, *Abrus precatorius*, etc.).

With the support of Dr. K. S. Channabasappa, Dean (Forestry) and under the guidance of Dr. M. Hanumantha, Assistant Professor and Course guide we were able to produce decorative products like bamboo hanging pots, pen stands, light lamps; wall decoratives, key chains and even seed based key chains. The feedback from initial marketing is very good and gained appreciable profit with a benefit: cost ratio of almost 2:1. This represents the importance of value addition through NTFPs and its products and demand for the same. Such exposures help us to develop entrepreneurship skills and show a way for establishment of small-scale forest-based industry in future. Being eco-friendly and sustainable, bamboo and decorative seed-based products are paving their way into our better future

Fig. 11. Decorative products prepared from Non Timber Forest Products by B.Sc. Forestry students, COF, Sirsi

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Rajendra Bawoor and Nandeesh V Naik
College of Forestry, Sirsi, UAS, Dharwad

Bamboo hanging pots: an eco-friendly approach for urban gardening

Due to increasing population in urban area; there is a scarcity of space for gardening, improving the aesthetic beauty and other activities. Hence, a new hope to solve this problem is terrace gardening with the use of different eco-friendly materials. But most people are forced to go for plastic containers/hanging pots in their homes due to its light weight, easy availability and low cost; but they are not eco-friendly, non-biodegradable and source for environmental pollution.

In order to avoid environmental pollution and other effects caused by the use of plastic containers, the best alternative eco-friendly raw material for terrace gardening is bamboo.

Bamboo is one of the most primitive plant species that survive today and popularly known as “The Green Gold” and “Poor man’s timber” and considered as one of the important Non-Timber Forest Product. It provides food, raw material and shelter and it is a great protector of earth’s health and wealth. Since, it has the potential for effective carbon sequestration, it helps in countering the emission of greenhouse gases, global warming and climate change. Its disadvantages include low durability and infestation by pest and diseases. They can be overcome by treating with different preservatives (boric acid solution) and insect resistant coatings. Many value added products/items were made from bamboo in many bamboo growing areas for higher income.

Keeping this concept, students of B.Sc. Forestry, College of Forestry, Sirsi, Uttara Kannada, UAS, Dharwad, prepared plant containers/hanging pots (Horizontal and vertical) using different bamboo species (Burma bamboo, Yellow bamboo, Thorny bamboo) during their hands on training programme with the supportive role of Dr. K. S. Channabasappa, Dean (Forestry). The prepared containers gained more popularity and demand with appreciable profit (B: C ratio of 2:1.) Being eco-friendly and sustainable, these bamboo pots/containers can be a better alternative choice to avoid plastic containers and for sustainable urban gardening

Fig. 12. Hanging pots prepared from bamboo species by B.Sc. Forestry students, COF, Sirsi

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College of Forestry, and KVK, Sirsi, UAS, Dharwad

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