International Scholars Journals

African Journal of Agricultural Marketing ISSN 2375-1061 Vol. 4 (10), pp. 001-005, October, 2016. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Rubber seed processing for value -added latex production in Nigeria

A. F. Iyayi*, P. O. Akpaka and U. Ukpeoyibo

Rubber Seed Oil Processing Division, Rubber Research Institute of Nigeria, P.M.B 1049, Benin City, Nigeria.

Accepted 24 July, 2016

Little or no attention has been paid to the seeds produced by the rubber tree (*Hevea brasiliensis)* unknown that it contains valuable oil which has potential industrial application in the production of soap, cosmetics, paints, glazing putty. Not much is known about the method of processing of the seeds from which the oil is derived. In this article, the processing stages for the seeds are presented and discussed. Possible problems that could be encountered during processing and the solutions are offered. It is anticipated that the added value of rubber seed processing would help raise and diversify sources of income for rubber tree farmers with a view to alleviating poverty in Nigeria.

Key words: Rubber seed, milled seeds, processing stages, extraction, Nigeria.

INTRODUCTION

The rubber tree (*Hevea brasiliensis)* is a tree crop that has long been commercialized for its latex production. Little or no attention has been given to the production and utilization of its seed in Nigeria (Hosen et al., 1981). Large quantity of rubber seeds abound in the country. A survey (Nwankwo et al., 1985) has shown that about 42,980 metric tons of the seeds could be produced annually in the country. However, the amount of the seed that could be produced in any year is influenced by factors such as powdery mildew disease, abnormal leaf disease, phytophora disease, genetic and weather (George and Kuruvilla, 2000; UNIDO, 1987).

The rubber seed usually matures and dehisces from the seed pod during the short dry period between August and September in the rubber belt in southern Nigeria. The weight of fresh rubber seed varies from 3 to 5 g of which about 40 percent is kernel, 35% shell and 25% moisture. The oil content in dried kernel varies from 35 to 45% (George and Kuruvilla, 2000; Nadarajapillai and Wijewantha, 1967).

Two products are obtainable from rubber seeds and they are the oil and the cake. The oil is semi-drying, yellowish and consists of 17 – 22% saturated fatty acids and 17 – 82% unsaturated fatty acids (George and Kuruvilla, 2000). The oil at the moment is not used for any edible purpose. It has characteristics that are similar to that of linseed oil and as such it could be used as partial replacement of imported linseed oil in some non-edible applications.

Studies have shown that rubber seed oil (RSO) has many areas of potential applications amongst which are: as lubricant (Njoku and Ononogbu, 1995), as printing ink, foaming agent in latex foam (Reethamma et al., 2005), fatice (Vijayagopalan, 1971; Fernando, 1971), biodiesel (Perera and Dunn, 1990; Ikwuagwu et al., 2000), paints and coatings (Aigbodion et al., 2003) and others (Iyayi et al., 2007). The seed cake has potential application in the formulation of livestock feeds and as nitrogenous fertilizer (Amritkumar et al., 1985; Nadrajah et al., 1973).

If the potentials of the rubber seeds as indicated above are to be realized, the seeds have to be processed and as such the knowledge of the process is paramount. The objective of this article therefore, is to present and discuss the series of operations necessary to transform rubber seeds into RSO and the seed cake based on our experience with a small scale mechanical oil screw press at our Research Station, Rubber Research Institute of Nigeria (RRIN).

Process description

The two common methods for vegetable oil extraction

*Corresponding author. E-mail: philipview05@yahoo.com

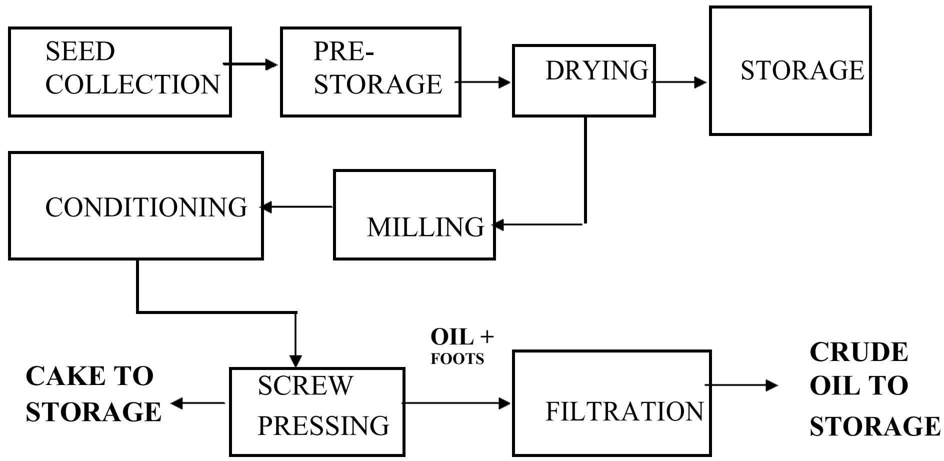

Figure1. Flowchart for rubber seed processing.

are: Solvent and Mechanical extraction. Solvent method of extraction uses a solvent such as hexane. It is highly inflammable and as such it is susceptible to fire-out break during its use. It also requires highly skilled personnel to operate the process and the initial capital investment is high. On the other hand the mechanical method of extraction which is used at RRIN on a batch scale is safer, initial capital investment is low, it does not require much skill to operate and is suitable for small scale use. In view of the above, the mechanical process of RSO extraction is discussed in this work.

The processing stages consist of seed collection, pre-storage, drying, storage, milling, conditioning, screw pressing and filtration as shown in the flowchart in Figure 1

Seed collection

The rubber trees produce the seeds much earlier before they are mature for tapping. From our experience at RRIN, rubber seed production occurs once a year. The seeds are harvested between the months of July and September. This is the pattern in southern Nigeria where rubber is grown.

The cost of collection of the seeds is critical to the availability of the seeds. This is in turn tied to two other factors such as rainfall and overgrown weeds during the collection season. Past experience has shown that whenever there is rainfall during this period, the seed pods will not dehisce to release the seeds. They grow mould and deteriorate rapidly. Sunshine is critical to the drying of the pods in order for them to dehisce and release the seeds. Overgrown weeds in the rubber plantation makes seed collection difficult as most of the seeds hide under the cover of the weeds. This causes collection delay and when seeds are not collected early enough, they pick up moisture and deteriorate. Otoide and Begho (1986) reported moisture content as high as 29.7% in collected seeds. High moisture content promotes rapid deterioration of the seeds by micro-organisms (Okhuoya and Ige, 1986).

In view of the above, early collection of rubber seeds is recommended. UNIDO report (1987) and Aniamaka and Uriah (1990) suggested that the seeds should be collected as soon as they drop from the trees and the collection repeated at least every fourth day.

The quantity of collectable seeds could be increased if the rubber plantations are clean-weeded and old seeds from previous seed season removed from plantation prior to seed collection season so that seeds could easily be spotted and collected (RRIN, 1989). The decay of the seed pods on the trees due to rainfall is unavoidable. However, a possible approach to overcome this would be the direct harvesting of the pods while still on the trees and drying them to release the seeds. This proposition is unfortunately not feasible now due to the height of the rubber trees and the labour cost for the exercise.

Pre-storage

A greater proportion of rubber seeds deterioration occurs in storage. However, strict adherence to proper handling methods in early post-harvest operations have been observed at RRIN to greatly reduce deterioration.

As soon as seeds are collected and transported from the plantation, they should be removed from the bags, cleaned, sorted, spread out for aeration if artificial drying cannot be done immediately. This allows for natural drying and an appreciable drop in moisture content. Otoide and Begho (1986) have reported a drop in moisture content of 8.4% from an initial content of 29.7% of whole seed after two months exposure on bare floor. Occasional turning of the seed if heaped in thick layers help to expose underlying layers to air.

During sorting of the seeds, weeds, broken tree branches, green leaves and sand are removed. These are reservoir of moisture which can accelerate spontaneous heating up of the seed layer where they are located (Spencer, 1976). The use of cleaning equipment such as vibrating screens or shaker-type combined with aspirator helps to remove these foreign bodies.

Fresh rubber seeds and its kernel contain about 638 and 749 mg of hydrogen cyanide (HCN) per kg (George and Kuruvilla, 2000). Storage at room temperature for a minimum period of two months is effective in reducing the hydrogen cyanide (HCN) content of rubber seed (Narahari and Kothandaraman, 1983).

Drying

The moisture content of rubber seed at the time of collection is usually high in the range of 20 - 25% (UNIDO, 1987). Drying halts the activity of the fat splitting enzymes and reduces lipase activity in the seed (RRIM, 1975; Ihekoroge and Ngoddy, 1985). Past experience has shown that there is little increase in free fatty acid (ffa) of oil extracted from properly dried seeds. It has been reported (Anon, 1975; Nadarajah et al., 1973) that increase in ffa of stored seeds can be effectively checked if seeds are heat-treated before being stored. Drying also greatly reduces the cyanide content of rubber seeds to innocuous level (Uzu et al., 1986). This is an important consideration in the utilization of rubber seed in livestock industry. Drying facilitates shrinking of kernel from the wall of the seed and make decortication easier.

Air-drying is fairly effective only for short-term storage of relatively small quantities of rubber seeds, especially if they are free of moulds and insects at the time of collection. For long-term storage, a safe moisture content of less than 5% (UNIDO, 1987) is desirable. At RRIN, drying of rubber seed is carried out (usually for a period of 12 h) by using hot air (60 – 70^{o}C) in a batch dryer of 500 kg capacity. Above this temperature range, the seed may become brittle and the colour of the seed and oil extracted from it darken (Igeleke, 1990).

Seed storage

After the drying process, the rubber seeds are either processed immediately or stored. The preferred bags for storing rubber seed is matted polypropylene bags (Otoide and Begho, 1986). They are easily available but has the disadvantage of being prone to insect attack. This is because insects can easily pass through the tiny space in the mat. Whole seeds store better than kernels (Igeleke and Ekpebor, 1986; Otoide and Begho, 1986) as the kernels are more easily attacked by insects than the whole seeds. Whole seeds are therefore considered for long-term storage. However, insects and pests are still able to attack the seeds after a few months in storage. In RRIN, we have observed that 80% of seeds lost are caused by these pests. Preventive measure against insect attack includes covering ventilation points with insect net and disinfecting the ware house before seeds are received for storage. Additionally, periodic cleaning and inspection of the warehouse reduce the level of pest attack. Observance of this storage process at RRIN has resulted in successful bulk storage of rubber seeds for a year.

Milling

Milling is done to reduce the size of the seeds. This helps to rupture a substantial percentage of the oil cell walls of the seeds (Bredeson, 1978). The mill is equipped with hammers which breakdown the seeds and reduce the size of the rubber seed to about a quarter of its original size. The kernels and shells are mixed together at the end of the milling operation, a situation which offers a special advantage in the downstream processing.

Conditioning

The objective of conditioning (or scorching) is to ease oil extraction. The milled seeds (meal) are conditioned by scorching in a gas heated rotary dryer for 10 – 20 min at a temperature of 60 – 70^{o}C. This insures that the actions of the enzymes that increase free fatty acid (ffa) of the oil are stopped and rupturing of the oil cell walls is completed. It also lowers the viscosity of the oil to be extracted. At temperature higher than the range given above, the colour of the meal may turn brown which is undesirable (Igeleke, 1990).

Screw pressing

This is the heart of rubber seed processing. The conditioned meal with about 3% moisture is feed into a continuous screw press. At RRIN, we have obtained an oil yield of 65 and 15% in the press cake using a locally fabricated screw press fed with whole seeds.

The screw press consists essentially of a motor driven screw which rotates in a perforated metal cage. As the screw turns, it grinds and pushes the meal along the cage against a narrow outlet, the ‘choke’. This action exerts considerable pressure on the meal and squeezes oil out of it and exit through the perforation in the cage. The residue, (press cake) exit from an orifice at the end of the screw press. The orifice, the exit point for the press cake is adjusted with a choke ring which also varies the pressure inside the press cake and hence the oil yield.

The production rate of the screw press depends on the size of the equipment, the speed of the screw and the setting of the choke ring (James and Synder, 1985). Screw presses have a number of different designs to accomplish a desired task (Dunning, 1956).

Whole seeds are most suitable for screw pressing than the kernels. Whole seed has higher coefficient of friction

Table 1. Main constituents of Rubber Seed cake (UNIDO, 1987).

Constituent	(wt %)
Moisture	9.1
Residual oil	6.2
Carbohydrate	19.9
Protein	30.0
Ash	6.5
Fibre	8.0

which is essential for oil yield whereas the kernel is fluffy and has low shear strength like groundnut (Ward, 1976) which would require a long shaft and low shaft speed. This low shear strength could also cause jamming of the meal inside the press cage (UNIDO, 1987). However, the screw pressing of the whole seed has some disadvantages as we have observed in our mill:

- A limit is placed on the amount of oil that could be extracted. The reason being that on application of pressure, some of the oil that would have been expelled are sealed up in between the seed shells within the cake
- The capacity of the press is reduced by inclusion of the shell of the whole seed.
- The shell increases wear on the screw.
- A lot of heat is generated during screw pressing and this affects the colour of the oil produced.
- It may not be possible to produce very good meal for the feed mill industry.

Filtration

This is the last stage in rubber seed processing. The oil produced with the screw press is usually accompanied with considerable amount of “foots”. The filter press is used to remove the “foots” to obtain a clean oil. The slimy nature of the rubber seed “foots” causes the pores of the filter medium to plug easily. Therefore, the filter medium is usually removed and cleaned before it is used again and this takes time. Furthermore, it is difficult to filter rubber seed oil that is cold due to the high viscosity of the oil. Plugging of the filter medium can be reduced with the use of a pre-coat on the medium and heating up ($35^{O}C$) prior to filtration.

Storage of RSO

Rubber seed oil is poly-unsaturated oil (UNIDO, 1987). The fresh oil rubber seed oil contains some free fatty acids. During storage, these acids may increase rapidly and produce unpleasant odour or taste thereby reducing the acceptability of the oil. The factors that affect oil degradation are light, air, temperature, heavy metals, natural oxidative enzymes, pro-oxidants present in the oil; and the degree of unsaturation of the oil (Okoye, 1985; Okoye and Akpobi, 1978, 1982). It has been shown that light and air play primary roles in the degradation of rubber seed oil (Okoye, 1985). To obtain a shelf life of several months, the oil should be stored in light proof, air-tight and moisture-proof containers. Polypropylene type of plastic containers are suitable when properly sealed.

Storage of rubber seed cake

After the extraction of oil from the seeds, the residue left is called the seed cake. Rubber seed cake is rich in protein as indicated in Table 1. It has been evaluated as a source for cattle and poultry feeds (Amritkumar et al., 1985, Nadrajah et al., 1973). The heat generated in course of extracting the oil from seeds is enough to render the hydrogen cyanide (HCN) present in the cake harmless (Uzu et al., 1986).

For the effective storage of rubber seed cake:

It should be sufficiently dry; possibly it could be in pellet form.
It should be packed in 25 – 50 kg polypropylene matted bags.

Fumigation can be done by inserting one phostoxin tablet in an envelope placed in a 25 kg bag. Phostoxin is one of the recommended insecticides for food storage (Agboola, 1992).

Conclusion

Part of the reason for the lack of enthusiasm for rubber seed processing in Nigeria is ascribed to limited knowledge of the production process. In an attempt to address this constraint this paper has reviewed the technology used in the extraction of rubber seed oil and production of rubber seed cake. The likely problems that would arise at each stage of processing were highlighted and solutions that would enhance the quality of the oil and cake were provided. It is anticipated that this information could motivate the establishment of processing units in impoverished rural areas of Nigeria where the rubber seeds are produced. This in turn, is expected to generate employment for youths, slow down rural to urban migration, provide additional source of income to farmers as well as be a boost to the rubber industry in the country.

REFERENCES

Aigbodion AI, Okieimen FE, Ikhuoria EU, Bakare IO, Obazee EO (2003) Rubber seed oil modified with maleic Anhydride and Fumaric Acid and their Alkyd Resins as Binders in water-Reducible coatings. J. Polym. Sci. 89: 3256 – 3259.

Amritkumar MN, Sundaresan K, Sampath SR (1985). Effect of replacing cotton seed cake by rubber seed cake in concentrate of cows on yield and composition of milk. Indian J. of Anim. Sci. 55(12):1064 – 1070.

Annual Report of Rubber Research Institute of Malaysia (1975). p.160.

Aniamaka EE, Uraih OBC (1990). Collection of preparation of rubber (Hevea brasiliensis) seeds for seedling production In: Proceedings of a National Workshop on Fruit/tree production. NAERLS Zaria, pp. 75-79.

Bredeson DK (1978). Mechanical Extraction. J. Am. Oil Chemist Soc. 55: 762 – 764

George KT, Reghu CP, Nehru CR (2000). By products and ancillary source of income. In: Natural Rubber Agromanagement and crop Processing (Ed. PJ George and C. Kuruvilla Jacob), Rubber Research Institute of India, Kottayam. pp. 509-520.

Dunning JW (1956). Unit Operations in a Mechanical Extraction Mill. J. Amer. Oil Chemist Soc.33: 462.

Fernando MRN (1971). Manufacture of dark Factice from Rubber Seed oil. J. Rubb. Res. Inst. Ceylon. 47: 59- 64

George TK, Reghu CP, Nehru Igeleke GL (1990). Effect of temperature on the storability of Rubber (Hevea brasiliensis) seeds. Nigeria J. of Horticultural Sci. 1 No 1: 27-30.

Igeleke GL (1986), Ekpebor SMC (1986). Fungal Species associated with deterioration of rubber seeds during storage. In: E.E Enabor (ed) Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood: RRIN Benin City. pp. 135-145.

Hosen SBM, Chin HF, Hor YL (1981). Fruit and Seed Development in *Hevea* (clone RRIM600) in Malaysia. Journal of Rubber Research Institute of Malaysia. 32(1), 101 – 110.

Igeleke GL (1990). Effect of temperature on the storability of Rubber (Hevea brasiliensis) seeds. Nigeria J of Horticultural Sci. 1 No 1: 27-30.

Ihekoronye AI, Ngoddy PO (1985). Integgrated food science and technology for the tropics. Macmillan Publishers, p. 386.

Ikwuagwu OE, Ononogbu OU, Njoku OU, (2000). Production of Bio-diesel using rubber seed oil. Ind. Crops products 12: 57 -62.

Iyayi AF, Akpaka PO, Ukpeoyibo U, Balogun FE, Momodu IO, (2007). Rubber seed oil: An oil with great Potentials; Chemtech J. 3:.507 – 516.

James Caston, Harry E Snyder TP 40: 12/85. Understanding Pressure Extraction of Vegetable Oils.

Nadarajapillai NRT Wijewantha (1967). Productivity Potentials of Rubber Seed; Bull. Rubber Res. Inst. Ceylon 2: 8 – 17.

Nadrajah, Ariya, Abeyasingbe Dayarathe, Thamalingam (1973). Potentials of Rubber Seed collection and utilization in Sri-Lanka. Rubber Research Institute of Sri-Lanka Bulletin 8: 9-12.

Narahari D, Kothandaraman P (1983). Influence of Processing and Storage on hydrogen cyanide and tannin contents of para-rubber seed and its products. Anim. Feed Sci. and Technol. 9: 319 – 324.

Njoku OU, Ononogbu IC (1995). Preliminary Studies on Preparation of lubricating greases from bleached rubber seed oil. Ind. J.N.R Res 8(2): 140 – 141.

Nwankwo BA, Aigbekaen EO, Sagay GA (1986). Estimates of Rubber (Hevea Brasiliensis) seed production in Nigeria. In: Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood: Proceedings of National conference (Ed. Ephraim E. Enabor). Rubber Research Institute of Nigeria, Benin City, pp. 78 – 87.

Okhuoya JA, Ige O (1986). Fungi Associated with Biodeterioration of rubber seeds. In: Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood: Proceedings of National conference (Ed. Ephraim E. Enabor). Rubber Research Institute of Nigeria, Benin City, pp.146 – 150

Okoye WI (1986). Strategy for effective storage of Rubber seeds, oil and cake: In: Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood: Proceedings of National conference (Ed. Ephraim E. Enabor). Rubber Research Institute of Nigeria, Benin City, p. 126

Okoye WI, Akpobi H (1977/78), (1982). The oil of ginger bread plum tree (*Parinarium Macrophylla).* Annual Report, Nigerian Stored Products Research Institute, No. 9.. Lagos. The relative contribution of light and air to deterioration of some vegetable oils. Annual Report, Nigerian Stored Products Research Institute. pp. 77 – 81

Otoide VO, Begho ER (1986). An assessment of some methods of storage of rubber seeds an undefatted seed cake In: E.E Enabor (ed). Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood: RRIN , Benin City pp. 130-134

Perera EDI H, Dunn PD (1990). Rubber seed oil for diesel Engines in Sri-lanka. J. Rubb. Inst. Sri-Lanka 70:11- 25

Reethamma J, Rosamma A, Premalatha CK, Kuriakose B, (2005). Use of rubber seed oil soap in latex foam from natural rubber/styrene butadiene rubber blend. 18(1): 7 – 13.

Rubber Research Institute of Nigeria (1989). Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed oil. Advisory Circular No. 8. RRIN, Benin City, Nigeria.

Rubber Seed Processing for the production of vegetable oil and animal feed (1989). Phase Two. UNIDO, project report No. us/GLO/81/103, UNIDO, Vienna, 214p (http://www.unido.org/data/ida/017854.cfm)

Spencer MR (1976). Effect of Shipping on Quality of seeds meals, fats and oils. J.Amer. oil Chemist Soc. 53: 238 – 240

Uzu FO, Ihenyen GA, Imoebe SO (1986). Processing, analysis and Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed and cake. In: E.E Enabor (ed). In: Industrial Utilization of Natural Rubber (Hevea brasiliensis) seed, latex and wood, RRIN Benin City, pp.19 – 26.

Vijayagopalan K (1971). Factice from rubber seed oil. Rubber Board Bulletin. 11(2): 48 -51.

Ward JA (1976). Processing High Oil Content Seeds in Continuous screw presses. J. of Amer. Oil Chemist Soc. 53, 261 – 264.