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Rubber Seed: Its Biological and Industrial Applications - A Review

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Rubber seeds are utilised primarily for raising root stock for the propagation of high yielding varieties through budding. Seeds collected from well maintained polyclonal garden are recommended as planting material especially in non-traditional rubber growing areas. Seed morphological characters are unique for clones and hence assume taxonomic significance. Oil and cake obtained from the rubber seed have commercial importance. Products derived from rubber seed oil (RSO) are used in paint industry, for factice, for soft soap, in medicine as antimalarial oil, and in engineering as core binders. The study on the diesel engine performance test with RSO has been reported. Rubber seed cake has nutritive value and is being used in cattle and poultry feeds. Seed cake can also be used as good manure. The edibility of rubber seed has also been mentioned.

Keywords: *Clone identification,* Hevea brasiliensis, *industrial applications, propagation, rubber seed*

Hevea brasiliensis, the most important source of natural rubber is being cultivated on a very extensive scale in many tropical countries. Among the four resources obtained from rubber plantations (latex, wood, seed and honey) seeds have greater potential use (Potty, 1980; Haridasan, 1992; Thomas *et al.*, 1996). In the early phase of rubber cultivation, propagation of the crop was through seeds only. However, nowadays major part of the seed produced annually is used for raising root stock materials for the multiplication of established varieties and the remaining as industrial raw material for oil extraction (Udomaskdhi *et al.*, 1974; Uzu *et al.*, 1986) or just not utilised. Though rubber seeds have wide range of applications, compiled literature on this aspect is meagre. The present attempt is to compile the available information on various applications of rubber seed.

BIOLOGICAL APPLICATIONS

The quality of the seed can be assured by its proper collection and timely utilisation. Seeds should be collected soon after seed fall because the viability of the seed is retained only for a short period of one week, and deterioration of the seed may happen due to the attack of microorganisms. Thomas *et al.* (1996) had reviewed different methods to prolong the viability of the seed. Seeds with good quality are used for plant multiplication and identification of clones.

Plant multiplication

Rubber seeds are used to generate root stock for the vegetative multiplication of proven clones. The seeds for this purpose are usually collected from commercial plantations whereas the seeds for the establishment of seedling plants must be

obtained from a well maintained and properly established seed garden (Dijkman, 1951; Tan, 1987; Webster, 1989). Polyclonal hybrid seeds of proved parents are used to exploit their inherent vigour and moderately high yielding characters and is being predominantly used in non-traditional rubber growing areas. They are hardier than vegetatively propagated clones and their establishment is easier. Polyclonal seeds from Prang Besar Isolation Garden (PBIG) *viz.* Gough Garden series GG1-GG7, were earlier imported and widely used as planting materials even in India in the 1950s and 1960s. Monoclonal seeds especially that of clone Tjir 1, were also once used. At present monoclonal seeds are no longer recommended for planting, due to their inferior qualities compared to the modern clones.

In a well established polyclonal seed garden several clones are planted intermixed in such a way that trees of each clone are surrounded by trees of other clones so as to favour cross pollination. Clones planted in the garden are selected on the basis of several desirable characters such as high yield, disease resistance, vigour and ability to produce good seedling families. Synchronised flowering is also important for profuse production of seeds (Mydin, 1990; Varghese, 1992). Production of seeds from a garden varies widely due to various factors such as variation shown by different clones, their seed production capacity, influence of climate, incidence of disease *etc.* However, an average of 60 000 seeds per hectare per year can be expected from a well maintained garden. The Rubber Research Institute of India has established polyclonal seeds gardens in Kanyakumari District - the main seed production centre in collaboration with different estates. This location was particularly selected due to the low incidence of diseases, leading to the production of more number of viable seeds. Seedlings are not comparable with high yielding clones in production potential. However, superior polyclonal seedlings have special agricultural merits in maintaining genetic variability of the population, which serve as gene reservoirs and source materials for development of high yielding mother trees. These materials can also be utilised as base materials for selective breeding.

Significance in clone identification

Seeds of *Hevea* clones show variation with respect to its seed size, shape, colour markings and weight. The seeds are large measuring 2-4 cm x 1.5-3 cm, ovoid, slightly compressed and dorsiventral. The weight of the seed ranges from 4-6 g. The seed coat testa is smooth, rough or shiny and greyish brown with irregular dark brown and grey dots, lines or blotches.

Even though the shape, size and markings of the seed vary between clones, the variation are not marked within the clones (Mercykutty *et al.*, 1991). The seeds from a single mother plant or clone are similar in appearance because the seed coat is derived from the mother parent, which is the most reliable method for identifying a particular clone (Sprecher, 1915; Saraswathyamma *et al.*, 1981; Jayasekhara *et al.*, 1984; Rubber Research Institute of Malaysia, 1990; Mercykutty *et al.*, 1991). The size and shape of the seed from a single mother tree vary occasionally, if they have an abnormal number of seeds (Rubber Research Institute of Malaysia, 1974). Sprecher (1915) has suggested a method for the identification of clones based on the mottlings of the raphae and micropyle. For a standard seed sample

collection, a minimum of 20 seeds are sufficient from each lot of a particular clone. This standard seeds sample can be dried in desiccating ovens and stored in bottles with ground glass with Para-dichlorobenzene added as preservative.

INDUSTRIAL UTILISATION

British industrialists were the pioneers in rubber seed processing (Anonymous, 1903). A shipment of 269 049 kg of the seed was received in the United Kingdom from British Malaya for crushing. Commercial evaluation of the rubber seed, oil and cake was done and it was found that these materials have great industrial implications. In South East Asia, this line of approach was initiated only after the middle of 20th century.

Fresh seeds should be collected soon after they fall from the mother tree. If collection is delayed, the fat splitting enzyme present in the kernel makes the oil rancid. In order to avoid this, seeds should be roasted at 60°C immediately after collection in order to disintegrate the fat splitting enzymes.

The processing methods available for obtaining rubber seed oil are solvent extraction, expression and rendering. A combination of expression and solvent extraction was recommended by Uzu *et al.* (1986) for a better oil recovery. Cant (1930) had reported the method of rubber seed oil (RSO) extraction in India. Using a crushing machine, the seed was made into powder and then the oil separated by steam treatment.

In India there exists some misinterpretation that RSO contains poisonous substances and its processing would pollute the neighbourhood. Because of this the municipal authorities had prevented the processing of rubber seed in two towns in South India. Around 1965 the Khadi and Village Industrial Commission of India took the initiative in the processing of rubber seed. Even though the major source of seed is from Kerala, the industry is concentrated mainly in Virudhunagar in Tamil Nadu. These mills were originally set up for groundnut processing. During their off season *i.e.* July-September months, which is the rubber seed fall season in India, these millers can shift and process the rubber seed. Another advantage is the favourable dry climate for drying the seeds prior to processing, and availability of labourers at a cheaper wage. All these favourable factors have encouraged the establishment of rubber seed processing in Tamil Nadu. Usually the rotary machine is used for oil extraction.

Characteristics and composition of rubber seed varies with place and clone (Azeemoddin & Thirumala Rao, 1962). Fresh seed contains about 65 per cent kernel and 35 per cent shell (Nadarajapillai & Wijewantha, 1967). Chemical analysis of the kernel showed that it contains about 43 per cent oil. RSO is light yellow coloured semi-drying oil with the following chemical properties:

Acid value	4-40
Saponification value	190-195
Iodine value	132-141
Hydroxyl value	12-32
Unsaponification (%)	0.5-1.0
Refractive index 40°C	1.46
Specific gravity	0.924-0.930
Titra (0°C)	28-32

Uses of rubber seed oil

There are various industrial applications for RSO. The oil is used to produce a material known as factice, which finds use in rubber compounds (Vijayagopalan, 1971). Since the

price of the factice depends upon the type of the oil used, RSO may be an ideal substrate in order to produce factice economically. Vijayagopalan and Gopalakrishnan (1971) had reported the epoxidation of RSO with H_2O_2 and acetic acid. Epoxidised oil is used in the formation of anti-corrosive coatings, adhesives and alkyd resin coating (Aigbodion, 1994).

The oil is similar to linseed oil and can partly replace linseed oil in industrial process. The use of the oil in a 25/75 blend with linseed oil indicated promise for manufacturing alkyd resins. Appropriately treated seed oil could be used for the manufacture of adhesives, artificial leather, impregnating compositions for textiles and other materials (Uzu *et al.*, 1986), and also for the manufacture of liquid soap. RSO is excellent as a semi drying oil in paint industry for the production of linoleum, for soft soap, in medicine as antimalarial oil and in engineering as core binders (Green & Leaper, 1933; Anonymous, 1950; Njoku & Onongobu, 1995). RSO is effective against houseflies and lice (Alam *et al.*, 1982).

Perera and Dunn (1990) have carried out the diesel engine performance test with RSO. They have used a single cylinder, four stroke, air cooled, naturally aspirated petter engine, giving 4.9 KW at 3 600 r p m and found that RSO has fuel properties very similar to other vegetable oils. The fuel properties of methyl ester of RSO (MRSO) were found to be much more closer to those of diesel oil. More research is needed in this field to enable the use of RSO as fuel in diesel engines, which may be a solution for the current fuel problems. In India, RSO is being used as energy source for firing rockets (Ogowewo, 1986).

RSO is cheaper and also easily miscible with coconut oil. It was suspected widely during the 80s that RSO was being used for adulterating coconut oil in India. In Tamil Nadu, during the 60s RSO was used for lighting oil lamps for evening worship.

Rubber seed cake

Another by-product of the rubber seed is the seed cake. About 70 per cent by weight of the milled kernel is left as seed cake. It has been mentioned that rubber seed cake was marketed in the United Kingdom as dairy cattle feed since the 1930s. Rubber seed meal (RSM) was found to be rich in protein (29%), carbohydrates (56%) and minerals (3%) and calcium (1.14%) which make it a suitable material for formulation of livestock diets.

In Sri Lanka, use of 25 per cent RSM was found to be a satisfactory substitute for coconut cake in broiler feeds (Onuwaje & Imoukhuede, 1986). About 50 per cent RSM fed porkers showed good performance for weight gain and carcass quality.

In order to improve the nutritional level of the seed cake it was subjected to either autoclaving or fermentation (Narahari & Kothandaraman, 1984). Fermentation successfully reduced both HCN and tannin levels in the products and this could overcome some of the problems noted. Occurrence of tannin may reduce the digestibility of the feed. The cattle relish the cake because of its sweetness. Increasing levels of the rubber seed meal in the maternal diets caused an increase in embryonic mortality in poultry and pigs (Buvanendran, 1971; Nadarajah *et al.*, 1973; Rajaguru, 1973).

Rubber seed cake is rich in nitrogen content hence it can also be used as a good manure (Nadarajah *et al.*, 1973).

Rubber seed shell

About 34 per cent weight of the rubber

seed is the shell. Nadarajah (1969) opined the possibility of using rubber seed shell flour as a filler in the plastic industry, but this has not been followed up.

Edibility of the seed

Hevea seed contains the cyanogenetic glycoside linamarin, which on hydrolysis yields highly toxic hydrogen cyanide (HCN). Because of the toxicity, oil and cake of rubber seed can be utilised as food to livestock only to a limited extent. The toxicity of the seed can be brought down to a non-lethal level either by roasting or soaking the seed in water for a period of time. Roasting of the seeds at 105°C can reduce the cyanide content from 4.774 to 0.145 µg per gram.

Wheeler (1982) mentioned the edibility of the seed of *Hevea*. During World War II, the prisoners of war in Java ate seeds of *Hevea* with no preparation other than roasting them on fire. He also mentioned another method of preparation as follows: the seeds are first deprived of the testa and then cooked till they have become quite soft. After being washed well they are steeped in floating water for two to three days. Then the stuff covered with banana leaves, is placed for two days in a cool place indoors. Only then the danger of poisoning can be averted. An alternate method is to soak the seeds for 24 hours in an excess of water. Several changes of water should be given within this time so that the poisoning material leaches out. The seeds should then be boiled in an uncovered vessel for half an hour. The material could then be used for different delicious preparations.

Tribals of Nigeria and Amazonia use the rubber seed to prepare a paste which is added to the soups for better viscosity (Baldwin, 1949).

The seed of para rubber tree is a potential source of raw material both in plantation and industrial sectors. The rubber seed production is not stable every year, *i.e.* the quantity of the seed available will be greater if there is no severe attack of *Oidium* and *Phytophthora*. Annual average rubber seed production in India, Nigeria and Malaysia is 150, 100 and 65 kg per hectare respectively. Perera and Dunn (1990) had reported that approximately 130 000 tonnes of rubber seed oil and 200 000 tonnes of rubber seed cake may be available annually from rubber plantations in the world.

The collection of rubber seed is not a tedious process. The price of rubber seed and RSO per kg is rupees 2 and 22 respectively in India. If adequate attention is given for its collection and processing, it will form an additional source of revenue to the farmer.

In research point of view, detailed investigations on the scope of RSO are essential since it seems very promising as a source of vegetable oil for both domestic and industrial use.

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REFERENCES

AIGBODION, A I (1994) Effect of storage of seeds on quality of rubber seed oil. *Indian Journal of Natural Rubber Research*, **7**: 141-143.

ALAM, M N; FARUQ, M O; HOSSAIN, M E & ALAM, M S (1982) Investigations on rubber seed oil. *Bangladesh Journal of Science and Industrial Research*, **17**: 200-204.

ANONYMOUS (1903) The commercial utilisation of the seeds of the para rubber tree (*Hevea brasiliensis*). *Bulletin Imperial Institute*, **1**: 156-

159.

ANONYMOUS (1950) Drying oils for the paint industry. *Board of Trade Journal*, **159**: 771-773.

AZEEMODDIN, G & THIRUMALA RAO, S D (1962) Rubber seed and oil. *Rubber Board Bulletin*, **6**: 59-68.

BALDWIN, J T, JR (1949) Loss of oil from *Hevea* seed. A variation having phyletic and economic implications. *Journal of Heredity*, **40**: 47-49.

BUVANENDRAN, V (1971) Effect of rubber seed meal on hatchability. *Tropical Agriculture*, **77**: 111-115.

CANT, F, VAN (1930) Oil from rubber seed. India Rubber Wild. pp. 91.

DIJKMAN, M J (1951) Hevea: *Thirty Years of Research in the Far East*. University of Miami Press, Florida.

GREEN, L W & LEAPER, J M F (1933) Pure rubber seed oil as a substitute for linseed oil in foundry core binders. *Chemical Abstracts*, **27**: 1957.

HARIDASAN, V (1992) Ancillary income from rubber plantations. In: *Natural Rubber: Biology, Cultivation and Technology* (M R Sethuraj & N M Mathew, eds). Amsterdam: Elsevier Scientific Publishers. pp 561-567.

JAYASEKERA, N E M; FERNANDO, D M & KARUNASEKARA, K B A (1984) Identification of clones. In *A Practical Guide to Rubber Planting and Processing* (A de S Liyanage & O S Peries, eds). Sri Lanka: Rubber Research Institute of Sri Lanka.

MERCYKUTTY, V C; VARGHESE, Y A; LICY, J & PANIKKAR, A O N (1991) Juvenile characters and seed morphology of certain modern *Hevea* clones. *Indian Journal of Natural Rubber Research*, **4**: 16-25.

MYDIN, K K (1990) Polyclonal seed gardens: Their role in rubber improvement and production. *Rubber Board Bulletin*, **29**: 3-4.

NADARAJAH, M (1969) Collection and utilisation of rubber seed in Ceylon. *R R I C Bulletin*, **4**: 23-32.

NADARAJAH, M; ABEYASINJHE, A; DAYARATNE, W C & THARMALINGAM, R (1973) The potentialities of rubber seed collection and its utilisation in Sri Lanka. *Bulletin of Rubber Research Institute of Sri Lanka*, **8**: 9-21.

NADARAJAPILLAI, N & WIJEWANTHA, R T (1967) Productivity potentials of rubber seed. *R R I C Bulletin*, **2**: 8-17.

NARAHARI, D & KOTHANDARAMAN, P (1984) Chemical composition and nutritional value of para-rubber tree seed and its products for chickens. *Animal Feed Science and Technology*, **10**: 257-267.

NJOKU, O U & ONONGOBU, I C (1995) Alkyd resin from rubber seed oil. *Indian Journal of Natural Rubber Research*, **8**: 63-65.

OGOWEWO, N (1986) Marketing strategies for rubber seed oil and cake. In *Industrial Utilisation of Natural Rubber* (Hevea brasiliensis) *Seed, Latex and Wood* (E E Enabor, ed). Rubber Research Institute of Nigeria, Benin City.

ONUWAJE, O U & IMOUKHUEDE, S K (1986) Rubber (*Hevea brasiliensis*) seed meal: a potential material for livestock diets in Nigeria. In *Industrial Utilisation of Natural Rubber* (Hevea brasiliensis) *Seed, Latex and Wood* (E E Enabor, ed). Rubber Research Institute of Nigeria, Benin City.

PERERA, E D I H & DUNN, P D (1990) Use of vegetable oils as fuels for diesel engines with specific reference to rubber seed oil. *Journal of the Rubber Research Institute of Sri Lanka*, **70**: 11-25.

POTTY, S N (1980) Nursery establishment and field planting. In *Handbook of Natural Rubber Production in India* (P N Radhakrishna Pillay, ed). Kottayam, India: Rubber Research Institute of India. pp. 113-131.

RAJAGURU, A S B (1973) Effects of rubber seed meals on the performance of mature chicken. *Bulletin of Rubber Research Institute of Sri Lanka*, **8**: 39-45.

RUBBER RESEARCH INSTITUTE OF MALAYSIA (1974) Collecting, handling and planting of propagation materials of para rubber, *Hevea brasiliensis*. *Planters' Bulletin*, **132**: 98-103.

RUBBER RESEARCH INSTITUTE OF MALAYSIA (1990) *Hevea* seed: Its characteristics, collection and germination. *Planters' Bulletin*, **202**: 3-8.

SARASWATHYAMMA, C K; MARKOSE, V C & PANIKKAR, A O N (1981) Studies on fruit characteristics of *Hevea*. In *Proceedings of the Fourth Annual Symposium on Plantation Crops: Genetics, Plant Breeding and Horticulture*. PLACROSYM IV, Mysore, India.

SPRECHER, A (1915) Same und Keimung von *Hevea brasiliensis*. *Bull Jard Bot Buitenz. XIX*.

TAN, H (1987) Strategies in rubber tree breeding. In *Improving Vegetatively Propagated Crops* (A J Abbot & R K Atkin, eds). London: Academic Press.

THOMAS, V; MERCYKUTTY, V C &

SARASWATHYAMMA, C K (1996) Seed biology of para rubber tree (*Hevea brasiliensis* Mell. Arg., Euphorbiaceae) - A Review. *Phytomorphology*, **46**: 335-342.

UDOMSAKDHI, B; MUNSAKUL, S & STHAPITANONDA, K (1974) Potential value of rubber seed. *Thai Journal of Agricultural Science*, **7**: 259-271.

UZU, F O; IHENYEN, G A; CHUKWUMA, F & IMOEBE, S O (1986) Processing, analysis and utilisation of rubber (*Hevea brasiliensis*) seed oil and cake. In *Industrial Utilisation of Natural Rubber* (Hevea brasiliensis) *Seed, Latex and Wood* (E E Enabor, ed). Rubber Research Institute of Nigeria, Benin City.

VARGHESE, Y A (1992) Germplasm resources and genetic improvement. In *Natural Rubber: Biology, Cultivation and Technology* (M R Sethuraj & N M Mathew, eds). Amsterdam: Elsevier Publishers. pp. 88-115.

VIJAYAGOPALAN, K (1971) Factice from rubber seed oil. *Rubber Board Bulletin*, **11**: 48-51.

VIJAYAGOPALAN, K & GOPALAKRISHNAN, K S (1971) Epoxidation of rubber seed oil. *Rubber Board Bulletin*, **11**: 52-54.

WEBSTER, C C (1989) Preparation of land for planting and replanting. In *Rubber* (C C Webster & W J Baulkwill, eds). England: Longman Scientific and Technical.

WHEELER, L C (1982) Rubber seed as food. *The Planter*, **58** (676): 317-321.

Strange Mango Flowers

The below was received from Mr Vincent Pang who wishes to share it with others and perhaps get some feedback from someone who has some idea about the flowers. The Chinese name of the mango is "Siam Mong" or "Siam Panjang" In Malay. The mangoes remained in that position for about 2 months.