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SHOREA ROBUSTA (DIPTEROCARPACEAE) SEED AND ITS OIL AS FOOD

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ABSTRACT

Shorea Robusta (Sal) belongs to the family of *Dipterocarpaceae*. Sal has an important role in the economics of central states of India (i.e. Orissa, Jharkhand and Madhya Pradesh). These states cover about 45 % of forest area. Sal is a deciduous tree that reaches up to 50 m height. Sal is famous for its seed and oil. Sal fruit pulp is edible; it contains sugar, gum, malic, citric and tartaric acids. Sal is a crucial plant for veterinary medicines (used as vaccine and medicine for respiratory diseases). Sal fruit content 66.4% of kernel and pod, remaining 33.6% is shell and calyx. Sal seeds are processed mainly for its fat or oil. It also has a leading role in food and cosmetic sectors. The extracted Sal oil is greenish brown colour and characteristic odour. The refined oil from Sal seed is used for cooking and substitutes for cocoa butter in chocolate manufacturing industries. It also used for the production of vanaspati, paints, pigments, lubricants, biogas and biodiesel. Besides, de-oiled cake also has a good export market for cattle, poultry and fish feed.

Kew words: *Shorea Robusta*, *Dipterocarpaceae*, Sal seed oil.

INTRODUCTION

Sal (*Shorea robusta*) is an important non timber forest product. It is spread across 10 million ha in India, covering approximately 14% of the total forest area of the country (Singh *et al.*, 2014^a). Also it plays an important role in the economic of some Indian states i.e. Orissa, Jharkhand and Madhya Pradesh. Orissa has the largest Sal forest area that covers an area of 38,300 km² (NTFP, 2015). About 20-30 million forest dwellers, mostly tribal depend on Sal seeds, leaves and resins for their livelihood. In the months of May and June, primary collectors are engaged for about six weeks in Sal seed collection.

Sal is a deciduous tree (Fig. I) that grows up to 50 m height, with a stem circumference up to 5 m. Under normal conditions it reaches 18-32 m height, with girth of 1.5–2 m. The stem is clean, straight and cylindrical, often bearing epimorphic branches. The pinnacle is spreading and spherical.

The bark is dark brown in colour. The average temperature required for the growth of this tree is 22-47°C throughout the year. The tree requires mean annual rainfall around 3000 mm and maximum 6600mm. Sal grows in deep, well-drained, moist, slightly acid, sandy to clayey soils (Singh *et al.*, 2014^b).

Leaves are reddish, delicate green, simple, shiny, about 10-25 cm long and broadly oval at the base, with the apex tapering into a long point. Flowers are yellowish-white colour arranged in large terminal or axillary racemose panicles. Sal fruit of full size is about 1.3-1.5 cm long and 1 cm in diameter, it has surrounded by segments of the calyx enlarged by 5 unequal wings about 5-7.5 cm long. Sal seed has brown in colour, it has calyx and wings. The decorticated or deshelled seed contain a thin and brittle seed kernel. The kernel has 5 segments covering the embryo (Pali, 2013). The seed contains 34.6% of fat (Singh *et al.*,

2014^b). Sal seeds are rich in fat and constitute about 69% symmetrical triglycerides, which makes them potentially useful for the food industries. It forms the primary ingredient for a diverse range of products such as oil, soap, cocoa butter equivalent in chocolate manufacturing (Saini *et al.*, 2013). Sal fat is also used in the confectionery industries for processing and production of Vanaspati ghee.



Figure I: Sal Forest area in Jharkhand

Sal seed is identified as a potential source of biodiesel production (Pali, 2013). At present about 1.50 million metric tons of Sal seeds are produced per year in India, which generates around 1.32 million metric tons of de-oiled cake after oil extraction. Sal de-oiled seed cake can be considered as a prominent inducer for protease production (Saini *et al.*, 2013; Chaitanya, and Naithani, 1998). The de-oiled cake is used in proportions up to 20% in concentrates for cattle feed. At present the cake is used for non-biological processes such as fuel for boiling in solvent extraction plants, as a sizing material in textile industries and coal briquettes (Mahdi *et al.*, 2012; Saini *et al.*, 2013).

SAL FRUIT

Sal fruit is green in color (Fig. II). A matured fruit is of 1.3-1.5 cm long and have diameter of 1 cm. It is attached to calyx which is pink in color and has 5 unsymmetrical wings ranging from 5-7.5 cm in length. Fruit contains kernel and pod (66.4%), shell and calyx (33.6%). The fruit generally ripen in month of May. Sal fruits pulp is edible, as it contains sugar, citric acid, malic acid and tartaric acid. Traditionally Sal seed is being used as medicine in veterinary science. Many report shows that feeding the Sal fruits to chicken is an excellent way to maintain their health. The fruit pulps are also used for fed to chickens as both a vaccine and medicine for respiratory and other diseases.

Also the stem, bark and flowers of sal exhibited antifungal activity (Saini *et al.*, 2013).



Figure II: Sal Fruit

SAL SEED

Sal seed (Fig III) is light brown in colour, contains calyx and wings. It is mainly used for oil extraction. The de-shelled seeds contain a thin seed coat and seed pod. The kernel has five segments covering the embryo. Nearly 2 kg of seed yields 1 kg of kernel (Singh *et al.*, 2014^b). The seed contains 34.6% fat, 8.46% of moisture, and 6% of ash. The proximate analysis of sal seed is reported in Table I (Singh *et al.*, 2014^b). Sanjoy (2015) were reported that Sal seed has a largest demand in Indian export market and seven multinationals companies that account for 60% of the global chocolate and confectionery production. Sal fat can also be used as a substitute for cocoa butter.



Figure III: Sal seed

Table I: Proximate analysis of Sal seed

Proximate analysis	Sal Seed (%)
Moisture content	8.46
Volatile content	71.54
Ash content	6
Fixed carbon	16
C	68.69
H	23.68

N	1.23
S	3.28
O	33.12
C/H molar ratio	0.24
C/N molar ratio	64.19
% of oil content	34.6
Empirical formula	$C_{65}H_{26.9}O_{0.23}NS_{0.011}$

Source: Singh *et al.*, 2014^b

POST-HARVEST PROCESSING

HARVESTING

Sal seeds are harvested and collected in second to third week of May. Strong wind or storm helps in bumper fall towards end of May. Forest dwellers get an opportunity and sufficient time to harvest the seed. In rural areas almost all men, women and children's from poor or marginal farmers engaged in harvesting the Sal seeds. Generally harvesting is done in forenoon because during this time there is apprehension for casual storm or rainfall in the afternoon (Grover *et al.*, 1985).

CLEANING AND GRADING

After harvesting, cleaning and grading is done by manually, to remove the foreign, unwanted, contaminated or insect attacked seeds. Cleaned seeds are graded based on size and quality parameters of the seed by manually. These two operations are the most important post-harvest operations, to increase the self-life and quality of the seeds (Sahay and Singh, 2004).

DRYING

Drying of agricultural products is an important unit operation under post-harvest operation. At the time of harvesting, Sal seed contains around 60 to 80% moisture. It is dried up to 8 to 10% moisture content (Rao *et al.*, 1971). The most common methods of Sal drying are by sun drying method. Drying process is carried out to minimize processing loss and storage loss. But this sundrying process is a time consuming process, low capacity, inefficient process and also it depended on sunlight. Hence there is a requirement of efficient low cost drying methods for the sal seeds in rural areas.

STORAGE

Storage is a crucial issue in the process of Sal kernel collection and shipment. The quality of Sal fat depends on

how the kernels have been processed and stored. Since in the month of May and June follows the Sal seed collection season, there is a risk that a high moisture content in the kernel increases the free fatty acid level, making it unfit for use in the food sector (Grover *et al.*, 1985). After drying, the primary collectors invariably store Sal seeds in their houses using gunny bags, at ambient room temperature (Sanjoy, 2015).

PROCESSING

Timely processing plays an important role in enhancing oil and other quality (Nasrallah *et al.*, 1981). The quality of oil increases if the kernel has minimum moisture content. Sal seeds are processed in two ways. In one process seeds are beaten on a plain hard ground area with a wooden stick to remove the wings. In this process the wings are separated from the seed kernel. This is the recommended process for manual collection since quality and nature of kernels remains unchanged.

In second process seeds are spread on plain dry hard ground area and putting a light fire to Sal seed. With the light fire the wings are burnt. The round seed kernel with shell and covers remain unhurt. This is a risky process, but easier for de-winged. Sometimes fire adversely affects seed and oil contents. In case of cloudy weather or pre-monsoon showers this is the only process for de-winged fruits. Other methods like Sal seeds are spread on hard ground area and pressed by a wooden roller or stone roller. During the process of rolling under pressure the kernels are come out from the whole seed. This can be separated by using natural air blowing or artificial air blower. After this process Sal seed kernels are kept in dry place to increase the quality of oil (Sanjoy, 2015).

Sanjoy (2015) was reported that, of late, it is being suggested that in order to collect a dry kernel, the seed should not be burn, as this affects the quality of the kernel and enhances the free fatty acid content, making it highly uncompetitive in the export market. Besides, another area of concern for Sal seed processing is the time taken between collection and shipment to factories for crushing. Oil quality is high if the gap between collection and crushing is kept to a minimum. The ideal gap is up to a maximum of 72 hours, to maintain a low free fat acid level. But normally the process of procurement and shipment to traders is so lengthy that the gap can be more than 4 or 5 months. There is no equipment's available for Sal seed decortication or

processing. Separation of Sal kernel from the whole seed, is done by manually, which is a labour intensive process, time consuming, low efficiency and it is also affect the health hazards.

SAL FAT OR OIL

The extracted crude Sal oil is greenish-brown colour and has a characteristic odour. Due to the presence of more saturated fatty acids, it is solid at room temperature. Because of this, it is known as Sal fat or Sal butter (Grover *et al.*, 1985). Sal fats were extracted by three methods. Traditionally, fat is determined by water rendering method. Secondly, in mechanical method, oil is extracted by oil expeller and rotary mills. In the third method, oil was extracted by solvent extraction, in which the Sal seeds are pressed as flacks first in a flaker mills and then exposed to solvent extraction. The oil contains 45-60% stearic acid, 18-carbon saturated fatty acid, and 35-50% of oleic acid, which is a mono unsaturated fatty acid, with 18 carbon atoms (Table II).

The extracted fat is used as cooking oil, after refining. And also refined oil is used as substitute for cocoa butter in chocolate manufacturing (Nasirullah *et al.*, 1982). Mishra, (1980) was reported that physicochemical properties, hydrolysis, vitamin contents and storage study of seed oil and its component of fatty acids compared well with those of other edible vegetable oils. Mishra, (1980) was reported that, it can be used for edible purposes and their studies showed a good digestibility, keeping quality and sensory properties (Table III).

Table II: Fatty acid composition of oil

Fatty acid	Percentage
Plamitic acid (C16:0)	2-8
Margaric acid (C17:0)	0-5.0
Stearic acid (C18:0)	45-60
Arachidic acid (C20:0)	0.5
Oleic acid (C18:1)	35-50
linoleic (C18:2)	0-8

Source: Nasirullah et al., 1982

Table III: Physical and chemical properties of Sal oil

Property	Range/limit
Appearance	White color solid
Odor	Characteristic odor
Taste	Typical taste

Specific gravity	0.88-0.914
Slip meting point	32.35° C
Peroxide value	4.0
Iodine value	35-41
Saponification value	187-193
Unsaponifiable matter	1.2% max
Refractive Index at 40 °C	1.4500-1.4600

Source: Nasirullah et al., 1982

APPLICATION OF SAL SEED OIL

Sal seed is an important industrial crop, widely available in central part of India. Due to lack of technology, low level processing and unsustainable harvesting methods it remains underutilization. It has a wider opportunity in confectionery and cosmetic industries and in international terms of trade reserving space for Sal oil in chocolate making (NTFP 2015: Geover *et al.*, 1985). Some important points on sal seed oil are highlighted below:

- Refined modified Sal seed oil is used for cooking.
- Sal fat is used in the manufacturing of edible ghee or Vanaspati.
- It is also used for soap manufacturing industries up to 30%.
- It is also used for paints, pigments, lubricant, and auto oil.
- Sal seed oil can also be used for production of bio gas and biodiesel (Saini *et al.*, 2006).
- The de-oiled seed cake is a cheap natural substrate for lipase production under submerged fermentation (Saini, *et al.*, 2013; Mahdi *et al.*, 2012).

OTHER USES OF SAL

- Fodder: Leaves, flowers and fruits are lopped for goats and sheep. Seed cake is also fed to cattle (Mukhopadhyay and Ray, 1997).
- Leaves: The dry leaves of Sal are a major source for the production of leaf plates called as patravali and leaf bowls in northern and eastern India (Patnaik and Mohaptra, 2013).
- Timber: The hardwood is dark brown colour, strong, and durable. It is used for house construction, naves and felloes of cartwheels, door and window frames.

- d) Erosion control: Sal has a large spreading superficial root system that holds soil together.
- e) Reclamation: Sal is planted on wasteland with hard lateritic soils in India.
- f) Soil improver: The seed cake has been used as fertilizer.
- g) Boundary or barrier or support: It is planted along the boundaries of fields.
- h) Intercropping: Sal plant can be raised with agricultural crops.

CONCLUSION

Shorea robusta or Sal is one of the most important oil yielding forest plants in India. It is a semi evergreen or deciduous tree, widely distributed in tropical regions of India. It is grown in forest and private lands. It is also an important industrial crop having industrial uses. It is mainly cultivated for Sal seed and its oil. Sal seed contain 34.6% fat, 8.45% moisture and 6% ash. Sal oil is also known as Sal butter. It is solid at room temperature, due to the presence of more unsaturated fatty acids. It is used as cooking oil after refining. Sal fat is used in the confectionery industries, for processing and production of vanaspati and ghee. Also, sal fat is used as a primary ingredient in the pharmaceuticals and cosmetic sector, for manufacturing of medicine. Sal seed oil can also be used economically for production of bio gas and biodiesel. Due to the lower value and lack of technology for Sal seed decortication or processing, it remains underutilized largely and hence it is available at a very cheap cost.

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