Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 1457-1463

Received: 18-05-2020
Accepted: 20-06-2020

Lalita
Department of Agricultural Entomology, Maharishi Markandeshwar University Sadopur, Ambala, Haryana, India

Corresponding Author:
Lalita
Department of Agricultural Entomology, Maharishi Markandeshwar University Sadopur, Ambala, Haryana, India

Lac production technology in India and its role in Indian economy

Lalita

Abstract
The lac insect, *Kerria lacca* Kerr (Coccoidea: Homoptera) is well known for its valuable resin. It thrives on many host plants like Palas, Kusum, Flemingia and Ber etc. Lac cultivation involves pruning, inoculation, removal of phunki sticks, harvesting and lac scraping instruments. Farmer perform these operation manually with the traditional equipments includes secateurs, sickle, spade, knife, axe, shaw and scrapping instruments and these traditional equipment needs modification to increase work efficiency and lac production. Lac constituents is used in various ways as in pharmaceutical industry, cosmetic industry, mirror coating, shoe polish, sealing material in post office etc and many other industry for various purpose. Lac cultivation in India is mainly confined to the states of Jharkhand whose contribution amounts to 57%, followed by Madhya Pradesh to be 24%, and the rest 19% shared by Maharashtra, Orissa and West Bengal. Lac cultivation has proved to be a subsidiary source of income for the village communities of poor people or landless farmers. Lac cultivation serves as both a complementary and supplementary source of income to the existing livelihood options for the farmers. It is also an assured source of income during lean period of agricultural activities. With low cost inputs it gives high returns which make it highly favorable with the farmers. Lac was a subsidiary crop for the growers who depend on it for meeting cash expenses towards family needs and cash purchase for their household requirements. Lac cultivation is one of the important secondary sources of income for villagers and this is particularly more in the tribal districts.

Keywords: Lac, resin, crawler, phunki sticks, shellac

1. Introduction
Lac is Nature's gift to human kind as it is natural, biodegradable, non-toxic, odourless, tasteless, hard resin and non-injurious to health also a resinous exudation from the body of female scale insect. Since Vedic period, it has been in use in India. Its earliest reference is found in Atherva Veda. Therefore, the insect is termed as 'Laksha', and its habit and behaviour are described. Since ancient times, Greeks and Romans were familiar with the use of lac. The great Indian epic 'Mahabharata' also mentions a 'Laksha Griha', an inflammable house of lac, cunningly constructed by 'Kauravas' through their architect 'Purocha' for the purpose of burning their great enemy 'Pandavas' alive. There are some findings that lac production and trade in China is almost 4000 years and developed along with silk [17].
The English word lac synonyms Lakh in Hindi which itself is derivative of Sanskrit word Laksh meaning a lakh or hundred thousand. It is also worth to mention that a laksh griha would need a lot of lac, which could only come from a flourishing lac industry in that period [12]. Lac is the only known commercial resin of animal origin. It is the hardened resin secreted by tiny lac insects belonging to a bug family. To produce 1 kg of lac resin, around 300,000 insects lose their life. The lac insects yields resin, lac dye and lac wax. Application of these products has been changing with time. Lac resin, dye etc. still find extensive use in Ayurveda and Siddha systems of medicine. With increasing universal environment awareness, the importance of lac has assumed special relevance in the present age, being an eco-friendly, biodegradable and self-sustaining natural material. Since lac insects are cultured on host trees which are growing primarily in wasteland areas, promotion of lac and its culture can help in eco-system development as well as reasonably high economic returns. It is a source of livelihood of tribal and poor inhabiting forest and sub-forest areas.

2. Lac insect taxonomy
The first scientific account of the lac insect was given by J. Kerr in 1782 which was published in *Philosophical Transaction of Royal Society of London*. The first scientific name given to it

was *Tachardia lacca* following the name of French Missionary Father 'Tachardia'. It was later changed to *Laccifera lacca* Kerr. The other name given to it has been *Kerria Lac* Kerr.

Phylum - Arthropoda
Class - Insecta
Order - Hemiptera
Suborder - Homoptera
Super family - Coccoidea
Family - Lacciferidae
Genus – *Laccifera/ Kerria*
Species – *lacca* [11, 10]

Lac insect of South East Asia is referred to as *Kerria chinensis*. Lac insect belongs to super family Coccoidea which includes all scale insects. The mouth part of these insects is piercing and sucking type. They can be very destructive to tree-stunting or killing twigs and branches by draining the sap. There are six genera of lac insects, out of which only five secrete lac, and only one, i.e. *Laccifera* secretes recoverable or commercial lac. The commonest and most widely occurring species of lac insect in India is *Laccifera lacca* (Kerr) which produces the bulk of commercial lac.

3. Distribution

Since the lac insects bloom and feed on certain species of the tropical trees, it is found distributed in South-East Asian countries. Lac is currently produced in India, Myanmar, Thailand, Malaya, Lao and Yuan province of China and to some extent in Vietnam and Mexico. Although it is generally categorized as a 'non-timber forest produce [5]. India and Thailand are main areas in the world, while India has leading position in relation to lac production. Lac cultivation is introduced into Thailand from India. Over 90% of Indian lac produced comes from the states of Bihar, Jharkhand, West Bengal, Madhya Pradesh, Chhattisgarh, Eastern Maharashtra and northern Orissa. Some pockets of lac cultivation also exist in Andhra Pradesh, Mysore, Gujarat and Mirzapur and Sonebhdra districts of Uttar Pradesh. In India, lac is cultivated in 50 districts spread over 12 states. A total of 16978 tons of raw lac was produced in 2017 [20]. In Jharkhand, lac cultivation constitutes the second most important source of rural family income. Due to its diversified uses, demand of lac is increasing globally and price of the commodity is also in its increasing trend.

4. Life cycle

Lac insect is a minute crawling scale insect, which inserts its suctorial proboscis into plant tissue, sucks juices, grows and secretes resinous lac from the body. Its own body ultimately gets covered with lac in the so called 'Cell'. Lac is secreted by lac insects for protection from predators. Male is red in colour and measures 1.2-1.5mm in length. It has reduced eyes and antennae. Thorax bears a pair of hyaline wings. Female is larger than male, measures 4-5 mm in length and has a pyriform body. The head, thorax and abdomen are not clearly separate. The antennae and legs are in degenerated form and wings are absent. The Life cycle of lac insect takes about six months and consists of stages: egg, nymph instars, pupa and adult. The lac insects have an ovoviviparous mode of reproduction. Female lays 200-500 ready to hatch eggs *i.e.*, the embryos are already fully developed in eggs when these are laid. Eggs hatch within a few hours of laying and a crimson-red first instar nymph called crawlers come out. The crawler measures 0.6×0.25 mm in size. The emergence of nymph is called swarming, and it may continue for 5 weeks. The nymphs crawl about on branches. On reaching soft succulent twigs, the nymphs settle down close together at rate of 200-300 insects per square inch. At this stage, both male and female nymphs live on the sap of the trees. They insert their suctorial proboscis into plant tissue and suck the sap. After a day or so of settling, the nymphs start secreting resin from the glands distributed under the cuticle throughout the body, except mouth parts, breathing spiracles and anus. The resin secreted is semi-solid which hardens on exposure to air into a protective covering. The nymphs molt thrice inside the cells before reaching maturity. The duration of each instar is dependent on several factors, *viz*. temperature, humidity and host plant [7].

After the first moult, both male and female nymphs lose their appendages, eye and become degenerate. While still inside their cells, the nymphs cast off their second and third moult and mature into adult. Both the male and female larvae become sexually mature in about eight weeks. Only the male one undergoes a complete metamorphosis or transformation into another form; it loses its proboscis and develops antennae, legs and a single pair of wings. It is contained in a brood cell somewhat slipper like with a round trap door (operculum) through which it emerges. The adult male is winged and walks over the females to fertilize them. The female brood cell is larger and globular in shape and remains fixed to the twig. The female retains her mouth parts but fails to develop any wings, eyes or appendages. While developing, it really becomes an immobile organism with little resemblance to an insect. Females become little more than egg producing organisms. The female increases in size to accommodate her growing number of eggs. Lac resin is secreted at a faster rate and a continuous layer coalesces or grows into one body. After fourteen weeks, the female shrinks in size allowing light to pass into the cell and the space for the eggs. About this time, two yellow spots appear at the rear end of the cell. The spots enlarge and become orange coloured. When this happens, the female has oviposit a large number of eggs in the space called 'Ovisac'. The ovisac appears orange due to crimson fluid called lac dye, which resembles cochineal. It indicates that the eggs will hatch in a week time. When the eggs hatch, larvae emerge and the whole process begins all over again After the cycle has been completed and around the time when the next generation begin to emerge, the resin encrusted branches are harvested. They are scraped off, dried and processed for various lac products. A portion of brood lac is retained from the previous crop for the purpose of inoculation to new trees [18].

5. Host plants

Lac insects thrive on twigs of certain plant species, suck the plant sap, and grow all the while secreting lac resin from their bodies. These plants are called host plants. Although lac insect is natural pest on host plant, these insects enjoy the privileged position not being treated as pest. This is because: i) the yield a useful product, ii) the host plants are economically not so important, and iii) the insects cause only temporary and recoverable damage to the host plants. About 113 varieties of host plants are mentioned as lac host plant. Out of which the followings are very common in India [15].

1. *Butea monosperma* (Vern. Palas)
2. *Zizyphus* spp (vern. Ber)
3. *Schleichera oleosa* (Vern. Kusum)

4. *Acacia catechu* (Vern. Khair)
5. *Acacia arabica* (Vern. Babul)
6. *Acacia auriculiformis* (Vern. Akashmani)
7. *Zizyphus xylopyrus* (Vern. Khatber- grown in part of M.P. & U.P.)
8. *Shorea talura* (Vern. Sal grown in mysore)
9. *Cajanus cajan* (Vern. Pigeon-pea or Arhar)
10. *Grewia teliaefolia* (Vern. Dhaman preferred in Assam)
11. *Albizzia lebbek* (Vern. Siris/Gulwang)
12. *Flemingia macrophylla* (Vern. Bholia)
13. *Ficus benghalensis* (Vern. Bargad)
14. *Ficus religiosa* (Vern. Peepal)

Of these host plants, palas, kusum, ber and khair are of major importance, while others are of regional and minor importance. India contributes 95% of commercial production of lac [8]. It is also important to mention that the quality of lac is directly related to the host plant and to the strain of lac insects. Based on industrial parameters, Kusumi lac is better and fetches higher price in market. Similarly, Siris (*Albizzia* sp.) has also been identified as good host for kusumi brood lac. The trees can be raised and utilized within a period of 5-6 years of plantation in comparison to around 15 years for kusum. *Flemingia semialata* is a bushy host plant and has also been identified as well as established as a good kusumi lac host on plantation basis.

6. Strains of lac insect

In India, Lac insect is known to have two distinct strains: Kusumi and Rangeeni. The kusumi strain is grown on Kusum or on other host plants using Kusumi brood. The Rageeni strain thrives on host plants other than Kusum. The life cycle of lac insects take about six months, hence, two crops a year can be obtained. In case of Kusumi strain, two crops are: i) Jethwi (June/July) and ii) Aghani (Jan./Feb). In case of Rangeeni, tow crops are: i). Karrtiki (Oct./Nov.) and ii) Baisakhi (May/June). The crops have been named after Hindi months during which these are harvested. The lac of rangeeni crops is harvested while it is still immature. Aghani and baisakhi of rangeeni strain are the main corps contributing about 90% of lac production, remaining 10% is contributed by kusumi crops. However, the kusumi crop lac is considered superior resin, because of the lighter colour of resin, and it fetches better price [19].

7. Lac cultivation

Lac cultivation is done by putting brood lac on suitably prepared specific host plants. The brood lac contains gravid females which are about to lay eggs to give birth to young larvae. After emergence from mother cells, the young larvae settle on fresh twigs of host plants, suck the plant sap and grow to form encrustations [2, 3].

7.1. Local practice

Lac cultivation is simple and does not need any large investment and requires only part-time attention. In India, lac cultivation is carried out casually, and the cultivator is satisfied with what he gets, as it is being regarded as subsidiary crop. The local practices in lac cultivation has some disadvantages like – i) The same host plants are continuously exploited without giving rest for recoupment.
ii) Only natural inoculation occurs.
iii) Partial harvest is done leaving few branches untouched for auto inoculation of next crop and no pruning is done.

As a result of the defective local practices, host trees loss the vigour and unable to throw out new succulent shoots, and in course of time, the trees become weak and die. The self inoculation leads to heterogeneous infestation of nymphs, which results in wholesome mortality of brood in seasons of extreme heat, and thereby, the cultivator is forced to abandon lac cultivation.

7.2. Improved practice

Sustained production of lac and steady returns can be achieved by adopting improved method of cultivation. The underlying principle in improved method of lac cultivation is to provide much needed rest to the host plants after a harvest has been taken. For this purpose, coupe system of lac cultivation is adopted. As the term coupe means a chamber, the host plant trees are divided into coupes i.e., groups that consist of certain number of trees. In practice, only few numbers of trees in a coupe are inoculated. Following harvest, these trees are made to rest and recoup the lost vigour, while other trees (which have till now been restring) are ready with succulent twigs for inoculation. Thus, in a coupe system, alternate groups of trees are put to lac cultivation. Full inoculation and full cropping is the rule under this system. Considerations are desirable in improved lac cultivation include superior breeds of lac insect, providing proper rest to host plants, use of good quality brood lac in appropriate quantity, post harvest management of lac crop, host plant management and lac pest management.Timely harvesting of mature crop and proper inoculation will reduce the risk of loss of lac insect to a large extent.

7.3. Propagation of lac insects

Propagation means the spread of lac insects on the same or different host plants. This is done by inoculation of newly hatched (Brood) nymphs. Inoculation is of two types.

1. **Natural or self/auto – inoculation:** This type of inoculation occurs naturally. It is very simple and common process, when the swarmed nymphs infect the same host plant again. Natural inoculation, being repeated on the same host, makes in host plant weak, and thereby, nymphs do not get proper nutrition. Also in natural inoculation, it is not sure that uniform sequence of inoculation takes place. Therefore, natural inoculation should be discouraged.
2. **Artificial Inoculation:** Artificial inoculation is brought about by the agency of man. The main idea behind the artificial inoculation is to check the drawbacks of natural inoculation. In this method, the host plants are first of all pruned in Jan. or June. Pruning means cutting away old, weak and diseased twigs. It induces host plants to throw out new succulent twigs and is as important in lac culture as plouging is for seed sowing in agriculture. Pruning should be done with a sharp instrument (scateur, pruning shaw and pruning knife) to give a sharp and neat cut. Only light pruning should be carried out. In artificial inoculation, brood twigs are cut in size 20 - 30 cm in length. Then, the cut pieces of brood twig are tied to fresh tree twigs in such a way that each stick touches the tender branches of trees at several places. The nymphs swarm from brood and migrate to tender and succulent twigs and infest them. Following swarming, the brood twigs should be removed from the host plant, as this would decrease the chance of pest infestation. Following precautions are desirable is artificial inoculation:-

3. Fully mature and healthy brood free from pest infestations should be taken.
4. Brood meant for inoculation should not be kept for long and used immediately after crop cutting.
5. Tying of the brood lac stick should be done securely on the upper surface of branches. This will prevent falling of twigs and provide full contact for quick and easy crawling of the nymphs. One should keep a watch on the brood lac dropping down.
6. Sometimes due to bad weather, swarming of nymphs from brood is prevented. Hence, the room storing brood lac sticks is moderately heated to 200C to induce swarming, and then sticks are tied.
7. Generally, cultivation of kusumi in rangeeni area and vice versa should be avoided. Brood lac from a particular host used year after year is likely to deteriorate in quality. Therefore, alternation of brood and host give production of a better quality of brood lac.

7.4. Inoculation period
As discussed above, each strain of lac insects (Kusumi and Rangeeni) yield two crops a year: Jethwi and Aghani in case of Kusumi strain, and Kartiki and Baisakhi in case of Rangeeni. The inoculation period of all the four types of crops is different: for kartiki, June/July; for Baisakhi, Oct. /Nov. for Agahani, June/July; for Jethwi, Jan. /Feb.

7.5. Harvesting of lac
Harvesting is the process of collection of ready lac from host trees. It is done by cutting the lac encrusted twigs when is crop is mature [6]. It may be of two types:-

A. Immature harvesting: lac is collected before swarming, and lac thus obtained is known as 'ARI LAC'. The immature harvesting has drawbacks, as the lac insects may be damaged at the time of harvesting. However, in case of palas lac (Rangeeni lac), it is found that ARI Lac gives better production. Hence, ARI lac harvesting is recommended in case of palas only.

B. Mature harvesting: lac is collected after swarming. The lac obtained is known as mature Lac. To know the exact date emergence and swarming of nymph, A yellow spot develops on the posterior side of lac cell towards crop maturity. This spot spread forwards until it covers half of the cell. Cutting of twigs for harvest can be done at any time between the stages while yellow spot occupies one third to one half of the cell area. The harvesting periods of different crops are different. The Kartiki crop is harvested in Oct./Nov.; Baisakhi, in May/June; Aghani in Jan/Feb.; and Jethwi, in June/July. When the nymphs have escaped from the brood lac, left is the stick lac or phunki lac. These sticks should be tied in bundles and immersed in water, preferably running water for 3- 4 days, keeping them well under waters with help of heavy stones. The stick lac should then be kept in shade for drying. The raw lac should be scraped while sticks are still moist.

8. Composition of lac
The major constituent of lac is the resin. Lac resin is a polyester complex of straight- chain hydroxy fatty acids of $C_{14} – C_{18}$ carbon chain (such as Aleuritic acid, butolic acids), mono- and di – hydroxy acids along with hydroxyterpenic acids. Other constituents present are: dye, wax, sugar, proteins, soluble salts, sand, woody matter, insect body debris etc. Lac wax is a mixture of anthroquinoid derivatives. Composition of lac includes resin – 68 to 90%, dye – 2 to 10%, wax – 5 to 6%, mineral matter – 3 to 7%, albuminous matter – 5 to 10% and water – 2 to 3% etc. [13, 1].

9. Lac processing
9.1. Stick lac
Following harvest, lac encrustations are removed from the twigs of host plant by scraping. The raw lac thus obtained is known as raw or crude lac or scraped lac or stick lac. This crude lack consists of resin, encrusted insect body, lac dye, sand and twig debris. The freshly scraped lac contains a lot of moisture and usually left to dry. The quality and value of stick lac depend very much upon variety of factors, *viz*. host tree, climate, whether the crop is harvested before or after emergence of larvae, and the method of drying and storage. The stick lac cannot be stored for longer duration, as the lac has tendency to form lump, and there is loss in quality of lac. High moisture content is responsible for lump formation. The optimum moisture content has been identified to be 4% for storage of stick lac to avoid lump formation. It is recommended to store the stick lac on floor in layers less than 30 cm. in height and racked frequently. If stick lac is converted into seed lac, it can be stored for longer duration like food grains.

9.2. Seed lac
The primary processing to seed lac soon after harvesting is necessary, because the storage of stick lac is more congenial for lump formation and breeding of storage pests, and thereby causing substantial loses and deterioration in quality of desired industrial parameters. The stick lac is crushed and sieved to remove sand and dust. It is then washed in large vats again and again to break open the encrusted insect bodies, to wash out the lac dye and twig debris. Decaying bug bodies turn the water a deep red that is processed further to get the byproduct lac dye. The remaining resin is dried, winnowed and sieved to get the semi refined commercial variety product called seed lac. The dusty lac eliminated by sieving is refuse lac known as molamma. The seed lac is in form of grain of 10 mesh or smaller and yellow or reddish brown in colour in general appearance. Adhering impurities on the grains of seed lac may be to 3 - 8%.

9.3. Shellac
The shellac is the name of finished product and is commonly used across the world. Seed lac is processed into shellac by any of the three methods: hand made country Process or heat process or solvent process.

9.3.1. Hand made Process
Traditionally seed lac is processed by hand. The seed lac is filled into long sausage shaped cloth bag of about 2 inch diameter and 30 feet long. The long bag is passed gradually in front of a charcoal-fired hearth hot enough to melt the lac. By twisting the bag, molten lac is squeezed out through cloth. The residue left inside cloth bag is another variety of refuse lac known as kirilac. The molten filtered mass is stretched into sheets approximately 0.5 cm thick and thinner by skilled work man with the help of glazed ceramic cylinder. Alternatively, the molten mass is allowed to solidify in form of discs, and then it is called as 'button lac'.

9.3.2. Heat Process

In this process of manufacturing of shellac, the seed lac is melted by steam heat. The molten soft lac is squeezed through filter by means of hydraulic pressure. The filtered molten lac is drawn into long and continuous sheets with help of roller. The sheet is then broken into pieces called flakes [16].

9.3.3. Solvent Processes

If the solvent process is used to purify the semi refined lac, dewaxed and decolorized shellac can be obtained as end product. The normally amber colour resin can also be bleached to get bleached shellac. Seed lac is dissolved in a refrigerated alcohol and filter through filter press to remove wax and impurities. The colour may be removed to any required standard by charging with the activated carbon and then alcohol is recovered. The molten shellac is stretched with a roller.

10. Lac products and their use

10.1 Lac dye

Lac dye is a mixture of anthroquinoid derivatives. It is traditionally used to color wool and silk. Its colour varies between purple red, brown and orange often depending upon the mordant used. It is used in food and beverages industry for coloring. In recent past, lac dye has been replaced by synthetic dye [14]. But, now-a-days with increasing stress and awareness on use of eco-friendly and safe material particularly associated with human contact and consumption has made revival of great demand of lac dye as a coloring material.

10.2 Lac wax

Lac wax is a mixture of higher alcohols, acids and their esters. It is used in –

- Polishes applied on shoes, floor, automobiles etc.
- Food and confectionary, and drug tablet finishing
- Lipsticks
- Crayons

10.3 Shellac

Shellac is a natural gum resin, a nature's gift to the mankind and is used in over 100 industries. It is natural, non toxic, physiologically harmless and edible resin. Shellac is a hard, tough, amorphous, and brittle resin containing small amount of wax and a substance responsible for its characteristic pleasant odour. The lac resin is not a single chemical compound, but an intimate mixture of several components. Shellac is slightly heavier than water. Its natural colour varies from dark red to light yellow. Shellac is insoluble in water, glycerol, hydrocarbon solvents and esters, but dissolves readily in alcohols and organic acids. The solvent most commonly employed to dissolve shellac is methylated spirit. Usually the milder alkalis, ammonia, borax and sodium carbonate can also be employed to prepare aqueous solutions. Normal wax content of shellac is 5% which is insoluble in alcohol. It is soluble in n-hexane, pure terpentine, and other hydrocarbon oils. It has the following extra ordinary properties:

1. It is thermoplastic.
2. It is approved for various applications in the food industry.
3. It is UV-resistant.
4. It has excellent dielectric properties, dielectric strength, a low dielectric consent, good tracking resistance etc.
5. It has excellent film forming properties. Its film shows excellent adhesion to wide variety of surfaces and possess high gloss, hardness and strength.
6. Shellac is a powerful bonding material with low thermal conductivity and a small coefficient of expansion.

Use

- It is used in fruit coatings, e.g. for citrus fruits and apples, parting and glazing agents for sweets, marzipan, chocolate etc. Also used as binder for foodstuff stamp inks, e.g. for cheese and eggs.
- It is used as binder for mascara, nail varnish additive conditioning shampoo, film forming agent for hair spray, micro-encapsulation for perfumes.
- It is used for enteric (i.e. digestive juice-resistant) coatings for tablets and as odour barrier for dragées.
- It is used in manufacturing of photographic material, lithographic ink and for stiffening felt and hat material.
- It is utilized in preparation of gramophone records.
- Jewellers and goldsmiths use lac as a filling material in the hollows in ornaments.
- It is also used in preparation of toys, buttons, pottery and artificial leather.
- It is also used commonly as sealing wax. With increasing environmental awareness of consumers, this natural and renewable raw material is being used increasingly in the development of new products apart from the conventional user industries and few to name:
- Leather**:** Seasoning, Leather care products
- Printing inks**:** As binder for flexographic printing inks for non-toxic printing of food packaging
- Wood treatment: Primers, polishes, matt finishes
- Textiles: As stiffeners
- Electrical: Insulation, capping, lamination
- Abrasives**:** Binder for grinding wheels
- Others: Binder for inks and water colours, Micro-encapsulation for dyes [4].

10.4 Bleached shellac

Bleached shellac is non-toxic, physiologically harmless (edible), and is widely used in the food industries, food packaging and allied industries. Apart from the above, bleached shellac is also used for its qualities i.e. binding, adhesive, hardening, gloss, odourless, fast drying, and extending shelf life (in absence of refrigeration) etc.

Use

Bleached shellac is widely used in the following industry:

- Paints (primer for plastic parts and plastic film)
- Aluminium industry (primer for Aluminium and Aluminium foils)
- Flexographic printing inks
- Pharmaceuticals (for coating of pills, tables and gel capsules)
- Confectionery (in coating of confections, chewing gums, marzipan chocolates, nutties, jelly- and coffee-beans etc)
- Binder for food marking and stamping inks and Binder for egg coating
- Barrier coating for processed food, vegetables, fruits and dry flowers
- Textiles (used as textile auxiliaries and felt hat-stiffening agents)
- Cosmetics (used in hair spray, hair and lacquers, hair shampoos, and binder for mascara)

- Wood finishing (as binder for wood coatings and wood stains and as filler/sealer for porous surfaces and cracks)
- Antique frames for paintings and Wood polish (French polish)
- Fire works and pyrotechnics (as binder for fireworks, matches etc and used in coating of magnesia
- Electric (as binder for lamp cements)
- Electronics (it is binder for insulation materials, serves as additive to moulding compounds. Mass coating for print-plates and is adhesive for si-cells.)
- Grinding wheels (it is binder for additive of grinding wheels)
- Plastic (it is primer for plastic parts and films)
- Rubber (it is additive to natural rubber)
- Leather (in leather auxiliaries)

10.5 Dewaxed bleached shellac

Dewaxed white shellac is used in the same way as any other grade of shellac. The major difference between this shellac and the others is that it is a bit harder, shines a bit brighter, is completely free from wax. Bleached lac has super characteristics and qualities i.e. adhesive, binding, hardening, gloss, odorless. It has good film forming properties, a high gloss and excellent adhesion to various substrates including the human hair.It is non-toxic and physiologically harmless.

Use

- Coating of fruits and vegetables
- Coating in tablets & capsules
- Coating in confectionary
- Coating in aluminium foil, paper
- Coating in cosmetic industry
- In cosmetics, it is used in hair sprays (pump sprays or aerosol sprays, hair setting lotions, hair shampoos, mascara, eyeliners, nail polishes, lipsticks, micro encapsulation by coacervation of fragrances and perfume oils.
- In food, it is used for coating of confections, chewing gum, candles, cakes, eggs, citrus fruits and apples, and printing inks for eggs and cheese.

10.6 Aleuritic Acid (Shellac Aleuritic Powder)

Aleuritic Acid (9, 10, 16-trihydroxypalmitic acid), obtained from shellac by saponification, is a unique acid containing three hydroxyl groups of which two are of adjacent carbon atoms. Technical grade Aleuritic Acid (purity 99%) a slight yellow and almost odourless solid.

Use

There is a continuous growing demand of Aleuritic acid in the fields of perfumery and pharmaceuticals due to it being an excellent starting material for the synthesis of civetone, ambrettolide, isoambrettolide etc, which have the musk like odour. Civetone is obtained from Shellac Aleuritic Acid. It is used for manufacturing of perfumes and is very much in demand with perfume manufacturing companies in France, Italy, Germany, USA etc. The other suggested applications of Aleuritic acid are the following:

- Synthesis of Glucose monoaleuritate (a non-toxic non-hemolytic water-soluble compound) in medicine as an isocaloric substitute for dietary tripalmitin.
- Preparation of plastics with good adhesive properties by the condensation of Aleuritic acid with pithalic andydride and glycerin, rosin etc.
- Aleuritic acid esters used in the preparation of lacquers, plastics and

11. Lac pests

The insects are serious and damaging pests to the lac crop also, like the other agricultural crops. These insect pests destroy 30-40% of lac. The insects damage the lac crop is two ways:

1. **As Parasites:** Lac insects are parasitized by small winged eight species of insect belonging to family chalcidae order Hymenoptera. These insect pests lay eggs in lac cells. Their grubs on hatching feed on lac insects within the cells. Loss due these parasites is 5-10%

2. **As Predators:** Lac insect has some vertebrate predators like monkeys, squirrels, rats, lizards, woodpeckers, birds. The predators account major damage (up to 35%) of lac crop. There are three main insect predators on lac:

a. *Eublemma amabilis* Moori: commonly known as white lac moth of order Lepidoptera
b. *Holocerca pulverea* Meyr : commonly known as black lac moth of order Lepidoptera
c. *Chrysopa spp.* includes *Chrysopa madestes, C. lacciperda*: Commonly known as lacewing bug of order Neuroptera [9].

These predator's moths and fly lay their eggs on the lac encrusted twigs. On hatching, their larvae make their way inside the lac encrustation and feed on the lac insects as well as on lac encrustations. The white lac moth is more destructive on trees; while black lac moth, on the stored lac. In addition to insect pests, squirrels and monkeys also damage lac. The rodents could damage greatly. These pests gnaw the mature lac encrustations on the trees or brood lac sticks tied for inoculation, and thus, consuming gravid females. The brood lac can be made to fall on the ground by these animals preventing inoculation. Forest fires too often break out in deciduous forests in summer season and destroy both lac insects and their host plants.

Following precaution should be taken to prevent the damage caused by insect pests:-

1. Only healthy pest-free brood lac should be used for inoculation. The twigs for inoculation should be cut just before swarming to get healthy brood.
2. Entire crop should be harvested, as left over may attract the pests.
3. The stick or phunki lac should be fumigated or immersed in water to kill the pest, if any.
4. Scrapping of encrusted lac from twigs should be done as soon as possible, andlac, thus obtained should be immediately converted into seed lac and not left near the inoculated lac hosts.
5. Infected stick lac should be destroyed along with predators and pests.

12. Conclusions

Lac insects are exploited for their products of commerce, i.e., resin, dye and wax. Cultivation of lac not only provides livelihood to millions of lac growers, but also helps in conserving vast stretches of forests and biodiversity associated with lac insect complex. Promoting and encouraging lac culture will not only check environmental

degeneration but also conserve associated fauna and flora for posterity.

13. Reference

1. Agarwal SC, Kumar P, Gowami DN. Safari of ILRI through seven decades. Indian Lac Research Institute, Ranchi, 1998, 84.
2. Arvind K, Vadhya SN, Mahto RK. Cultural practices in lac cultivation. Prospects of Scientific Lac Cultivation in India, 2013, 27-34.
3. Ghosal S, Sharma KK, Singh AK, Singh BP. Recent advances in lac production technologies. Journal of Pharmacognosy and Phytochemistry, 2018, 158-1600.
4. Goswami DN, Sarkar PC. Applictaion of lac. In: Baboo B, Goswami DN (ed.) processing, chemistry and application of lac. Directorate of information and application of agriculture, Indian Council of Agricultural Research, New Delhi, 2010, 118-153.
5. Jaiswal AK, Sharma KK, Kumar KK. Importance of lac in the socio-economic life of tribals in Ranchi district (Jharkhand). New Agriculturist. 2006; 17(1-2):133-137.
6. Jaiswal AK, Sharma KK, Ramani R. Lac cutture operations -when, why & how? Bulletin (Extension) No. 05/2011 lndian lnstitute of Natural Resins and Gums (lndian Council of Agricultural Research) Namkum, Ranchi (Jharkhand), 2011.
7. Jaiswal AK, Sharma KK. Lac insect, its development and life cycle. In: Recent Advances in Lac Culture. Kumar KK, Ramani R, Sharma KK (Eds.), ILRI, Namkum, Ranchi, 2002, 20-24.
8. Kumar KK, Ramani R, Sharma KK. Recent Advances in Lac Culture, ILRI, Namkum, Ranchi, 2002, 290.
9. Mohanta J, Dey DG, Mohanty N. Studies on lac insect (Kerria lacca) for coservation of biodiversity in Similipal Biosphere Reserve, Odisha, India. Journal of Entomology and Zoology Studies. 2014; 2(1):1-5.
10. Mohanta J, Dey DG, Mohanty. Performance of lac insect Kerria lacca Kerr. In conventional and nonconventional cultivation around Similipal Biosphare Reserve. Odisha, India. The Bioscan. 2012; 7(2):237-240.
11. Pal G. Impact of Scientific Lac cultivation Training on Lac Economy-A Study in Jharkhand. Agricultural Economics Research Review. 2009; 22:139-143.
12. Paul B, Kumar S, Das A. Lac cultivation & their host trees found in Bastar Forest Division. Plant Sciences Feed. 2013; 3(1):8-12.
13. Reshma BV, Nithin MR, Anaha VI. A review on *Laccifera lacca*. World Journal of Pharmaceutical Research. 2018; 7(10):206-218.
14. Sarkar PC. Application of lac: past, present and emerging trends.in: Sharma KK, Ramani R (ed) recent advance in lac culture. Indian Institute of Naturel Resin and Gum, Namkum, Ranchi, 2011, 252-258.
15. Shah AI. Importance of lac culture on socio-economic and biodiversity conservation fronts. International Journal of Advance Research. 2016; 4(9):1708-1711.
16. Sharma KK. Lac crop harvesting and processing. Industrial entomology, 2017, 181-196. doi: 10.1007/978-981-10-3304-9-7
17. Singh R. Lac Culture. *Applied zoology*. Department of Zoology, Udai Pratap Autonomous College Varanasi, 2006.
18. Srivastava SC. Advanced lac production, storage and application technology for emplacement and income generation. Model training cource on advanced lac production, storage and application technology for employment and income generation. Indian Lac Research Institute Namkum, Ranchi, 2007, 64-67.
19. Yogesh KM, Rajeev G, Katlam BP. Performance of different host plants of lac (*Kerria lacca* Kerr.) insect in Korba district of Chhattisgarh. International Journal of Recent Science and Research. 2018; 9(8):28529-28533. DOI: http://dx.doi.org/10.24327/ijrsr.2018.0908.2475
20. Yogi RK, Bhattacharya A, Jaiswal AK. Lac, Plant Resins and Gums Statistics at a Glance. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical) No. 06/2014, 2014, 1-38.