

COORDINATOR'S REPORT

(December 2021 – December 2022)

14th Annual Workshop

of

Network Project

on

Harvesting, Processing and Value Addition of Natural Resins and Gums

**Venue: Online Virtual Platform
Organized**

by

ICAR-NISA, Ranchi

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ICAR- National Institute of Secondary Agriculture
(Indian Council of Agricultural Research)
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1.1 Background Information

Natural Resins and Gums

Gums are found in a greater or less degree in most plant families. Various parts of the plant may produce or secrete them. They may be produced only in very small quantities and not be readily discernible, or they may be produced very copiously forming large, conspicuous incrustations on the surface, as with most of the commercial gums, particularly the tree gums.

Various views have been put forward concerning the processes whereby gum is formed in plants. In some instances, it is believed that gum is part and parcel of the normal metabolism of the plant and is in every sense a natural or physiological rather than a pathological product. While some vegetable gums may originate in this manner and be part of the normal cell content, as in the case of the gums in sugar beet and yeasts, it is now generally agreed that most gums owe their origin to infection of the tissues by some form of micro-organism. In some cases, the production of gum has been attributed to fungi attacking the plant, these fungi being responsible for enzymes that penetrate the tissues and transform the celluloses and hemicelluloses of the cell wall into the gum. This may be the origin of the gum produced in the "gummosis" diseases of certain deciduous and other fruit trees. They are characterized by the ability to dissolve in water forming viscid solutions, or by absorbing water to form jellies or gelatinous pastes as in tragacanth and allied gums. On desiccation or exposure to the air, these solutions or pastes lose their water and dry to hard, clear, rather glassy masses.

Indonesia and China are among the world's major producers of gums and resins. India is the rich center of plant bio-diversity having more than 45,000 plant species including about 120 gum and resin-yielding plants. In India, natural gums are derived from the selected tree species. The gum sector is one of the most important sources of livelihood support for more than 50 million population inhabiting the forest and sub-forest areas besides being a major source of employment. In recent years, due to the 'back to nature' trend, there has been a revival of interest in natural gums collected from forests by rural and tribal people who depend on these resources to sustain their livelihood.

The three major exudate gums-gum Arabic, gum tragacanth, and gum karaya-possess a unique range of functionalities. Gum arabic is the oldest and best-known of all-natural gums. Its use can be traced back to the third millennium B.C., the time of the ancient Egyptians. It was used as a pigment binder and adhesive in paints for making hieroglyphs, and ancient inscriptions refer to it as kami. Furthermore, it was used as a binder in cosmetics and inks and as an adhering agent to make flaxen wrappings for embalming mummies. Gum tragacanth, like gum

Arabic, has an ancient history. It was described by Theophrastus in the third century B.C. Its name is derived from the two Greek words tragos (goat) and akantha (horn) and probably refers to the curved shape of the ribbons, the best grade of commercial gum. The dried exudation obtained from the stems and branches of *Astragalus gummifer* and other Asiatic species of *Astragalus*. Gum karaya has a more recent history and has only been used commercially for about 100 years. In the early 1900s, it was introduced on the market as an adulterant or alternative for gum tragacanth, due to the great similarity between both gums. Gum karaya is the dried exudation from stems and branches of *Sterculia urens* Roxb and other species of *Sterculia* (Fam. Sterculiaceae). Many other higher plants exude gums, such as *Anacardium*, *Pithecellobium*, *Spondias*, *Albizia*, *Prosopis*, *Enterolobium*, *Hakea*, and *Combretum*.

Plant resins are widely distributed in the vegetable kingdom and may be present in almost any organ or tissue of the plant. Sometimes they are excreted on the surface of the plant in a more or less natural fashion or they may occur only in the inner tissue and not be visible. Resin is generally secreted in plant tissue in special cavities or resin ducts and rarely, if ever, in the actual living cell. These cavities are lined with a special layer of secretory cells which secretes the resin into the cavity through thin cuticular skin. However, they do possess certain properties in common and form a distinct group of plant products easily recognizable in practice. They are insoluble in water but usually dissolve readily in alcohol, ether, carbon bisulphide, and certain other solvents. With heat, they first soften and then melt to a more or less clear, sticky fluid. They burn with a smoky flame and are resistant to most reagents and to decay. The three most important families for the bulk production of natural resins for commercial purposes are the *Pinaceae*, *Leguminosae*, and *Diptarocarpaceae*.

Natural gum resins, as the name implies, consist of natural mixtures of gums and resins in variable proportions and therefore partly soluble in water and have a characteristic odor and taste. They also contain a minor portion of essential oils. They are usually derived from the plants of dry and arid regions. Asafetida, Myrrh, Salai, and Guggul are some common examples of gum resins.

The research emphasis is required to enhance the quantity and quality as also on developing and standardizing techniques to increase the harvest of gums and resins, and their processing, handling, and storage. Identification and process development for the isolation of potential phytochemicals from gums and resins for use in nutraceuticals, functional foods, and an antioxidant call for priority attention. Keeping in view the immense potential of these natural, non-toxic, and bio-degradable products of social, livelihood, and industrial importance, the ICAR decided to include these as part of the regular research programs at the National Institute of Secondary Agriculture, Ranchi.

To address the harvesting, processing, and value addition of region-specific gums and resins, an outreach program in a Network mode was sanctioned during XIth Plan with NISA (NISA), Ranchi as the lead center, and six other Network co-operating centers. The Network project in XIth Plan covered the aspects of harvesting/tapping, processing, and value addition of three gums (guar gum, karaya gum, and gum arabic), one resin (pine resin), and one gum resin (guggul).

Apart from these gums and resins covered under the Network Project during XIth Plan, there are other gums and resins of commercial importance which need R&D attention. Hence three more centers have been included in the project in XIIth Plan to look after these gums and resins (Tamarind seed gum, Dammar, and *Pinus kesiya* resin). The project continues in the plan period 2017-18 to 2022 with 09 centres.

1.2 Objectives of the Project

1. To study production, processing and marketing, and utilization of region-specific resins (except lac), gums and gum-resins
2. To develop and standardize protocols for harvesting & collection
3. To improve/refine the primary processing techniques for enhanced recovery and quality
4. To improve the process and machinery for making value-added products in collaboration with NISA, Ranchi
5. To transfer the resins, gums, and gum- resins specific technologies in the region

1.3 Location of the Cooperating Centers

1.3.1 ICAR Institutes

1. National Institute of Secondary Agriculture, Namkum (Ranchi)
2. Central Arid Zone Research Institute, Jodhpur (Rajasthan)
3. Central Agro-Forestry Research Institute, Jhansi (Uttar Pradesh)

1.3.2 State Agricultural Universities

1. Dr. Y. S. Parmar University of Horticulture & Forestry, Solan (Himachal Pradesh)
2. Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (Chhattisgarh)
3. Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra)
4. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh)
5. Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu)
6. Kerala Agricultural University, Thrissur (Kerala)

1.4 Monitoring of the Project

The project was launched on Feb. 09, 2009, by Dr. Mangala Rai, the Secretary, DARE, and Director General, ICAR at NISA Ranchi. After the launch of the project, work started at the centers. The progress of the project is reviewed in Annual Workshop held every year at different locations. Details of the last thirteen Annual Workshops organized at different locations are given below.

Annual Workshop Organized	Venue	Date of meeting
1 st	CAZRI, Jodhpur	June 08-09, 2009
2 nd	Dr.YSPUH & F, Solan	Aug.17-18, 2010
3 rd	IASRI, New Delhi	Nov. 22-23, 2011
4 th	NISA, Ranchi	Sept. 14-15, 2012
5 th	JNKVV, Jabalpur	Oct. 08-09, 2013
6 th	CAFRI, Jhansi	Oct. 17-18, 2014
7 th	FCRI, TNAU, Mettupalayam	Oct. 27-28, 2015
8 th	KAU, Thrissur	Oct. 06-07, 2016
9 th	IGKVV, Raipur	Nov. 01-02, 2017
10 th	ICAR-NEH Region, Barapani	Oct. 30-31, 2018
11 th	VNMKV, Parbhani	Nov. 19-20, 2019
12 th	ICAR-NISA, Ranchi	Dec. 22-23, 2020
13 th	ICAR-NISA, Ranchi	Nov. 09-10, 2021

Salient Research Achievement

1. CAZRI, Jodhpur, Rajasthan

- Seven *Cordia rothii* tree species were selected to carry out the experiment at CAZRI research farm in summer season (March-April, 2022) with 2 ml dose of CAZRI gum inducer. Tree structural traits of selected trees like average height, DBH and canopy cover were 4.54m, 7.46cm and 2.66 sq. m. Average gum yields 88.14 g/ tree was found ranging from 52.0 g to 137 g.
- Comparative study of gum production in Moringa tree species was carried out adopting borehole and blaze methods. The average height (7.3 m), GBH diameter (102.3) cm and average canopy (3.63m) were recorded for trees in which borehole method was adopted. Similarly, for trees adopted for blaze method recorded the average height – 6.76m, GBH-66.33 cm and canopy-2.6 sq. m. Average gum yield was 88.3 g/ tree in borehole method and 57.0 g /tree in blaze method.
- In a study, normal Ethephon and colourless Ethephon as gum inducer were applied to compare their performance. Results indicated that there was no adverse effect during pre and post treatment. Average gum production in normal Ethephon as gum inducer was 1140 g/tree and in case of colourless Ethephon as gum inducer was 885.0 g/tree.
- During the period (2021-22), 14520 trees of *A. senegal* were treated by CAZRI gum inducer, resulting in production of approximately 6.53 t of gum Arabic. In more than 48 villages of Chauhatan and Baytu tehsils of Barmer district; Shergarh and Phalodi tehsils of Jodhpur district; and some villages of Nagaur, Jhunjanu and Pali districts farmers adopted the gum inducing technology on large scale. In the year 2021-22 the average rate of gum Arabic was Rs. 800/- per kg in local market. Thus, farmers registered at CAZRI, Jodhpur of said villages earned revenue of Rs. 52.24 lakhs. In this way, in each village additional income of Rs. 1.08 lacs came through sale of gum Arabic.
- Organized 10 training programmes during 2021-22 in which 480 trainees (Farmers, Students and Officials of Forest departments) attended.

2. IGKVV, Raipur, Chattishgarh

- The button mushrooms treated with coating material prepared using babul gum and carboxymethyl cellulose maintained good firmness and had palatable eating quality till 8 days of storage.

- In the study, it was found that development of film for coating fruits and vegetable was possible using Charota seed gum in combination with starch and plasticizer.
- Based on the study it was found that Dhawara tree is suitable for gum tapping throughout the year except rainy season.
- Use of ethephon was significantly effective in gum tapping in Chironji (*Buchanania lanzan*) during April to June as compared to mechanical and traditional method of gum tapping.
- As compared to mechanical or traditional method of tapping, use of gum inducer was found to be significantly effective in gum production in Rohina (*Soymida febrifuga*).
- Transferred gum and resin specific techniques in the region through 10 training programmes organized for 398 farmers.

3. JNKVV, Jabalpur, Madhya Pradesh

- Guggul stored in earthen pot wrapped with moist jute bag was better in comparison to the Guggul stored in earthen pot in wet sand bath in retaining maximum bioactive compounds of Guggul.
- Earthen pot wrapped in moist jute bag efficiently maintains antifungal activity of Guggul sample in comparison to the Guggul stored in earthen pot in wet sand bath.
- Among four solvents, Methanol extracts of Guggul stored in earthen pot produced better results during anti-fungal analysis of guggul gum.
- One Patent application was filed on ‘A novel low cost efficient storage system for Guggul oleo-resin and method thereof’.

4. VNMKV, Parbhani, Maharashtra

- Three Technologies developed and released at State Level in Joint Agricultural Research and Development Committee in SAU’s of Maharashtra:
 - i. Development of Instant Tomato soup powder by fortification of partially hydrolyzed guar gum (PHGG) as a soluble fiber source and its characterization

in Joint Agricultural Research and Development Committee 2022 held at Dr . Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

- ii. Standardization of pizza sauce using partially hydrolyzed guar gum in Joint Agricultural Research and Development Committee 2021, held at Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani.
 - iii. Development of Crackers (Pet Dog Food) by Incorporation of Guar Meal Protein Isolate in Joint Agricultural Research and Development Committee 2021, Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani.
- The production of Dog Pet Food Crackers started in collaboration with V-cube Fresh Pvt. Ltd, VNMKV, Parbhani for sale and generated receipt of Rs. 20000.
 - Regarding the process modification of PHGG and its utilization in ice cream desserts on commercial scale to Shree Shanti Enterprises. Jodhpur and started the work in their specific interest accordingly.
 - Received an appreciation letter form Association of Pet Food Manufacturers, New Delhi 110024. for the research carried on developing Vegetarian Pet Food Crackers for Dogs.
 - Prof. Dr. R. B. Kshirsagar participated in Regional Soy Food Workshop held at Kathmandu, Nepal on 22 – 23 November 2022, organized by US Soybean Export Council (USSEC).
 - Centre conducted three training programmes for two women self-help group and one on farm training for farmers on utilization guar gum.

5. FCRI, TNAU, Mettupalayam, Tamil Nadu

- Tamarind Seed Gum(TSG) Freeze drying technique – Freeze Drying using freeze dryer (Lyophilization technique) with freezing temperature (-400 C), Vacuum range from 0.100 to 0.130 mbar and 18 hours of drying time.
- TSG Spray drying technique - drying of TSG gum solution at inlet temperature 1920C and out let temperature 1350C.
- TSG hydrocolloid Filtration technique - The hydrocolloid extraction with bucket centrifuge at 1200 rpm using woven polypropylene filter cloth micron size 0.2 µm to 0.5µm.

- Flowering induction in Tamarind (Florigen Application) – Application of Paclobutrazol 500 ppm and Etherel 500 ppm at full foliage stage.
- Application Gum inducer in *Moringa oleifera* gum production- Hand drilling with 4 ml gum inducer showed yield of 16.21 g/tree/month in diameter class of 90-120 cm.

6. Dr. YSPUH & F, Solan, Himachal Pradesh

- Amongst the different borehole angles (25o, 40o, 55o and 70o) studied, the highest oleoresin yield (4255.22 g/season) in Nauni Campus was recorded at an angle A2 (40o) and in diameter class D4 (>60 cm).
- Studies on rosin content of *Pinus roxburghii* under three storage conditions (Room Temperature, Freeze and Deep Freeze) and for different time periods (2 months, 4 months, 6 months and 8 months) in different storage containers (Glass, Plastic, Steel, Earthen pot and Tin) revealed that after two, four, six and eight months storage, the maximum rosin content (82.38 %), (82.58 %), (82.99 %) and (83.07 %) were found in earthen pot at Room Temperature (storage condition) respectively. Further work on this aspect is to be continued to draw conclusions.
- In case of effect of storage condition and container on turpentine content, after two, four, six and eight months storage, the maximum turpentine content (21.63 %), (20.85%), (20.31 %) and (19.32 %) were found in tin container at deep freeze condition respectively. Further work on this aspect is to be continued to draw conclusions.
- In Rill method, all the trees were classified into four diameter classes viz., 30-40 cm(D1), 40-50 cm(D2), 50-60 cm(D3) and >60 cm(D4). The effect of diameter (dbh) on oleoresin yield has showed that the highest oleoresin yield (7.93 kg/season) was found in diameter class >60 cm (D4) and lowest (4.62 kg/season) was observed in diameter class 30-40 cm (D1).
- The maximum number of resin ducts (1.17/ mm²) was observed in diameter class D4 (>60 cm). The maximum Tracheid length (4.12 mm) and diameter (0.077 mm) was also noticed in D4 (>60 cm). The maximum ray height (0.45 mm), ray width (0.050 mm) and frequency (39.15/mm²) were found in D4 (>60 cm).
- The maximum ray length (0.439 mm), ray width (0.045 mm) and ray frequency (37.10 /mm²) was observed in Progeny, Kaldoo P4 and Kopra P5, respectively.
- The maximum tracheid diameter (0.085 mm) was noticed in Progeny Kopra P5.

- The oleoresin yield was found to be positively correlated with maximum temperature whereas; it was negatively correlated with average relative humidity. The oleoresin yield exhibited positive significant correlation coefficient with maximum temperature (0.959) and the negative significant correlation coefficient was observed between oleoresin yield and average relative humidity (-0.852).
- The borehole method of oleo-resin tapping was demonstrated to 71 trainees including Forest Guards and Range Forest Officers trainees of State Forest Department of Himachal Pradesh through 02 training programmes.

7. KAU, Thrissur, Kerala

- Made a technical alliance with Kerala State Federation of SC ST Development Co-operatives Ltd (KSFSCSTDC Ltd) Trivandrum for the value addition of Dammar and other forest sourced NTFPs. One of their registered center from Vilangad, Kozhikkode District received our training and technical supports regarding the production of Black dammar incense sticks and Dhoop cones. Now they had successfully started their own venture under the brand name “VANAMAALIKA”. This product was officially launched by Mr. MV Govindan, Hon. State Minister for Co-operation. Inauguration of the Production unit and first sale was conducted by Mr. Vijayan, Hon. MLA in the presence of KAU officials.
- Made a collaboration with Participatory Forest Management (PFM) cell attached to State Forest Development Agency (SFDA) Kerala Forest Department, for the value addition of dammar and other forest sourced NTFPs. With our training and technical support they have purchased a agarbathy making machine under the PM Van Dhan Yojana scheme and started the production of Black Dammar incense stick at Pottamavu Tribal settlement colony, Kulathupuzha, Trivandrum under the brand name of “SANKILY” which is managed by a group of tribal women
- Ten hands-on trainings/demonstrations were organized for SC/ST farmers, forest officials and students etc.

8. ICAR-CAFRI, Jhansi, Uttar Pradesh

- The growth of *Acacia nilotica* was better on research farm than on farmer’s fields whereas performance of *Acacia senegal* was at par on research farm and farmer’s fields.
- Gum exudation in *A. nilotica* was more consistent than *A. senegal*.

- During the year, 6000 seedlings of *A. senegal* were raised in nursery and provided to farmers and other stakeholders.
- For ITK on gums and resin, three districts of MP viz. Sheopur, Dewas and Khandwa were surveyed and information collected.
- Round the year gum exudation study in *Butea monosperma* revealed that maximum exudation takes place in the month of December and January, while in the month of July, August and September, gum exudation was negligible.
- Studies on fine root distribution pattern of *A. senegal* revealed that in general the root density decreases vertically with maximum concentration between 30 and 60 cm depth. Horizontally, the root density decreased with increase in the distance from tree trunk.
- Studies on above- & below-ground biomass of *A. senegal* revealed that root: shoot ratio varied from 0.14 to 0.17 in 4 to 7-year-old trees.

9. ICAR-NISA, Namkum, Jharkhand

- Nanocomposite film reinforced with piyar-AgNPs was developed for diversified applications through solution casting method. The developed film possessed improved mechanical, barrier, antifungal and antibacterial properties. The study indicated that the nanocomposite films can be utilized as potential antimicrobial packaging material.
- Information and photographs of 50 minor gum and resin producing plant species compiled and it is in the process of publication in press.
- Gum inducer technology was found better for piyar gum tapping from *Buchanania lanzan* trees using battery operated drill as gum production was higher compared to all other techniques based on six month observation.
- ‘Resin and Gum plants germplasm farm’ developed by plating various NRG trees collected from various parts of the country at the Institute was maintained and participants of training programme conducted in the Institute visited the farm.
- The 13th Annual Workshop of Network Project on ‘Harvesting, Processing and Value Addition of Natural Resins and Gums’ was organized via Virtual Online Platform coordinated by lead Centre ICAR- IINRG, Ranchi on November 09-10, 2021.

Progress (Dec. 2021 – Dec. 2022)**CAZRI, Jodhpur, Rajasthan****Project:** Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums”

Sub-project No. 1:	
Study on gum production from known and lesser-known gum producing tree species of arid zone of Rajasthan	
Investigator(s)	: Dr. Archana Verma Dr. Kamlesh Pareek
Date of start	: 2016
Date of completion	: 2023
Objectives	: 1. To study gum production potential of various tree species in the arid region.

Progress:**Well-known gum producing tree species:**

- Structural traits and gum yield of *Anogeissus rotundifolia* were recorded this year (Mar to April 2022). This year, both normal Ethephon and colourless Ethephon gum inducer were applied in separate treatment group of trees. For each treatment three trees per treatment were selected. The concentration of ethephon was kept same in colourless gum inducer. Two groups were made with same type of tree structural traits to understand relation between gum yields and tree health. *A. rotundifolia* had an average tree height 6.3m & 6.8 m, DBH with 19.0 & 22.0 cm and canopy diameter 4.1& 3.8 m in both treatment groups respectively.
- Correlation was determined between tree structural traits i.e. height, DBH and canopy diameter against gum yield. The gum colour obtained from regular gum inducer has dye in it therefore the colour of gum is darker and the traces of dye are more at the sight of hole used to insert dye. However, this year colourless ethephon was also used for exudation of gum. It was found that the gum exuded using colourless ethephon was more transparent and light in colour preferred by consumers.

- Gum yield pattern was also recorded with same interval (12 days/picking) from treatment of tree. In all interval maximum gum yield was found in first picking and second picking which gradually decreased in its next picking. In general, some tree groups total gum yield was only in two picking in both the inducers used.

Moringa oleifera

- Comparative study of gum-resin production including borehole and blaze method were studied in *Moringa* spp. In case of *Moringa* tree species, the average height (7.3 m), GBH diameter (32.59) cm and average canopy diameter (3.63m) for borehole method were measured. While in blaze method average height, DBH and canopy diameter was 6.76 cm, 21.13 cm and 2.6 m respectively. Average gum yield of 88.3 g/ tree was obtained in borehole method as compared to 57.0 g /tree in blaze method. However, no significant difference was found between yields with both treatments. Correlation was determined between tree growth parameters and yield of gum from trees for both the methods. In borehole method maximum correlation of gum yield was found with Diameter at breast height i.e. $r=0.75$ whereas, in blaze method maximum correlation of gum yield was found with canopy of the tree i.e. $r=0.94$. This shows that in borehole method that as diameter increases yields of gum also increase, while in blaze method as canopy of the tree increases yield of gum was also more. However, both the methods had positive correlation with tree height and were $r > 0.50$.

Boswellia serrata

- In *Boswellia serrata* gum production using blaze method, spray method and control (use of no gum inducer) was studied. In blaze method droplets of gum inducer were used, blaze with spray of inducer and control condition with no inducer were used for gum exudation. Colourless inducer was also applied to understand effect on oleo-gum-resin production. Experiment was carried out during month of March -April, 2022 at CAZRI research farm. Exudation of oleo-gum-resin started after 4 days of treatment in all treatment's groups. First picking started from 11 days after treatments, second in 15days, third in 18 days and last picking done in 22 days from inducer application.

Investigation No. 2:		
Extension of gum inducing technique in arid regions of Rajasthan		
Investigator(s)	:	Dr. Archana Verma Dr. Pratibha Tewari Dr. Kamlesh Pareek
Date of start	:	2015
Date of	:	2023

completion		
Objectives	:	<ol style="list-style-type: none"> 1. Dissemination of CAZRI gum inducer technology 2. Farmer's fields trials in new villages 3. Hands on training to stakeholders

Progress:

- During the period (2021-22), 14520 trees of *A. senegal* were treated by CAZRI gum inducer, resulting in production of approximately 6.53 t of gum Arabic, in more than 48 village.
- Besides *A. senegal*, other gum yielding trees like *A. tortilis*, *A. nilotica*, *A. leucophloea*, *Prosopis cineraria*, *P. juliflora*, *Anogeissus rotundifolia*, etc. were also treated in villages by using this technique effectively for gum production. Moreover, it seems through feedback survey that the preparation of CAZRI gum inducer is in public domain and many KVKs and NGOs are also providing CAZRI gum inducer to stakeholders.
- We estimated that the same amount of gum inducer was provided by KVKs and NGOs to the farmers/ other stakeholders. Thus, at least 30,000 trees of *A. senegal* were treated by the farmers' in western Rajasthan using CAZRI developed gum inducer.

Investigation No. 3:		
Value addition of gum Arabic through convenient technology		
Investigator(s)	:	Dr. Archana Verma Dr. Pratibha Tewari Dr. Kamlesh Pareek
Date of start	:	2018
Date of completion	:	2023
Objectives	:	<ol style="list-style-type: none"> 1. To initiate value addition of edible gums. 2. To develop a convenient methodology for the value added products. 3. Technology transfer to rural households and entrepreneurs

Progress:

Gum Arabic based sweets/ Confectionary products:

In making sweets and confectionaries gum arabic was used in the range of 16-37.5% for enhancement of nutritive value and organoleptic characters of prepared products.

In all above mentioned products. highest energy value (651.0 kcal) was obtained in Gond Laddu, followed by Gond chocolate (644.9 kcal). Maximum calcium content (48 mg/100g) was found in gond laddu; whereas maximum iron content (12.02 mg/100g) was found in gond chocolate.

IGKVV, Raipur, Chhattisgarh

Project: Network project on Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Sustainable utilization of gum and resin by establishing improved tapping technique in Dhawara / Ghatti (<i>Anogeissus latifolia</i>)	
Investigator(s)	: Dr.Pratibha Katiyar
Date of start	: April, 2015
Date of completion	: December, 2022
Objectives	: <ol style="list-style-type: none">1. Survey of availability of tree Dhawara, Gum Ghatti (<i>Anogeissus latifolia</i>) in Chhattisgarh.2. To develop and standardize protocols for safe harvesting and collection of gum.3. To study production, processing, marketing and utilization of gum Ghatti (Dhawara gum).4. To transfer gum Dhawara specific technologies in the region.

Progress:

- Use of gum inducer enhanced the gum production in Dhawara. This tree has tremendous potential of producing gum throughout the year. Rainy season is not favourable to any tree for gum collection.
- It was observed that the tree trunk diameter of one meter or more are appropriate for tapping Dhawara tree for gum production.
- Summer season (temp > 38°C & RH <50%) was found favorable for tapping Dhawara gum. Use of gum inducer had synergistic impact on the process of gummosis and additive impact on production of gum. Application of small amount of ethylene producing substance (etherel, ethephon), 50-150 mg /tree/season injected in hole made by hand/battery operated drill machine in sap wood (at a depth of 2-3cm) in summer season resulted in enhanced production of gum. While combined effect Ethylene with sulphuric acid (2 ml, 1-5%) was effective for high production of gum tapping in Dhawara in winter season.

Investigation No. 2:	
Sustainable utilization of gum and resin by establishing improved tapping technique in Sal (<i>Shorea robusta</i>) and Salai (<i>Boswellia serrata</i>)	
Investigator(s)	: Dr.Pratibha Katiyar

		Dr. S. Patel Er. P. S. Pisalkar
Date of start	:	Nov.,2016
Date of completion	:	Dec., 2022
Objectives	:	<ol style="list-style-type: none"> 1. Survey of availability of tree species in Chhattisgarh. 2. To develop and standardize protocols for safe harvesting and collection of gum/resin 3. To study production, processing, marketing and utilization of gum/resin 4. To transfer gum/resin specific technologies in the region.

Progress:

- Salai (*Boswellia serrate Roxb*) is one of the high potential gum-resin producing tree abundantly available in all most all climatic zones of Chhattisgarh state. Double V shape cuts at one DBH (2 cm deep) on more than 90 cm diameter tree was found best amongst all mechanical and traditional tapping in both the seasons.
- Use of gum inducer *ie* combined effect of ethephon 78-156 mg per tree per season with 2 ml Sulfuric acid @5-10%, injected by hand or battery operated driller in sap wood (2-3 cm deep) was found to be superior over mechanical and traditional method of tapping for both the season.
- SEM analysis for evaluating for surface fractures, flaws, contaminants or corrosion and surface texture and EDX analysis for elemental composition indicated that Ca, K and Mg were present in salai gum.
- DSC (Differential scanning calorimetry) analysis of salai gum indicated that the exothermic peak occurred at around 200°C.
- The solubility of salai gum was more in organic solvents like acetone and ethanol indicated the availability of more resin content in exudates. The physiochemical properties of gum tapped by mechanical, traditional and gum enhancer indicated that there were non-significant difference in their properties of gum with respect to moisture content, ash content, protein and nitrogen content, viscosity, solubility, and pH value. Tannin and phenol content slightly (non-significant) increased with use of gum inducer in exudate of salai.

Investigation No. 3:		
Development of tapping techniques for sustainable extraction of biopolymer in Rohini (<i>Soymida febrifuga</i> Roxb), Chironji (<i>Buchanania lanzan</i> Spreng) and Saja (<i>Terminalia tomentosa</i> Roxb.)		
Investigator(s)	:	Dr. Pratibha Katiyar Er. P. S. Pisalkar

Date of start	:	Nov, 2017
Date of completion	:	Dec., 2022
Objectives	:	<ol style="list-style-type: none"> 1. Survey of area for abundant availability of true species for experimentation. 2. Assessment of efficacy of gum enhancer for potential production of gums. 3. To transfer gum/resin specific technologies in the region.

Progress:

- The comparative study on tapping of all the experimental trees, *i.e.* Rohina (*Soymida febrifuga*), Salai (*Boswellia serrata*) and Saja (*Terminalia tomentosa*) was conducted in last four years, using various gum inducer and traditional method of tapping (single cut with axe). It was observed that the season of tapping had a significant impact on gum/resin production and high temperature and low RH were found favorable enhanced gum/resin production.
- It was observed that the exudation started in experimental trees within week after applying various gum inducer. In winter (January and February) the flow rate of gum/resin exudation was relatively slow as compared to summer season of tapping.
- In all the experimental trees treated with the gum inducer the exudation started within a week and continued throughout the summer (March to June) and winter (January to February).
- The use of ethephon @3.9 % at triple places was found to be significantly effective to increase the rate of exudation as well as quantity of gum in Salai and Rohina in winter as well in summer . However, use of H₂SO₄ @2 % triple place in summer and Use of use of H₂SO₄ @5 % triple place in winter was significantly effective in enhancing rate of exudation and quantity of gum production in Saja. Combined effect of ethephon @3.9 % + H₂SO₄ @10% single place was quite effective in tapping in chironji (*Buchanania lanzan* Spreng.).
- The comparative study on tapping season (summer and winter) it was observed that the summer season of tapping showed significantly higher rate of gum exudation as compared to winter season of tapping.
- The physicochemical properties of experimental gum were analyzed in samples tapped by various methods. The gum produced using gum inducer had slightly different physicochemical properties *i.e.* pH, swelling index, acid insoluble ash. While hydrophobic

protein, tannin content, alkaloid, ash content increased significantly with use of gum inducer. However, there was no change in crude fat, total fiber content in exudates of experimental trees.

- DSC (differential scanning calorimetry) analysis of all experimental gums indicated that the Salai exudates were stable over other gums.
- TGA (Thermal gravimetric analysis) indicated that the exudates of experimental trees shown the presence of volatile compounds and ash.

Investigation No. 4:		
Development of scientific harvesting and collection of Palash (<i>Butea monosperm</i>) gum, Kamarkas		
Investigator(s)	:	Dr. Pratibha Katiyar Er. P. S. Pisalkar
Date of start	:	April, 2019
Date of completion	:	December, 2023
Objectives	:	1. Efficacy of various techniques of tapping on gum production of Palash. 2. Methods of collection of gum Kamarkas. 3. Assessment of physico-chemical properties. 4. To transfer gum and resin specific techniques in the region

Progress:

Palash (*Butea monosperma*)

The tree were selected for experimentation having girth between 1.5 – 2.3 m at 1 DBH. It was observed that gum exudation commenced within a week in all treatments and the exudation continued up to 2 weeks.

Moisture content was high in gum sample tapped by semi arc method (12.57%) followed by single cut method (12.15%) and minimum moisture content was observed in gum tapped using H₂SO₄ @ 1% (11.11%) or in combination with ethephon @ 1.17% + H₂SO₄ @ 1% is 11.11%.

Ash content was high in gum sample tapped traditionally (single cut method) (6.06%) and gum exudated in semi arc method contained 3.8 % ash content. The ash content in gum inducer methods (ethephon 1.17 + H₂SO₄ 1%) and (ethephon 0.78%) were 3.59 & 3.47 % respectively. The Palash gum pH were found in the range of 5.53 – 5.91.

Investigation No. 5:	
Utilization of gum as edible coating for shelf life extension of button mushroom (<i>Agaricus bisporus</i>)	
Investigator(s)	: Dr. S. Patel Dr. Pratibha Katiyar Er. P. S. Pisalkar Er. Pooja Sahu,
Date of start	: January, 2022
Date of completion	: December, 2023
Objectives	: 1. To study the effect of Babool gum coating on shelf life extension of button mushroom

Progress:

Fresh button mushroom was procured from local market in Raipur, Chhattisgarh. Gum was purchased from local market in Raipur, Chhattisgarh. and CMC were purchased from local shop in Raipur, Chhattisgarh and then stored in a cool, dry place until it was employed in further experiment.

Babul gum solution (3-7%) was made by dissolving different weight (g) of babul gum in 100 ml of distilled water and to create the gum based edible coating solution. Then the mixture was agitated at a low temperature of (40°C) for 60 minutes on a hot plate magnetic stirrer, and any un-dissolved contaminants were then filtered out using cheese cloth. After cooling at 20°C, carboxymethyl cellulose of known weight (g) was added as emulsifier in order to increase the potency and flexibility of the coating solutions. Then for 10 minutes, the solution was mixed properly. Before usage, the prepared coating solution was held for an hour in room temperature.

Button mushroom was washed and cleaned properly before applying coating solution and dried at room temperature. After drying, the button mushrooms were dipped in coating solutions for one minute, making sure the coating solution was dispersed evenly across the whole surface of button mushroom while the controlled mushrooms were dipped in distilled water. After coating, the mushrooms were air dried at room temperature. Then the dried coated mushrooms were packed in LDPE polythene (with 1% area open). Then, the packed coated mushrooms were stored at refrigerated condition (10-12°C). The data was collected before treatment (*i.e.* day 0) and 2nd, 4th, 6th and 8th day. The entire analysis was done in triplicate.

The button mushrooms treated with coating material maintained good firmness and had palatable eating quality up to 8 days of storage.

Investigation No. 6:	
Development of biopolymer film from extracted Charota (<i>Cassia tora</i>) seed gum	
Investigator(s)	: Dr. S. Patel Er. P. S. Pisalkar Dr. Pratibha Katiyar Er. Pooja Sahu,
Date of start	: January, 2022
Date of completion	: December, 2024
Objectives	: To study the possibility for preparation of bio- polymer film from extracted Charota seed gum. To evaluate the quality of developed bio-polymer film.

Progress:

Starch and glycerol was purchased from local market of the Raipur. Charota seed gum was extracted from Charota seed in Laboratory of department of Agricultural, Processing and Food Engineering, SVCAET & RS, IGKV, Raipur. To prepare the film following method was followed:

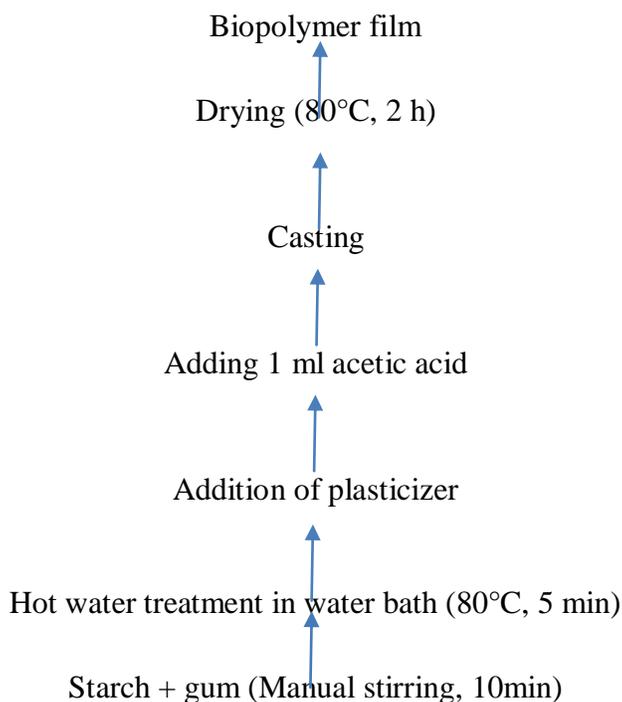


Fig. Process flow chart

In the study initially it was found the development of film polymer is possible by using extracted Charota seed gum with combination of starch and plasticizer.

JNKVV, Jabalpur, Madhya Pradesh

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Qualitative analysis of guggul gum stored in moist earthen pots	
Investigator(s)	: Dr. Moni Thomas Dr. Gyanendra Tiwari Dr. Niraj Tripathi
Date of start	: Jan., 2019
Date of completion	: Dec., 2022
Objectives	: 1. Qualitative analysis of guggul stored in the earthen pot wrapped with moist jute bag 2. Qualitative analysis of guggul stored in earthen pot placed on wet sand bath

Progress:

- The data of the second year experiment revealed that a total of seventeen compounds with different Retention Time were detected in the sample stored in the earthen pot wrapped with moist jute bag.
- Only 13 compounds were detected from that stored in the earthen pot in moist sand bath

Investigation No. 2:	
Analysis of anti-fungal activity of guggul stored in different containers	
Investigator(s)	: Dr. Moni Thomas Dr. Gyanendra Tiwari Dr. Niraj Tripathi
Date of start	: Jan., 2019
Date of completion	: Dec., 2022
Objectives	: 1. To analyze anti-fungal activity of Guggul samples stored in different containers

Progress:

- Methanol extracts of guggul gum oleoresin stored in earthen pot had better Minimum Inhibitory Concentration (MIC) against studied fungal isolates over the samples stored in other containers.
- Ethanol extract of guggul sample stored in earthen pot was again found better in comparison

to other samples stored in jute bag, plastic container and polythene bag.

- Guggul samples stored in earthen pot showed better results and inhibited the growth of most of the studied fungal isolate with the use of minimum concentration of this sample.

Investigation No. 3:		
Analysis of anti-fungal activity of guggul gum stored in moist earthen pots		
Investigator(s)	:	Dr. Moni Thomas Dr. Gyanendra Tiwari Dr. Niraj Tripathi
Date of start	:	2019
Date of completion	:	2022
Objectives	:	1. To analyze anti-fungal activity of Guggul samples stored in moist earthen pots

Progress:

- Alcoholic (Methanol and Ethanol) extracts of guggul gum oleoresin stored in both earthen pots, the earthen pot wrapped in moist jute bag had better efficiency against studied fungal isolates in comparison to the sample stored in earthen pot in wet sand bath.
- Aqueous extracts of guggul samples stored in earthen pot wrapped in moist jute bag showed better results and inhibited the growth of most of the studied fungal isolate with the use of minimum concentration of this sample

VNMKV, Parbhani, Maharashtra

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Extraction of PHGG by using different enzymes and their quality assessment	
Investigator(s)	: Prof. Dr. R. B. Kshirsagar Dr. B.A. Jadhav Dr. N.M. Deshmukh
Date of start	: January, 2021
Date of completion	: December, 2022
Objectives	: <ol style="list-style-type: none">1. Effect of different enzymes on the yield and recovery of PHGG2. Assessment of physicochemical properties and functional properties of extracted PHGG3. Dietary fiber content and rheological properties of PHGG4. Exploration of extracted PHGG for improvement of different nutraceutical aspects of food products.

Progress:

- The % recovery of partially hydrolyzed guar gum was found 96%, 95%, 93% and 94% of native guar gum by hydrolysis with Cellulase, Mannanase, Pectinase and Pullulanase enzymes respectively. Further proximate analysis was carried out and protein was found to be reduced whereas fiber found increased.
- Significant change of fiber content was observed as compared to native guar gum sample. This might be due to the hydrolysis of native guar gum i.e. conversion of branched chain in to linear short chains. Viscosity of native guar gum showed 5600 cPs in 1% aqueous solution while 1% PHGG solution showed drastic reduction in viscosity. Significant increase in solubility was noticed in case of partially hydrolyzed guar gum samples than native guar gum, also same trend was observed with respect to average molecular weight.
- PHGG samples indicated reduced value of average degree of polymerization as compared to native guar gum due to its decreased molecular weight as a result of enzymatic hydrolysis. It was concluded that PHGG produced by cellulase enzyme was found to be better with respect to quality parameters than other enzymes.

Investigation No. 2:	
Development of guar seed fractions based edible film	
Investigator(s)	: Prof. Dr. R. B. Kshirsagar Dr. B.A. Jadhav

		Dr. N.M. Deshmukh
Date of start	:	April 2022
Date of completion	:	August 2022
Objectives	:	1. To assess the nutritional quality of edible film. 2. Storage study of edible film

Progress:

- The microbiological evaluation of guar seed fraction based edible film showed differential bacterial count. It also showed that the total plate count increased slightly with the increase of storage period. Microbial examination showed that the sample was free from microbial spoilage up to 30 days of storage. The total plate count after 45, 60, and 75 were 8×10^2 , 66×10^2 , 272×10^2 cfu /ml respectively, whereas after 90 days of storage period the total plate count was $>387 \times 10^2$ cfu/ml. There was no presence of yeast and mould count in the guar seed fraction based edible film from 0 to 45 days of storage. This could probably be attributed to the heat treatment given to the guar seed fraction based edible film during the processing. After 60 and 75 days of storage period yeast and mould count was obtained 7×10^3 and 11×10^3 cfu/ml under ambient storage condition, whereas after 90 days of storage yeast and mould count was obtained 16×10^3 cfu/ml under ambient storage condition.
- In the present study, the percentage of carbohydrate was very high compared to other parameters because of the potato starch present in the composition in making of guar seed fraction based edible film is the main ingredient for stabilizing and maintaining the thickness and the overall quality of guar seed fraction based edible film, Also the mineral profile of guar seed fraction based edible film indicated that guar seed fraction based edible film contain high level of both phosphorus and magnesium.

Investigation No. 3:		
Effect of feeding different level of guar meal on growth performance on Kaveri chicken		
Investigator(s)	:	Prof. Dr. R. B. Kshirsagar Dr. B.A. Jadhav Dr. N.M. Deshmukh
Date of start	:	January, 2021
Date of completion	:	December, 2022
Objectives	:	1. To study the effect of feeding guar meal (<i>Cyamopsis tetragonaloba</i>) on growth performance of kaveri birds. 2. To assess the feed conversion efficiency. 3. Clinical study of poultry chicken including body weight gain, blood glucose and protein level.

	4. Economical cost of production per bird.
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Progress:

- Efforts have been made to standardize the formulation of poultry feed ration by replacing 4% to 8% soya meal with guar meal. In the starter and finisher diet of poultry, guar meal was added from 4 to 8 % by replacing soya meal in the experimental birds as per treatment.
- It was observed that growth parameters of the poultry birds fed with guar meal based poultry feed was at par with soya meal based feed and also there was no evidence of adverse effect on health of the poultry birds.
- The hematological parameters of birds showed no significant difference in blood Hb concentrations and red blood cells count. There was significant decrease in total protein, albumin, globulin and glucose with increase in level of guar meal.

FCRI, TNAU, Coimbatore, Tamil Nadu

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
High density tamarind plantation	
Investigator(s)	: Dr.A.Balasubramanian Dr.S.Radhakrishnan Dr. M.Sivaprakash
Date of start	: August, 2014
Date of completion	: March, 2025
Objectives	: 1. To study the effect of florigen application on tamarind genotypes 2. To characterize the gum properties of different genotypes

Progress:

- Paclobutrazol 500 ppm and etherel 500 ppm showed maximum fruit yield in FCRI-TAM-06 and FCRI-TAM-08 (9.05 kg/tree and 6.22 kg/tree respectively).
- Seed testa to kernel ratio varied among the genotypes in which FCRI-TAM-06 observed maximum kernel percentage (76.15 per cent) and minimum kernel content in FCRI-TAM-04 (71.63 cm).
- Tamarind seed gum yield was observed highest in genotype FCRI-TAM-06 with the value of 2.59 g in 5 g of tamarind kernel powder and lowest of 2.31 g/5g of TKP in FCRI-TAM-04. In case of biochemical characteristics of TKP and seed gum yield, FCRI-TAM-06 accounted best genotypes in their performance.
- The pH of tamarind gum (1% solution) was found to be 6.25±0.20 and 6.72±0.07 in chemical and non-chemical extracted TSG and the ash value of tamarind gum was determined to be 8.16±0.26 per cent and 13.72± 0.45 per cent respectively. Physical properties like bulk density (0.95±0.03 and 0.83±0.02 g/cm³), tapped density (3.43±0.03 and 2.57±0.06), compressibility index (0.782±0.01 and 0.743±0.01 g/cc) and Hausner ratio (2.12±0.02 and 3.09±0.03) of chemical and non-chemical extracted TSG, respectively.

Investigation No. 2:	
Value addition of tamarind seed polysaccharide for edible purpose	
Investigator(s)	: Dr.A.Balasubramanian Dr.P.Vennila

Date of start	:	April, 2021
Date of completion	:	March, 2023
Objectives	:	1. To develop value added products by using tamarind seed polysaccharides.

Progress:

- The food properties of TSG/TKP-based pineapple jam and guava jelly in control and optimized levels were TSS - 65.0 to 65.3° brix, pH - 3.2, Acidity - 0.99 to 1.03 %, Total sugar - 60.48 to 63.53 %, reducing sugar - 21.13 to 42.52 %, carbohydrates - 25.43 to 31.56 %, vitamin C – 27.54 to 70.35 mg/100g, β-Carotene – 63.27 to 91.65 µg/ 100g, respectively.
- The sensory scores showed that overall acceptability for Ice cream was maximum in (0.4 per cent TKP) with the value of 8.9/9.0 followed by 8.6/9.0 (0.3 per cent) as compared to the control (9.0/9.0).

Investigation No. 3:		
Preliminary studies on assessing gum production in few tree species of regional importance		
Investigator(s)	:	Dr.A.Balasubramanian Dr.S.Radhakrishnan Dr. M.Sivaprakash
Date of start	:	April, 2021
Date of completion	:	March, 2025
Objectives	:	1. To standardize the gum tapping methods for the gum production trees with regional importance. 2. To characterize the gum properties of different gum species

Progress:

- Hand operated drilling with ½ inch drill + 4 ml inducer application + patching with moistened clay performed well in *Chloroxylon swientenia* (36.67 g gum production/tree/month in 45-60 cm diameter class), *Acacia leucophloea* (28.20 g gum production /tree/month in 70-90 cm diameter class) and *Azadirachta indica* (49.65 g gum production /tree/month in 70-80 cm diameter class).

- The bulk density, tap density, Carr's compressibility index, swelling index and Hausner ratio of the neem gum were observed as $0.76 \pm 0.01 \text{ g/cm}^3$, $1.23 \pm 0.01 \text{ g/mL}$, 11.62 ± 0.65 per cent, 70 ± 2.45 per cent and 1.13 ± 0.02 , respectively
- The viscosity of different concentration (0.4 %, 0.8 % and 1.0 %) of *Chloroxylon swientenia* gum (31.8 cp, 33.4 cp and 35.0 cp), *Acacia leucophloea* gum (34.0 cp, 34.3 cp and 35.3 cp) and neem gum (66.3 cp, 68.3 cp and 71.9 cp), respectively were observed

Investigation No. 4:	
Establishment of Tree Gum garden	
Investigator(s)	: Dr.A.Balasubramanian Dr.S.Radhakrishnan Dr. M.Sivaprakash
Date of start	: April, 2021
Date of completion	: March, 2025
Objectives	: 1. To assemble less exploitable gum yielding species

Progress:

- A total of 10 Gum yielding species of regional importance were assembled apart from four species viz., *Butea monosperma*, *Moringa oleifera*, *Lannea coromendalica* and *Pterocarpus santalinus*.

Investigation No. 5:	
Standardization of gum extraction technique for Moringa (<i>Moringa oleifera</i>)	
Investigator(s)	: Dr.A.Balasubramanian Dr.S.Radhakrishnan
Date of start	: April, 2021
Date of completion	: March, 2025
Objectives	: 1. To standardize gum tapping techniques for maximum gum production 2. To characterize the properties for Moringa gum 3. To develop value added products from Moringa gum

Progress:

- In *Moringa oleifera*, hand drilling with 4 ml gum inducer and 2ml gum inducer showed maximum yield (25.40 g gum/tree/month and 16.21 g gum/tree/month) in diameter class of 90-120 cm.
- The viscosity of different concentration (0.4 %, 0.8 % and 1.0 %) of Moringa gum were observed as 67.7 cp, 68.4 cp and 71.5 cp, respectively

Dr. YSPUHF, Nauni, Solan, Himachal Pradesh

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Effect of Oleoresin storage on turpentine content in <i>Pinus roxburghii</i> Sargent	
Investigator(s)	: Dr. Bhupender Dutt Dr. Meenu Sood Dr. Y P Sharma Dr Rajneesh Kumar
Date of start	: April, 2020
Date of completion	: March, 2023
Objectives	: 1. To study the effect of different storage conditions and containers on oleoresin storage.

Progress:

- Studies on rosin content of *Pinus roxburghii* under three storage conditions (Room Temperature, Freeze and Deep Freeze) and for different time periods (2 months, 4 months, 6 months and 8 months) in different storage containers (Glass, Plastic, Steel, Earthen pot and Tin) revealed that after after two, four, six and eight month storage, the maximum rosin content (82.38 %), (82.58 %), (82.99 %) and (83.07 %) were found in earthen pot at Room Temperature (storage condition) respectively. Further work on this aspect is to be continued to draw conclusions.
- In case of effect of storage condition and container on turpentine content, after two, four, six and eight months storage, the maximum turpentine content (21.63 %), (20.85%), (20.31 %) and (19.32 %) were found in tin container at deep freeze condition respectively. Further work on this aspect is to be continued to draw conclusions.

Investigation No. 2:	
Effect of anatomical characteristics on oleoresin yield	
Investigator(s)	: Dr. Bhupender Dutt Dr. Meenu Sood Dr. Y P Sharma Dr Rajneesh Kumar
Date of start	: April, 2020

Date of completion	:	March, 2023
Objectives	:	1. To study different anatomical characteristics to find its effect on oleoresin yield

Progress:

- The oleoresin yield was found to be positively correlated with maximum temperature whereas; it was negatively correlated with average relative humidity. The oleoresin yield exhibited positive significant correlation coefficient with maximum temperature (0.959) and the negative significant correlation coefficient was observed between oleoresin yield and average relative humidity (-0.852).
- The maximum number of resin ducts (1.17/ mm²) was observed in diameter class D4 (>60 cm). The maximum Tracheid length (4.12 mm) and diameter (0.077 mm) was also noticed in D4 (>60 cm). The maximum ray height (0.45 mm), ray width (0.050 mm) and frequency (39.15/mm²) were found in D4 (>60 cm).

Investigation No. 3:		
To study the anatomical properties of wood of <i>Pinus roxburghii</i> from different progenies		
Investigator(s)	:	Dr. Bhupender Dutt Dr. Meenu Sood Dr. Y P Sharma Dr Rajneesh Kumar
Date of start	:	April, 2021
Date of completion	:	March, 2023
Objectives	:	1. To study anatomical properties to find its effect on oleoresin yield of different progenies

Progress:

- The maximum ray length (0.439 mm), ray width (0.045 mm) and ray frequency (37.10 /mm²) was observed in Progeny, Kaldoo P4 and Kopra P5, respectively.
- The maximum tracheid diameter (0.085 mm) was noticed in Progeny Kopra P5..

Investigation No. 4:		
Demonstration of Borehole Technology of Oleoresin Tapping		
Investigator(s)	:	Dr. Bhupender Dutt Dr. Meenu Sood Dr. Y P Sharma Dr Rajneesh Kumar
Date of start	:	April, 2016
Date of completion	:	March, 2025
Objectives	:	1. Training and Demonstration of of Borehole Technology of Oleoresin Tapping

Progress:

- The borehole method of oleo-resin tapping was demonstrated to 71 trainees including Forest Guards and Range Forest Officers trainees of State Forest Department of Himachal Pradesh through 02 training programmes.

KAU, Thrissur, Kerala

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
To develop a germplasm of gum and resin yielding trees of Western Ghats	
Investigator(s)	: Dr. S. Gopakumar
Date of start	: January, 2021
Date of completion	: December, 2025
Objectives	: 1. To develop a germplasm of gum and resin yielding trees of Western Ghats

Progress:

- **Identification of plants and selection of collection sites** - For this study, secondary data was collected from various Floras. From this data, various regions were selected for detailed survey and documentation. All the morphological data were recorded and further studies was carried out using this data. Most of the resin & gum yielding trees are evergreen or semi evergreen species and only few of them are deciduous or dry deciduous in nature. Fine grid survey was conducted to build up more collections for selected trees known to exist in identified pockets in previously explored areas.
- **Collection of seeds/seedlings** - Information regarding flowering and fruiting had already been collected during the Survey. The documentation and digital herbarium preparation of gum and resin yielding trees of Kerala forests is progressing. Common trees seen around were excluded and endemic and critically endangered species were included for the establishment of germplasm center. Using previously collected data and with the help of tribals, flowering and fruiting period of trees were determined for the timely collection. Field surveys has commenced at Athirappilly, Vazhachal, Nelliampathy, Munnar, and Marayoor forest areas.
- **Establishment of Germplasm conservation for resins & gum trees** - *Ex situ* conservation efforts will create “a living store of genetic diversity” that can support many activities in conservation and research in agriculture and allied sciences. These collections will also act as a “live field laboratory” for students and researchers for their academic and research purposes. Initial plot for ex-situ conservation of germplasm has been selected and works has almost completed. Three replicates of six species i.e. *Canarium strictum*, *Vateria indica*, *Calophyllum inophyllum*, *Palaquim ellipticum*, *Chukrasia tabularis* and *Myristica beddomei* were planted adopting 5 × 5 m spacing. Seedlings of *Kingiodendron pinnattum*, *Vatica chinensis*, *Semecarpus anacardium*, *Mesua ferrea*, *Garcinia spicata* and

several other plants were collected and raised in our nursery and the same will be planted in the upcoming monsoon season.

Investigation No. 2:		
Documentation of the phenology of gum and resin yielding trees of Western Ghats and Development of a Germplasm in the main campus of College of Forestry		
Investigator(s)	:	Dr. S. Gopakumar
Date of start	:	January 2021
Date of completion	:	December 2025
Objectives	:	1. To document the phenological events of the gum and resin yielding trees of Western Ghat.

Progress:

- Documentation of the distribution of resin/Dammar producing trees of Kerala viz. *Canarium strictum* and *Vateria indica*
- Standardization of Tapping methods of resin/ dammar extraction.
- Develop a scientific method of processing, value addition, and product diversification
- Study the influence of ecology/habitat with characteristics on production of natural dammars and Gum oleo resins
- Conduct training programmes to the members of the tribal societies on scientific collection, preservation and value addition of natural dammars

Investigation No. 3:		
Value addition of Gum oleo-resin of <i>Ailanthus triphysa</i>		
Investigator(s)	:	Dr. S. Gopakumar
Date of start	:	April , 2022
Date of completion	:	Dec., 2023
Objectives	:	1. To develop a scientific method of processing, value addition and product diversification

Progress:

- Collaborative work with Department of wood science, College of Forestry KAU is progressing in a phased manner.
- The oleoresin is separated in to two portion as hydrophilic and hydrophobic.
- The thin layer formation experiment with various solvents likes acetone, ethanol and chloroform is progressing.
- Experiment work for use this oleoresin as a wood coating work is progressing.

ICAR-CAFRI, Jhansi, Uttar Pradesh

Project: Network project on Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Productivity of gum yielding tree-based agroforestry models	
Investigator(s)	: Dr. Rajendra Prasad Dr. A. K. Handa Dr. B. Alam
Date of start	: February, 2009
Date of completion	: March, 2025
Objectives	: 1. To study the growth and productivity of agroforestry models based on gum yielding tree species.

Progress:

A. Plant growth

- **A. senegal based multi-component model (agri-horti-silviculture):** Data on survival and growth of trees were recorded. The maximum GBH (cm), plant height (cm) and canopy spread (m²) were recorded in *A. marmelos*, followed by *A. senegal*, *C. limon* and *C. carandas*. *C. carandas* recorded maximum survival (%), followed by *A. senegal*, *A. marmelos* and *C. limon*. Pruning of tree's crown was carried out in the month of October i.e. before sowing of winter crops. During *rabi* (2020-21) and *kharif* (2021) seasons, *T. aestivum* (variety HD 2967) and *V. radiata* (variety Sweta), respectively were cultivated as intercrops. During 2021-22, natural oozing of gum (average 78.39 g/tree from 4 trees) of *A. senegal* was recorded. This year i.e. 2021-22 (*rabi* season), wheat (variety HD 2967) was sown.
- **Rainfed agroforestry model (rainfed agri-silviculture):** The survival of *A. senegal* and *A. nilotica* ranged from 77.5 to 79.2 and 61.9 to 82.2%, respectively. *A. senegal* recorded maximum survival planted in 10 × 5 m while *A. nilotica* in 5 × 5 m spacing. After nine years of plantation, higher GBH and plant height were recorded in *A. nilotica* than *A. senegal* in almost all the spacing, barring few exceptions.
- **Silvi-herbal model:** In silvi-herbal model-I, *Terminalia arjuna* showed maximum survival (100%), followed by *A. senegal* and *A. nilotica*. Maximum plant height (cm) was recorded in *A. senegal* and minimum in *T. arjuna*. In silvi-herbal model-II, *T. arjuna* showed maximum survival (100%), followed by *A. nilotica* and *A. senegal*. Highest GBH, plant height and canopy spread were recorded in *A. nilotica*. In silvi-herbal model-

I, root slips of lemongrass were planted using four different spacing with four replications during 2020.

- **Block plantation on rocky hillock:** Survival of *A. senegal* in block plantation on rocky hillock was found to be 100% and plants attained mean height of 489.1 cm with GBH of 26.6 cm
- ***A. senegal* based gum garden:** In *A. senegal* based gum gardens Survival (%) was higher in *A. senegal* than *B. monosperma*. *A. senegal*, planted in new gum garden i.e. during 2015, showed relatively higher survival than that planted during 2014. The GBH, plant height and canopy spread of *A. senegal* was relatively higher in old gum garden than that recorded in new gum garden.

B. Productivity

- During *rabi* season of 2020-21, *T. aestivum* (variety HD 2967) was sown in *A. senegal* based multi-component agri-horti-silviculture model. Plant growth and yield attributes of *T. aestivum* were recorded at three distances viz., 1.0, 2.5 and 4.5 m from the stem base of *A. senegal*, *A. marmelos* and *C. limon*. Planted tree species significantly affected seed yield and above-ground dry biomass. Maximum biomass was recorded under *A. senegal*, followed by *A. marmelos* and *C. limon*, and these were statistically different from each other. Maximum grain yield was recorded under *A. senegal* which was found at par with the yield recorded with the association of *C. limon*. On the other hand, distance from tree trunk significantly affected all the recorded parameters. Plant population, seed yield and biomass were found to be increasing with increase in the distance from tree trunk. Two-way interaction between tree species and distance was found non-significant for plant population, while for remaining parameters (seed yield and above-ground dry biomass), the effects were significant. Maximum seed yield and above-ground biomass were recorded at 4.5 m distance from the tree trunk of woody perennials. In *kharif* season (2021), *V. radiata* (variety Sweta) was sown but due to heavy rains, the crop failed and was ploughed for green manuring. In this model, fruit yields were recorded from 13 plants of *C. limon*, 18 plants of *A. marmelos* and 18 plants of *C. carandas*. A total of 151 kg *C. limon*, 58 kg *C. carandas* and 2080 kg *A. marmelos* fruits were harvested. The average weight of *A. marmelos* variety CISH B1 was 0.82 kg and variety CISH B2 was 2.00 kg. Similarly, in rainfed agroforestry model.
- During summer season of the year 2021, natural exudation of gum in different fields of *A. senegal* was observed, Gum yield ranged from 17.59–138.79 g/tree in *A. senegal* based multi-component agri-horti-silviculture model (average: 78.39 g from 3 trees); 4.03–903.56 g/tree in rainfed agri-silviculture model (average: 119.41 g from 9 trees); 3.76–73.04 g/tree in old gum garden (average: 27.92 g/tree from 10 trees); 2.39–171.61 g/tree in new gum garden (average: 35.98 g/tree from 17 trees); and 1.85–184.93 g/tree (average: 27.93 g/tree from 8 trees) in block plantation in rocky hillock.

- Maximum number of gum tears/tree (4.11) was recorded in *A. senegal* based multi-component agri-horti-silviculture model while minimum (1.88) was recorded in new gum garden. Similarly, natural exudation of gum in different models of *A. nilotica* was also observed, and the gum yield ranged from 12.04–30.24 g/tree in silvi-herbal model (average: 19.10 g/tree from 6 trees) and 6.29–40.11 g/tree in rainfed agri-silviculture (average: 14.29 g/tree from 8 trees).

C. Soil health

- Soils of different gum yielding tree-based agroforestry models established at ICAR-CAFRI research farm viz., silvi-herbal model, gum gardens (new and old), progeny and plus tree trials of *A. pendula*, block plantation of *Anogeissus pendula* (field no. 33) and *Anogeissus latifolia* (field no. 34) were characterized during 2021-22. For the purpose, soil samples were collected from two layers (0-15 and 15-30 cm) of the tree's rhizospheres (i.e. <1.0 m distance from tree-base). Samples were analyzed for pH, EC, SOC, N, P, K, Fe, Mn, Zn and Cu. Soil depth affected the soil properties.
- Soil pH was recorded comparatively higher in sub-surface soil of all the models, except gum gardens. Soil EC did not show any definite trend; it was found higher in sub-surface soil of almost all the models, except in *A. senegal* based gum gardens (new and old) and plus as well as progeny trials of *A. pendula*. Relatively higher SOC was recorded in surface soil of all the studied models. Availability of N, P and K were also higher in top layer of the soil (0-15 cm) in almost all the agroforestry models. Higher amount of Fe, Mn and Zn were recorded in surface soil (0-15 cm) of all the agroforestry models, barring few exceptions. And, amount of Cu was comparatively higher in sub-surface soil (15-30 cm) in all the models, except in *A. senegal* based gum gardens (new and old).

Investigation No. 2:	
Demonstration and development of gum yielding tree based agroforestry models on farmer's fields	
Investigator(s)	: Dr. Rajendra Prasad Dr. A. K. Handa Dr. B. Alam Dr. Ashok Shukla Mr. Prashant Singh
Date of start	: 2009
Date of completion	: Continuing
Objectives	: 1. To demonstrate and develop gum yielding tree based agroforestry models on farmer's fields

Progress:

- *A. senegal* was planted on the field boundaries of 11 farmers. Among these 11 farmers, *A. senegal* recorded maximum survival in the field of Shri Mahendra (86.7%). *C. limon* was planted in the field of 7 farmers, and it showed maximum survival in the field of Shri Komal Singh (44.0%). *P. guajava* was planted in the field of five farmers, and its maximum survival was recorded in the field of Shri Komal Singh (50.9%). *P. granatum* was planted only in one field (Shri Komal Singh) which recorded 18.2% survival. Survival (%) of *A. senegal*, *C. carandas*, *C. limon*, *P. guajava* and *Dendrocalamus strictus* planted in various villages/sites during rainy season of 2018 varied from 36.7 (Dhikoli) to 65.5% (Talbehat) for *A. senegal*, from 25.5 (Parasai) to 40.0% (Dhikoli) for *C. carandas*, from 27.7 (Parasai) to 40.0% (Kotkhera) for *C. limon*, from 20.0 (Kotkhera) to 26% (Dhikoli) for *D. strictus*, and 20.0% in *P. guajava*.
- During rainy season of 2021, casualty replacement was done in bio-fence models. In bio-fence model-1, survival of *A. senegal* and *C. carandas* was 95.5 and 77.3%, respectively. *A. senegal* have attained 24.91 mm collar diameter with 151.9 cm height, and *C. carandas* recorded 4.52 mm collar diameter with 40.9 cm height. In bio-fence model-2, 81.9 and 98.8% survival of *A. senegal* and *C. carandas*, respectively was observed.
- In the model, *A. senegal* have attained 23.25 mm collar diameter with 152.7 cm height, and *C. carandas* recorded 4.90 mm collar diameter with 36.2 cm height. In bio-fence model-3, the survival of *A. senegal* in outer row was 90.9, 90.7 and 80.0% in 1.0, 1.5 and 2.0 m spacing, respectively. Similarly, 100.0, 93.0 and 88.0% survival in 1.0, 1.5 and 2.0 m spacing, respectively was recorded in inner row. In this model, planting spacing affected growth of the *A. senegal*. In general, comparatively higher growth in terms of collar diameter and height was recorded from *A. senegal* planted in inner row than that from outer row. In bio-fence model-4 consisting of two rows of *A. senegal* (inner and outer) kept at 1.5 m apart with plant to plant distance of 1.5 m,
- During rainy season of 2021, approximately 12000 quality seedlings of *A. senegal* were raised in nursery at ICAR-CAFRI, Jhansi, and out of which, 6000 seedlings were provided to “Doubling Farmer’s Income (DFI)” scheme for planting in seven districts namely Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakut of Bundelkhand, Uttar Pradesh.

Investigation No. 3:	
Indigenous technical knowledge (ITK) on gum and resin’s tapping, applications and post-harvest value addition	
Investigator(s)	: Dr. Rajendra Prasad Dr. A. K. Handa Dr. B. Alam Dr. Ashok Shukla Mr. Prashant Singh
Date of start	: 2017

Date of completion	:	2023
Objectives	:	1. To collect information on ITK on gum and resin's tapping, applications and post-harvest value addition from gum tappers/collectors

Progress:

- Indigenous tapping techniques for gums:** In all the surveyed villages, the tribal peoples generally peel off the bark (2-3 inches) of *B. serrata* and make a ring along the tree girth and collect gum after 4-5 days. For peeling off the stem bark, they use a special tool called “*Saluli*” and for collecting the salai gum, they use a special tool called “*Gaantri*”. On an average, they collect 200-400 g salai gum from a single tree.
- Normally, they start peeling off tree bark at men’s height and slowly move upwards as the season of gum exudation progresses from September to April. They peel off tree bark 15-20 times in a season. The tribal families in Sheopur do not give any cut or injury to *A. latifolia* for inducing gummosis. They collect gum tears naturally exuded from the trees. However, in Dewas and Khandwa districts, the tribal peoples generally make cuts on *A. latifolia* using a wooden bat having nails and axe, respectively for inducing gummosis. Tribal peoples in village Chakra of district Khandwa were using a gum inducer “*Ethrex*”. They generally make cuts with the help of axe on stem surface of *A. latifolia* and spray/pour *Ethrex* in each cut. They collect gum dhawra during summer season. Saharia tribe in Sheopur also collects natural exudation from *Acacia catechu* during summer season. For tapping palas gum, the tribal families in Sheopur and Dewas generally make cuts on the stem bark of *Butea monosperma* with the help of axe and collect gum after 3-4 days of notching.
- Constraints faced by tribals of surveyed areas:** The tribal dominated villages surveyed in Sheopur and Dewas districts enjoy full rights on forest for tapping gums and collection of other NTFPs. In district Khandwa, Forest Department imposed complete ban on gum tapping during 2019 while, collection of other NTFPs are not banned by the department. The tribal peoples of the area are tapping gum yielding trees illegally and collecting gums. When we interviewed them using questionnaire, they refused to provide any information on gum tapping, collection and their post-harvest value addition. The officials of Forest Department informed that the tribes of Khandwa district usually set forest on fire during the summer season, which probably increases the gum exudation from *A. latifolia* trees.
- Value addition of gums and other NTFPs:** Normally tribals of surveyed areas sell collected produce to local traders in original form i.e. without any post-harvest value addition. For storage of salai gum, traders of Sheopur as well as Dewas, make small balls from the salai gum by applying coat of *selkhadi* powder (chalk powder). Traders in Dewas informed that the juice exuded from salai gum fetches more price (Rs. 500/L). This practice of value addition to salai gum is not followed by the tribal peoples. We

noticed that all the traders have employed specific trained women labourers who can segregate and grade the dhawara gum by its appearance and smell. The detailed insights of identifying gum-tears of particular species from a mixed lot need further discussion with the women.

Investigation No. 4:	
Standardization of gum tapping techniques	
Investigator(s)	: Dr. Rajendra Prasad Dr. A. K. Handa Dr. B. Alam Dr. Ashok Shukla Mr. Prashant Singh
Date of start	: 2020
Date of completion	: 2023
Objectives	: 1. To observe natural exudation and gum yield from trees of <i>A. senegal</i> , <i>A. nilotica</i> and <i>A. pendula</i> planted in various agroforestry models. Also, to standardize seasonality of gum exudation from <i>B. monosperma</i> and use of ethephon for inducing gummosis in <i>A. pendula</i> , <i>A. senegal</i> , <i>A. nilotica</i> etc

Progress:

- The monthly observations were taken on gum exudation and yield from *B. monosperma*. Similarly, response of seven progenies of *A. pendula* to applied dose of gum inducer (ethephon) in the form of gum exudation and gum yield were recorded.

Investigation No. 5:	
Studies on root distribution pattern and above & below-ground biomass in <i>Acacia senegal</i>	
Investigator(s)	: Dr. Rajendra Prasad Dr. A. K. Handa Dr. B. Alam Dr. Ashok Shukla Mr. Prashant Singh
Date of start	: 2020
Date of completion	: 2025
Objectives	: 1. To study the root distribution pattern and above- & below-ground biomass including carbon sequestration potential in <i>Acacia senegal</i>

Progress:

- The one, two and three-year-old harvested plants attained 68.0, 112.5 and 360.0 cm plant height. In one and two-year-old plants, collar diameter (mm) were 5.38 and 10.23 mm, and in three-year-old plant, the recorded GBH was 18.5 cm. The canopy spread in these plants were 195.67 cm² (one-year-old), 2721.31 cm² (two-year-old) and 12.40 m² (three-year-old). In three-year-old *A. senegal*, the volume of the canopy was 34.70 m³. The total depth of root system was 76.0, 82.0 and 270.0 cm, and below-ground root bound soil volume was 0.375, 0.672 and 17.300 m³ in one, two and three-year-old *A. Senegal*.
- In shoot portion, 3, 6 and 24 primary branches; 2, 8 and 85 secondary branches; and zero, 2 and 193 tertiary branches were recorded in one, two and three-year-old *A. senegal* plants, respectively. The study recorded 31.68 g, 398.37 g and 9.20 kg fresh weight of main stem; 13.38 g, 179.86 g and 6.62 kg weight of primary branches; 2.65 g, 93.31 g and 3.87 kg weight of secondary branches; zero, 41.24 g and 2.25 kg weight of tertiary branches; 9.54 g, 187.50 g and 2.08 kg weight of foliage in one, two and three-year-old *A. senegal*. The total above-ground weight was 57.25 g, 900.28 g and 24.02 kg in one, two and three-year-old *A. senegal*. On the other hand, a total of 2, 3 and 25 primary roots; 2, 4 and 64 secondary roots; and 159, zero and 748 feeder roots were recorded in entire root system in one, two and three-year-old plants. The study recorded 9.90 g, 236.35 g and 1.58 kg fresh weight of main root; 3.97 g, 64.78 g and 1.14 kg weight of primary roots; 1.72 g, 13.21 g and 0.46 kg weight of secondary roots; and 0.86 g, 7.80 g and 0.16 kg weight of tertiary roots in one, two and three-year-old *A. senegal*. The total below-ground weight was 16.45 g, 322.14 g and 3.34 kg in one, two and three-year-old *A. senegal*. The root to shoot ratio was 0.287, 0.358 and 0.139 in one, two and three-year-old plants. Carbon sequestration was 35.100 g/tree, 580.650 g/tree and 12.996 kg/tree in one, two and three-year-old plants

ICAR-NISA, Namkum, Jharkhand

Project: Network project on “Harvesting, Processing and Value Addition of Natural Resins and Gums

Investigation No. 1:	
Preparation and characterization of modified guar gum nanocomposite films reinforced with piyar AgNPs for diversified applications	
Investigator(s)	: Dr. Arnab Roy Chowdhury Dr. (Ms) Mahtab Z. Siddiqui Dr. Priyanka Sakare
Date of start	: November, 2019
Date of completion	: March, 2022
Objectives	: 1. Development and characterization of modified guar gum - piyar-AgNPs nanocomposite films. 2. Bactericidal efficacy of the developed nanocomposite films.

- A number of nanocomposite films reinforced with piyar-AgNPs were developed for diversified applications through solution casting method,
- The developed nanocomposite films are characterized by physical properties (thickness, opacity, color value) and instrumentation techniques like UV-Vis, FT-IR spectroscopy, Field Emission-Scanning Electron Microscopy (FE-SEM) and Energy dispersive spectrum (EDS) analysis and Differential Scanning Calorimetry (DSC).
- The developed nanocomposite films exhibit better mechanical properties (tensile strength, flexibility) than the control film.
- The developed nanocomposite film showed improved barrier properties (water uptake and water vapour permeability) than the control film.
- The antifungal and antibacterial efficacy of the developed nanocomposite films were evaluated exhibited potential activity against fungal and bacterial pathogen. The study indicated that the nanocomposite films can be utilized as potential antimicrobial packaging material.

Investigation No. 2:	
Exploration of minor gum and resin plants in India and preparation of field guide	
Investigator(s)	: Dr. Nandkishore Thombare Dr. Vaibhav D. Lohot

		Dr. Niranjana Prasad
Date of start	:	April, 2021
Date of completion	:	March, 2023
Objectives	:	1. To identify minor but potential resin and gum producing plants in India and preparation of their photographic guide.

Progress:

- An additional 50 plants having NRG production potential were photographed.
- Information regarding these additional plants including botanical nomenclature, synonyms, vernacular names, habitat & distribution, description and gum-resin uses was compiled.
- An agreement was signed with M/s Brillion Publishing, New Delhi, for printing and publication of the book ‘Gum and resin plants of India: A field guide’.

Investigation No. 3:		
Effect of Tapping Techniques on Gum Yield from <i>Buchanania lanzan</i> Trees		
Investigator(s)	:	Dr. S. C. Sharma Dr. V. D. Lohot Er. S. K. Pandey
Date of start	:	January, 2022
Date of completion	:	December, 2023
Objectives	:	1. Study the effect of different tapping techniques for gum tapping from <i>Buchanania lanzan</i> trees

Progress:

- Gum production was observed about 20.91 and 10.83 times higher in trees treated with battery and hand operated drill (½") and about 5.93 times higher in trees treated using hand operated drill (1") along with inducer application compared to without inducer.
- Mean gum production was found 1.97 times higher in case of blaze developed using IINRG – Gum Tapping Blazer - 75 compared to blaze developed using chisel.
- Gum started oozing after couple of days in trees treated using battery and hand operated drill without and with application of inducer and immediately after blaze development using IINRG – Gum Tapping Blazer – 75 and chisel for semi circular incision.

- Gum inducer technology was found better for piyar gum tapping from *Buchanania lanzan* trees using battery operated drill as gum production was higher compared to all other techniques based on six month observation.
- Total maximum gum yield was found for bore hole developed using battery operated drill ($\frac{1}{2}$ ") with inducer application and minimum for battery operated drill ($\frac{1}{2}$ ") without inducer application, respectively.
- Maximum and minimum monthly piyar gum was collected in June and October, 2022.
- Blaze developed easily with sharp edges on the tree trunk utilizing IINRG – Gum Tapping Blazer – 75 with enhanced productivity of gum tapper compared to manual method of blaze development using chisel.

Statement of Fund Release & Expenditure

Network Project on HPVA of NRGs ICAR- NISA, Ranchi- 834010 <u>R.E. for Financial Year 2021-22</u>				
(Rs. in lakh)				
Budget Head	Other than NEH	NEH	SCSP	Total
Capital				
Equipment	10.22	0	0	10.22
Furniture & Fixtures	4	0	0	4
Sub- Total(1)	14.22	0	0	14.22
General				
Travelling Allowances	2.95	0	0	2.95
Research Expenses	110.63	0	0	110.63
Office Building	0	0	0	0
HRD	0	0	0	0
Sub-Total(2)	113.58	0	0	113.58
Grand Total (1+2)	127.8	0	0	127.8

**Network Project on HPVA of NRG
ICAR- NISA, Ranchi- 834010
Centre wise R.E. for Financial Year 2021-22**

(Rs. in lakh)

Budget Head	R.E. 2021-22	Lead Centre	ICAR Institutions				SAU's					Total
		NISA, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	ICAR Research Complex for NEH Region, Barapani	Dr. YSPUH&F, Solan	VNMKV, Parbhani	IGKV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	
Capital												
Equipment	10.22	3.22	1	1	0	1	1	1	0	1	1	10.22
Furniture & Fixtures	4	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	4.00
Sub- Total(1)	14.22	3.22	1.5	1.5	0	1.5	1.5	1.5	0.5	1.5	1.5	14.22
General												
Travelling Allowances	5	1	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	5
Research Expenses	108.58	20.58	11	12	0	12	11	10	10	12	10	108.58
Office Building	0	0	0	0	0	0	0	0	0	0	0	0
HRD	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total (2)	113.58	21.58	11.5	12.5	0	12.5	11.5	10.5	10.5	12.5	10.5	113.58
Grand Total (1+2)	127.8	24.8	13	14	0	14	13	12	11	14	12	127.8

Network Project on HPVA of NRG
ICAR- NISA, Ranchi- 834010
Statement of Expenditure for Financial Year 2021-2022

(Rs. in lakh)

	Lead Centre	ICAR Institutions			SAU's						
Budget Head	NISA, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	ICAR Research Complex for NEH Region, Barapani	Dr. YSPUH&F, Solan	VNMKV, Parbhani	IGKV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	Total
Capital											
Equipment	3.1995	1.30763	1	0	0.94789	0.99946	1.49563	0	1	0.945	10.89511
Furniture & Fixtures	0	0	0.5	0	0.49579	0.5	0	0.49985	0.5	0.489	2.98464
Sub- Total(1)	3.1995	1.30763	1.5	0	1.44368	1.49946	1.49563	0.49985	1.5	1.434	13.87975
General											
Travelling Allowances	0	0	0.5	0	0.22184	0	0.15246	0.06385	0.5	0	1.43815
Research Expenses	20.76735	13.13577	14.05	0	10.99324	11.04037	9.8397	9.66156	12.45	5.607	107.54499
Office Building	0	0	0	0	0	0	0	0	0	0	0
HRD	0	0	0	0	0	0	0	0	0	0	0
Sub-Total (2)	20.76735	13.13577	14.55	0	11.21508	11.04037	9.99216	9.72541	12.95	5.607	108.98314
Grand Total (1+2)	23.96685	14.4434	16.05	0	12.65876	12.53983	11.48779	10.22526	14.45	7.041	122.86289

**Network Project on HPVA of NRG
ICAR- NISA, Ranchi- 834010
Closing balance for Financial Year 2021-22**

(Rs. in lakh)

Budget Head	Lead Centre	ICAR Institutions				SAU's					Total
	NISA, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	ICAR Research Complex for NEH Region,	Dr. YSPUH&F, Solan	VNMKV, Parbhani	IGKV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	
Capital											
Equipment	0	0.19237	0	0	0.05211	0.00054	0.00437	0	0	0.055	0.30439
Furniture & Fixtures	0	0	0	0	0.00421	0	0	0.00015	0	0.011	0.01536
Sub- Total(1)	0	0.19237	0	0	0.05632	0.00054	0.00437	0.00015	0	0.066	0.31975
General											
Travelling Allowances		0	0	0	0.02816	0	0.14754	0.43615	0	0.5	1.11185
Research Expenses	0	0.21423	0	0	0.14324	0.20963	0.0303	0.08844	0	3.013	3.69884
Office Building	0	0	0	0	0	0	0	0	0	0	0
HRD	0	0	0	0	0	0	0	0	0	0	0
Sub-Total (2)	0	0.21423	0	0	0.1714	0.20963	0.17784	0.52459	0	3.513	4.81069
Grand Total (1+2)	0	0.4066	0	0	(-0.05876)	0.21017	0.18221	0.52474	0	3.579	4.90272 (4.84396)

Network Project on HPVA of NRGs
ICAR- NISA, Ranchi- 834010
B.E. for Financial Year 2022-23

(Rs. in lakh)

Budget Head	Other than NEH	NEH	SCSP	Total
Capital				
Equipment	14.85	0	0	14.85
Furniture & Fixtures	0	0	0	
Sub- Total(1)	14.85	0	0	14.85
General				
Travelling Allowances	3	0	0	3
Research Expenses	93.59	0	0	93.59
Office Building	0	0	0	0
HRD	0	0	0	0
Sub-Total(2)	96.59	0	0	96.59
Grand Total (1+2)	111.44	0	0	111.44

Network Project on HPVA of NRG
ICAR- NISA, Ranchi- 834010
Centre wise B.E. for Financial Year 2022-23

(Rs. in lakh)

		Lead Centre	ICAR Institutions			SAU's						
Budget Head	B.E. 2022-23	NISA, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	ICAR Research Complex for NEH Region, Barapani	Dr. YSPUH&F, Solan	VNMKV, Parbhani	IGKVV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	Total
Capital												
Equipment	14.85	4.4	1	1	0	2.45	1	0.5	2.5	1	1	14.85
Furniture & Fixtures	0	0	0	0	0	0	0	0	0	0	0	0
Sub- Total(1)	14.85	4.4	1	1	0	2.45	1	0.5	2.5	1	1	14.85
General												
Travelling Allowances	3	1	0.25	0.25	0	0.25	0.25	0.25	0.25	0.25	0.25	3
Research Expenses	93.59	21.09	11	11	0	7	11	5.25	7	9.25	11	93.59
Office Building	0	0	0	0	0	0	0	0	0	0	0	0
HRD	0	0	0	0	0	0	0	0	0	0	0	0
Sub- Total (2)	96.59	22.09	11.25	11.25	0	7.25	11.25	5.5	7.25	9.5	11.25	96.59
Grand Total (1+2)	111.44	26.49	12.25	12.25	0	9.7	12.25	6	9.75	10.5	12.25	111.44

Network Project on HPVA of NRG
ICAR- NISA, Ranchi- 834010
Fund released for Financial Year 2022-23

(Rs. in lakh)

	Lead Centre	ICAR Institutions			SAU's						
Budget Head	NISA, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	ICAR Research Complex for NEH Region, Barapani	Dr. YSPUH&F, Solan	VNMKV, Parbhani	IGKV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	Total
Capital											
Equipment	0	2.1	1	0	2.61	0.9	0.94	0	1.1	1	9.65
Furniture & Fixtures	0	0	0	0	0	0	0	0	0	0	0
Sub- Total(1)	0	2.1	1	0	2.61	0.9	0.94	0	1.1	1	9.65
Current											
Travelling Allowances	0	0.25	0.25	0	0.25	0.25	0.25	0.25	0.25	0.25	2
Research Expenses	13.53	9.5	9.5	0	6.5	9.5	5	6.5	8	9	77.03
Office Building	0	0	0	0	0	0	0	0	0	0	0
HRD	0	0	0	0	0	0	0	0	0	0	0
Sub-Total (2)	13.53	9.75	9.75	0	6.75	9.75	5.25	6.75	8.25	9.25	79.03
Grand Total (1+2)	13.53	11.85	10.75	0	9.36	10.65	6.19	6.75	9.35	10.25	88.68