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Quality Requirement and Standards for Natural Resins and Gums

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ABSTRACT

NRGs are metabolic by-products of plant tissues either in normal course or often as a result of either injury in the bark or wood or disease by insects. Most of the NRGs are plant origin and exudate product from the plant with the exception of lac resin which is secreted by lac insect mainly *Kerria lacca*. India has wide varieties of trees and plants which exudates Resins and Gums. The natural gums and resins are polymeric, biodegradable and non-toxic in nature. Being biologically originated, they have wide variations in their characteristics and properties. So, quality of the natural resins and gums are to be regulated for application in different sectors. Quality standards of natural resins and gums are to be set by according to national and international regulatory bodies. The quality standards of the natural resins and gums are very useful documents to find their in various novel application areas.

Keywords: Natural resins and gums, quality standard, BIS, JECFA standards

Natural resins and Gums being biologically originated do not have uniform quality. The climatic conditions also influence the quality and yield of the gum produced by the different plant species belonging to different locations. Hence, it cannot be used as such and is to be subjected to a variety of refining processes to obtain a more purified end product. It is necessary to test the sample for grading and judge for its quality. Due to increasing emphasis of the bio-safety of the product, quality management is extremely important for application related to human contact and consumption. Further in the trade a uniform quality is required to be supplied, hence, to sustain trade in the country, it becomes necessary to test the sample according to national/international standards like Bureau of Indian Standards (BIS), International Organization for Standardization (ISO) specification.

The BIS operates a product certification scheme, and has till date granted more than 30,000 licenses to manufacturers covering practically every industrial discipline from Agriculture to Textiles and Electronics. The BIS product certification scheme is largely based on ISO Guide, which provides general rules for third party certification system of determining conformity with product standards through initial testing and assessment of a factory quality management. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) is an international expert scientific committee administered jointly by the Food and Agriculture Organization and the World Health Organization. JECFA serves as an independent scientific committee which evaluates food additives, contaminants and naturally occurring toxicants, residues and veterinary drugs for their standard specification. The Committee also develops principles for the safety assessment of chemicals in food.

The importance of standards may be better appreciated by considering what would happen in its absence. When a product is made according to predefined standards and meets customer expectations, it is often taken for granted. However, in an environment without standards, people would very likely voice concerns about poor quality and unsafe products. The Standard agencies benefit

end consumers by safeguarding their interests and by ensuring that the products and services they purchase are safe and reliable. The BIS and ISO ensure fairness and transparency in businesses, governments and societies. The quality standards for natural Resins and Gums, prescribed by the Standard Agencies are given as follows.

Natural Gums

True gums are formed from the disintegration of internal plant tissues, mostly from the decomposition of cellulose in a process called gummosis. Gums contain high amounts of sugar and are closely allied to the pectins. They are colloidal and soluble in water, either dissolving entirely or swelling, but they are insoluble in alcohol and ether. They exude naturally from the stems or in response to wounding of the plant. Commercial gums arrive in the market in the form of dried exudations. Gums are especially common in plants of dry regions. They are used primarily as adhesives, and are also used in printing and finishing textiles, as a sizing for paper, in the paint and candy industries and as drugs. Some important commercial plant gums are gum arabic, gum ghatti, gum tragacanth and karaya gum and guar gum as seed gum.

Guar gum

Guar gum (also called guaran) is extracted from the seed of the leguminous shrub *Cyamopsis tetragonoloba*, where it acts as a food and water store. Many leguminous plant seeds contain Galactomannans. Guar Gum is known for its thickening properties. It is obtained from the seeds of *Cyamopsis tetragonolobus*, an annual leguminous plant originating from India and Pakistan. It is also cultivated in the United States. Guar fruit is a pod; its seeds have an average diameter of about 5 mm. They contain a reserve substance, the albumen. From the outside to the interior, we have:the hull, the albumen or endosperm, which is light cream in colour. It is made up of two hemispherical segments (splits), which surround the germ. Its major constituent is the polysaccharide, the germ, rich in protein. Interest for Guar Gum is fairly recent: its initial development was due to a lack of Locust Bean Gum in the 1940s. Its large-scale industrial production dates from the 1950s.

Structural unit: Guar gum is a galactomannan similar to locust bean gum consisting of a (14)-linked β-D-mannopyranose backbone with branch points from their 6-positions linked to α-D-galactose (i.e. 16-linked-α-D-galactopyranose). There are between 1.5 - 2 mannose residues for every galactose residue. Another galactomannan with lower substitution (with a mannose to galactose ratio of about 3:1) is tara gum, obtained from *Cesalpinia spinosa*. It has properties between those of guar gum and locust bean gum. Higher substituted galactomannans are found in fenugreek gum (*Trigonella foenum-graecum*) and mesquite gum (*Prosopis juliflora*), with mannose to galactose ratio of about 1:1 (but possibly as high as 5:4) and 5:4 respectively. The higher substitution of these gums gives them improved solubility, dispersiveness and 82 emulsification (although it appears that this emulsification activity is absent in the polysacchaharide but due to protein impurities).

REGULATORY STATUS

Minimum standards for good quality guar gum have been defined in the United States FCC and by European Union Specifications, E-412 as under:

- Moisture : 14% max.
- Ash (total) : 1.5% max.
- Acid Insoluble Residue : 4% max.
- Galactomannan : 75% min.
- Protein : 7% max.
- Arsenic : 3 ppm max.
- Lead : 10 ppm max.
- Zinc : 25 ppm max.
- Copper & Zinc : 50 ppm max.

Gum Arabic

A dried gummy exudate obtained from *Acacia senegal* and related acacias. These are small native trees of arid northern Africa and are extensively cultivated in the Sudan. The trees are tapped between February and May when the fruits are ripe. Transverse incisions are made with a small ax and thin strips of the outer bark are torn off. The gum slowly exudes as a viscous liquid, collects in a drop and hardens. After 3-8 weeks these "tears" are collected. Gum arabic is slowly and completely soluble in cold water and has a high degree of

adhesiveness and viscosity. Most has been used in textile, mucilage, paste, polish and confectionery industries and as a glaze in painting. In medicine it has been used as an emulsifying agent and as a demulcent.

REGULATORY STATUS

Characteristic	Requirement
Loss on drying, percent by mass,	Max:
a) Granular material	15
b) Spray dried material	10
Total ash, percent by mass, Max	4
Acid insoluble ash, percent by mass, Max	0.5
Insoluble matter, percent by mass, Max	1
Starch and dextrins	To pass the test
Tannin-bearing gums	To pass the test
Arsenic (as As), mg/kg, Max	3
Lead (as Pb), mg/kg, Max	2
Salmonella per g, Max	Negative
E. coli per g, Max	Negative

Karaya Gum

General: Gum karaya shall be a dried gummy exudation obtained from the stems and branches of *Sterculia urens* Roxb and *S. villosa* Roxb fam Sterculiaceae.

Description: The material shall be a white to amber colour. in the form of tears of variable size or in broken irregular pieces. It shall possess a slightly acetous odour and a mucilaginous and slightly acetous taste. Karaya gum has been used as a substitute for gum tragacanth, and several million pounds were imported annually from India by the mid 1900's. It is used in the textile, cosmetic, cigar, past and ice cream industries. It is obtained from *Sterculia urens*, a large tree in central India. Incisions are made into the heartwood and the gum oozes into these and accumulates as large irregular knobs. They are then collected, sorted and graded.

REGULATORY STATUS

	Characteristic	Requirement
(i)	Loss on drying, per cent by mass, Max	16
(ii)	Starch	Nil
(iii)	Total ash, per cent by mass, (on dry basis), Max	8
(iv)	Acid insoluble ash, per cent by mass, (on dry basis), Max	1
(v)	Acid insoluble matter, per cent by mass (on dry basis), Max	3
(vi)	Volatile acid (as acetic acid), per cent by mass, Min	10
(vii)	Swelling property, ml, Min	200
(viii)	Water absorption, ml, Min	75
(ix)	Arsenic (as As), mg/kg, Max	3
(x)	Lead (as Pb), mg/lkg, Max	10
(xi)	Heavy me'a)s (u Pb) Mg/kg, Max	40
xii)	Salmonella	Negative (on 1 g)
(xiii)	*E. coli*	Negative (on 1 g)

Gum Ghatti

Gum Ghatti (Indian gum) is a complex polysaccharide composed of l-arabinose, d-galactose, d-mannose and d-glucoronic acid residues. The gum has been used extensively in recent years both in the petroleum industry as a drilling mud conditioner and in the explosive industry as a preferential water absorbent or desiccant. It is used as an emulsifier, stabilizer and thickner in ceramics, foods and pharmaceuticals. Ghatti is an amorphous, translucent, water soluble gum exuded by the tree Anogeissus latifolia of the family combretaceae. The gum has a glassy fracture and occurs in rounded tears, which are normally less than 1 cm in diameter but more often occurs in larger vermiform masses. The colour of exudates varies from light to dark brown. Gum ghatti is used as a substitute of gum Arabic in pharmaceutical preparations for stabilization of suspensions.

REGULATORY STATUS

	Characteristic	Requirement		
		Grade 1	Grade 2	Grad 3
(i)	Volatile matter, per cent by mass, Max	14	14	15
(ii)	Total ash, per cent by mass, Max	2.2	3.0	4.0
(iii)	Acid-insoluble ash, per cent by mass, Max	0.2	0.3	0.8
(iv)	Viscosity of 5 per cent solution in centipoises at 270°C, Min	1000	900	800

Natural Resins

Resins are formed as oxidation products of various essential oils and are very complex and varied in

chemical composition. The resin is usually secreted in definite cavities or passages. It frequently oozes out through the bark and hardens on exposure to air. Tapping is usually necessary in order to obtain a sufficient amount to be of commercial value. Commercial resins are also frequently collected from fossil material. Resinous substances may occur alone or in combination with essential oils or gums. Resins, unlike gums, are insoluble in water, but they dissolve in ether, alcohol and other solvents.

Resins have certain characteristics that render them important to industry. Their ability to harden gradually, as the oil that they contain evaporates, makes possible commercial varnishes. The resins are dissolved in solvents and surfaces are painted with the mixture. As the solvents and oils evaporate, a thin waterproof layer of resin remains. Resinous substances have been utilized for waterproof coatings, and also for decorative coatings for millennia. Another property of resins that is of industrial importance is their ability to dissolve in alkalis to form soap. Resins are also used in medicine; for sizing paper; as a stiffening material for mats; in the preparation of sealing wax, incense and perfumes; and for many other purposes as well.

Shellac

Shellac is derived from the hardened secretion of the lac insect *Kerria spp.* feeding on resiniferous trees and bushes cultivated in India, China, Thailand, Indonesia, Bangladesh, Myanmar, Vietnam and Srilanka. In India, lac cultivation is done mainly through culture of Indian lac insect *Kerrialacca* on hosts such as *kusum* (*Schleichera oleosa*), *palas* (*Buteamono sperma*) and *ber* (*Ziziphus mauritiana*). Lac encrustations on the twigs of host trees are removed by scrapping, either manually or by machines. Lac resin, thus obtained is known as sticklac. It contains a number of non-resinous impurities like wood particles, insect body, wax,dye etc., which are to be removed, refined and converted into commercially acceptable form, known as shellac. Raw lac (sticklac) contains resin (68%), wax (6%), dye (10%), insect body (6.5%), bark of host trees as well as other impurities(4%). The lac resin is a polyester complex of long-chain hydroxyfatty acids and sesquiterpenic acids. The lac resin contains a number of aliphatic and sesquiterpennic acids as lactones, lactides and inter-esters. It consists of one free carboxyl, three ester and five hydroxyl groups and one unsaturated linkage. Lac dye is a mixture of at least five anthraquinone derivatives called laccaic acids. Lac wax is complex mixture of long-chain acids, alcohols, esters and hydrocarbons.

Shellac consists of resin as the major component along with wax and very small quantity of coloring component. The resin is polyester comprising a mixture of long chain hydroxy and sesquiterpenic fatty acids. Resin can be broadly resolved into two fractions on the basis of solubility in ether: Ether insoluble - hard resin (approx. 70%) and ether soluble - soft resin (approx. 30%). Component acids present in the rein portion of shellac are Aleuritic acid (30-35 %), Laccijalaric acid (22-26 %), epi-Laksholic acid (12-15%), Jalaric acid (8-10 %), Butolic acid (6-8 %), Shellolic acid (8-10 %), Myristic acid (traces) and Palmitic acid (traces).Besides this, Wax (4-5%) and coloring pigment, erythrolaccin (traces) are also present in shellac as co-components.

Shellac is the only natural resin of insect origin, mostly produced in India, Thailand, China, Vietnam, etc. which is exported to the different part of the world including European countries with the E number, E904. Being a natural product it finds applications in food, pharmaceuticals and cosmetics industries. U.S. FDA and European Union (EU) have permitted use of shellac for use in food and pharmaceuticals application.

REGULATORY STATUS

Properties	BIS value
Acid Value	65-75
Saponification value	220-230
Ester value	155-165
Hydroxyl number	250-280
Iodine value (Wijs' method)	14-18
Molecular weight	~1000
Specific gravity	1.08-1.10
Softening point	40-50 °C
Time of polymerization at 150° C	30-120 min

Oleoresins

A considerable amount of essential oils are contained in oleoresins in addition to the resinous materials. Thus, they are often liquid in nature. They have a distinct aroma and flavor. Among the oleoresins we find the turpentine, balsams and elemis.

Requirements for Rosin (GUM ROSIN)

Sl. No.	Characteristic	Requirement for Type		
		Extra Pale	Pale Medium	Dark
(1)	(2)	(3)	(4)	(5)
(i)	Colour	Equivalent to Gardner colour values (3.2) or matching colour of corresponding permanent Lovibond US rosin colour standards		
(ii)	Softening point, °C, Min	70	70	70
(iii)	Relative density ǂ, 27°C	1.05	1.0520	1.0520
(iv)	Acid number, Min	160	155	155
(v)	Saponification number, Min	165	160	160
(vi)	Volatile matter, per cent by mass, Max	1.50	2.0	2.0
(vii)	Ash content, per cent by mass, Max	0.05	0.2	0.5
(viii)	Matter insoluble in toluene, per cent by mass, Max	0.10	0.40	1.00
(ix)	Unsaponifiable matter, per cent by mass, Max	6.0	6.0	6.0

Turpentine

These are oleoresins that are obtained almost exclusively from coniferous trees. They are viscous, honey like liquids or soft and brittle solids. The resin is secreted and stored in ducts near the cambium layer and exudes naturally as a soft, sticky substance, often called pitch. For commercial use crude turpentine is obtained by tapping the trees. On distillation turpentines yield the essential oil or spirits of turpentine, and rosin, both of which are useful products around which an important industry had been built in the 20th Century. Turpentine and rosin are also produced in Europe and India and Vietnam.

ROSIN (GUM ROSIN)

This standard prescribes the requirement and the methods of sampling and test for rosin (gum rosin). The material is mainly used in paper, soap, cosmetics, paint, varnish, rubber and polish industries.

TYPE AND GRADES

TYPE – The material shall be of the following four types:

- Extra pale,
- Pale,
- Medium, and
- Dark.

Description: The material shall be derived from the oleoresin gums of the pines and shall be in the form of transparent or slightly transparent brittle lumps with a glassy fracture. It shall be free from more than traces of visible particles of the dirt or other extraneous foreign matter suspended in the solid mass. Slightly specky, opaque, crystallized or cloudy rosin may be acceptable when these conditions are not of a degree to prevent the true evaluation of the grade according to the colour.

GRADES: There shall be a total of 15 colour grades under 4 types of the material, the colour standards being approximately equivalent to Gardner Colour Values as given in above table.

CONCLUSION

Research in new applications of natural gums and resins is opening up new opportunities. New beverage innovations, such as wine coolers, novel confectionery coatings, high fiber drinks and powders, and synergistic combination with other gums are some of the examples of new product formulations using gums and resins. New patents using gum in confectionery coatings and lithography have been recently granted. With the increasing awareness of natural products use of gums is expected to increase in pharmaceutical industries.

Continuous research support is needed for processing, value addition and product development to meet the changing demand of domestic and international consumers, besides creating internal employment and income generation.

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