Rubber Seed Oil- A Non-traditional By-product of Rubber Tree and Its Commercial Prospect in Bangladesh

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Abstract

Rubber seed oil is a promising by-product of rubber plant (*Hevea brasiliensis* Muell. Arg.), has so far been unknown to the rubber growers of Bangladesh. A Laboratory-based research was made on different aspects of rubber seed oil of four selected clones (RRIM-600, RRIM-605, PB-255 and GT-1) grown in the country. Results show that rubber seeds of the clones contain 28-44% edible oil which is will be cheaper than soybean and palm oil. Gas Liquid Chromatography (GLC) analysis shows that the seed oil contains 83-89% essential unsaturated fatty acids and 17-22% saturated fatty acid. On the other hand, the seed-cakes contain 29-39% proteins which is determined by the Macro Kjeldahl Procedure can be used as animal feed.

Besides, the seed-cakes contain six minerals (N, P, K, Na, Ca and Fe), where percentages of N, P and K have been found to be 5.5%, 2.8%, and 1.4% compared to those in ground nut (7.1%, 1.3%, and 1.2%) and cotton seed (3.8, 1.1% and 1.4%). It has also been estimated that if proper initiatives are taken, at least Tk. 49.32 crore could be earned per annum from the seed oil of the existing 37,646 ha plantations of the country. The seed oil and the de-oiled seed-cakes will not only create employment opportunity and flow of economic activities, but will also save substantial amount of foreign exchange from importing other edible oils and the essential ingredients of animal feed.

সারসংক্ষেপ

রাবার বৃক্ষের (*Hevea brasiliensis* Muell. Arg.) একটি সম্ভাবনাময় উপজাত হিসাবে রাবার বীজ-তেল এতদিন বাংলাদেশের রাবার চাষীদের নিকট অজানাই ছিল। বিগত ২০০৫ সালে দেশে উৎপাদিত চারটি জাতের রাবার (আরআরআইএম-৬০০, আরআরআইএম-৬০৫, পিবি-২৫৫ ও জিটি-১) বীজ-তেলের বিভিন্ন বিষয়ের উপর গবেষনাগারে এক বিশ্লেষন-ধর্মী গবেষনা পরিচালিত হয়। ফলাফলে দেখা যায় যে, উক্ত চারটি জাত ২৮-৪৪% তেল সমৃদ্ধ, যা সয়াবিন ও পামওয়েলের তুলনায় সস্তা। গ্যাস লিকুইড ক্রোমাটোগ্রাফী (জিএলসি) বিশ্লেষনে দেখা যায় যে, এ বীজ-তেলে ৮৩-৮৯% আন-স্যাচুরেটেড ও ১৭-২২% স্যাচুরেটেড ফ্যাটি-এসিড রয়েছে। অপরপক্ষে, রাবার বীজ-কেক-এ ২৯-৩৯% প্রোটিন পাওয়া যায়, যা ম্যাক্রোজেলডাল পদ্ধতিতে নির্ণয় করা হয়েছে এবং এটি প্রানীজ খাবার হিসাবে ব্যবহার করা যেতে পারে।

এছাড়াও বীজ-কেক-এ রয়েছে ছয়টি মিনারেল (নাট্রোজেন, ফসফরাস, পটাশ, সোডিয়াম, ক্যালসিয়াম ও আয়রন) যেখানে সার হিসাবে ব্যবহৃত নাট্রোজেন, ফসফরাস ও পটাশের পরিমান যথাক্রমে ৫.৫%, ২.৮% ও ১.৪% যা বাদাম ও তুলাবীজে রয়েছে যথাক্রমে ৭.১%, ১.৩% ও ১.২% এবং ৩.৮%, ১.১% ও ১.৪%। হিসাব করে দেখা গেছে, যথাযথ ব্যবস্থা গৃহীত হলে দেশের বিদ্যমান ৩৭,৬৪৬ হেক্টর বাগান থেকে বছরে ৪৯.৩২ কোটি টাকার রাবার বীজ-তেল সংগ্রহ করা সম্ভব। উক্ত বীজ-তেল ও বীজ-কেক দেশে কেবলমাত্র নূতন কর্ম-সংস্থান ও অর্থনৈতিক কর্মকান্ডই বৃদ্ধি করবে না বরং এতে অন্যান্য ভোজ্য-তেল আমদানীসহ প্রাণীজ খাবারের প্রয়োজনীয় উপাদান আমদানীর ক্ষেত্রেও প্রচুর বৈদেশিক মুদ্রার সাশ্রয় হবে।

Keywords: Clones, cultivars, *Hevea brasiliensis*, kernel, latex

Introduction

Rubber (*Hevea brasiliensis*) is indigenous to the Amazon valley of Brazil, Venezuela, Peru, Ecuador and Colombia. Among the nine species and four varieties of the Amazon basin, *H. brasiliensis* was found the most outstanding owing to its high latex yield and superior quality rubber (Anon. 1959). Now-a-days, Malaysia, Indonesia, India, Sri Lanka and Nigeria are the leading rubber growing countries of the world. The concentration of rubber industry in South-east Asia is due to its congenial environmental conditions as well as availability of cheaper labour force (Lim 1985).

In Bangladesh, rubber plantations were first introduced in 1952 by the Forest Department and later extended by Bangladesh Forest Industries Development Corporation (BFIDC) and other private and public bodies. It is now grown in major areas of Chittagong, Chittagong Hill Tracts, Cox'sbazar, Srimangal, Modhupur and Dinajpur under different Rubber Estates of BFIDC, Private Estates, Chittagong Hill Tracts Development Board (CHTDB), Tea Estates and Private Small Holders. Emdad Hossain (2001) mentioned that there are a number of clones being cultivated in Bangladesh some of which are: (i) RRIM-600, 605, 617, 627 & 612, (ii) PB-235 & PB-255, (iii) PR-255 and (iv) GT-1. According to Nandy (1990), the average number of rubber trees planted in the country is about 400-450 per hectare. Unfortunately, Bangladesh has been commercially cultivating the 50-year old RRIM-600 clone of Malaysia. Though this country has developed number of improved clone from RRIM-600 series.

It is evident that both latex and rubber wood are, now-days, the two most important commercial commodities of rubber plants established throughout the world including Bangladesh. But, rubber seed oil (RBSO) did not so far appear into scenario as a non-traditional commodity in this country. According to Islam (2010) there are 37,646 ha of rubber plantations in the country under the Rubber Estates of BFIDC, Private Estates, CHT Development Board, Duncan Brothers, James Finley, Naptune Tea and Private Small Holders where the estimated number of matured rubber trees are 61,64,987. The total quantity of rubber seeds in the country has been estimated to be 7,000 metric tons. It means, only 1.14 kg seeds/tree could be produced from the existing rubber plantations of the country. On the contrary, Mannan (1999) mentioned that about 5-7 kg seeds/tree were found to be produced in the rubber gardens of Bangladesh which shows a big difference with the BFIDC estimates.

Ukhun *et al.* (1988) cited that rubber seed and Rubber Seed Oil (RBSO) are being used for edible purpose in Malaysia and Indonesia as it contains protein, fats and minerals. Rubber seeds of Karnataka, India contain the highest oil content of 44% and the lowest 28% (Jayappa *et al.*); and 45-50% in Bogor, Indonesia (Hardjosuwitu *et al.* 1976). It is also used in manufacturing resins and soaps (Aigbodion 1991). Njoku *et al.* (1996) reported that RBSO has large amounts of C18 fatty acids as well as traces of other fatty acids. So, there is no valid reason to consider it as a non-edible oil.

Rubber seed oil (RBSO) may, therefore, be considered as an important by-product to the rubber growers of Bangladesh as well. It has so far been overlooked and neglected as an unimportant produce. But, with the advancement of technical know-how, it is the time to consider RBSO also as a valuable commodity. Traditionally, rubber seeds had been used only for production of seedlings in the country. The huge seed-lots have been left unutilized and damaged without proper

utilization and fruitful use. The present study was, therefore, undertaken to determine the total oil content of the country, its chemical composition, mineral contents and also to establish a base line information on the rubber seed oil and the commercial prospect of rubber seed-based industry in the country.

Materials and Methods

Out of the 9-10 high yielding clones or varieties of rubber cultivated in Bangladesh, four were used for this study. These are RRIM-600, RRIM-605, PB-255 and GT-1. The seeds were collected from some old plantations of Datmara Rubber Estate, BFIDC, Hyanko, Chittagong during the month of December, 2004. Seed oils were extracted through solvent extraction method using soxhlet apparatus and purified standard method (Laurence and Christopher 1989). Oil contents were then determined. Composition of fatty acids (unsaturated and saturated) was determined through Gas Liquid Chromatography. Protein and mineral (N, P, K, etc.) contents of the de-oiled seed cakes for each clone were also determined.

To estimate the total RBSO in the country and the derived income to be generated from the rubber seed, the production of rubber seed/tree has to be ascertained first. A total of 7,000 metric tons of rubber seeds may be produced in the country from BFIDC rubber garden (Islam 2010). That is, only 1.14 kg seeds/tree may be procured from the existing 37,646 ha of rubber plantations while Mannan (1999) mentioned that about 5-7 kg seeds/tree were found to be produced in the rubber gardens of Bangladesh. These two estimates show a big gap. So, to be in safe side, if an average of 04 kg seeds/tree (which is less than the lowest quantity cited by Mannan) is taken into consideration, the following results will appear.

A. Total number of matured rubber trees: 61,64,987

B. Number of rubber seeds/tree: 4 kg

C. Total quantity of rubber seeds in the country (A x B): 2,46,59,948 kg = 24,660 metric tons.

D. Quantity of rubber seed oil (C x 20%): 4,93,1989 kg = 4,932 metric tons.

E. Value of the total RBSO produced in the country = D x Tk.100/- = Tk. 49,31,98,900/-

= Tk. 49.32 crore.

(Assuming that the price of RBSO is Tk.100/kg compared to soybean @Tk. 130/- and palm oil Tk. 120/- per kg.)

Results and Discussion

The oil contents of the four seed clones of *Hevea brasiliensis* were determined gravimetrically from the oil extracts of the crushed seeds on air-dry basis and found to be 31.4% (RRIM-600), 28.7% (RRIM-605), 32.2% (PB-255) and 44.0% (GT-1) shown in Table-1. ANOVA shows that GT-1 seeds contain the highest amount of oil (44.0%) while RRIM-605 the lowest (28.7%). On the other hand, PB-255 and RRIM-600 contains the second highest oil with no significant difference. It reveals that the average oil contents (28-44%) of the four rubber clones of Bangladesh seem to be reasonable compared to those in India (28-44.2%) and Indonesia (45-50%).

It has been observed and established that the oil contents of the rubber seeds decrease with the increase of storage time after harvest. So, the highest quantity of oil may be obtained if oils are extracted immediate after the harvest in July-August (Mannan 1999). The similar results of India and Bangladesh seem to be reasonable, may be because of near similarity in soil and climate conditions, although the yield of Indonesia is quite higher than these two countries. The oil contents (%) found in the

Table 1. Percent of oil content of rubber seeds of four rubber clones.

Replication	Oil content (%)			
	RRIM-600	RRIM-605	PB-255	GT-1
1	29.7	25.6	33.8	44.9
2	34.3	31.5	30.3	42.8
3	30.2	28.9	32.5	44.2
Mean	31.4	28.7	32.2	44.0
S.E.	1.5	1.7	1.0	0.6
F-ratio (P-value)	32.6*** (7.8E-5)			
LSD-value at 5%	1.9			

Note: SE- Standard Error, F-ratio- Variance ratio, LSD- Least Sig. Difference

present study could be higher (may be nearer to those of Indonesia) if the seeds were collected in July-August instead of December.

The Protein contents (Pearson 1976) of the seed-cakes of the four clones were found to be 39% (RRIM-600), 33% (RRIM-605), 36% (GT-1) and 29% (PB-255) by Macro Kjeldahl Procedure while the Soybean and Cotton seed contain 49% and 22% protein (Duffus and Slaughter 1987). It indicates that the rubber seed-cakes of the four clones have high protein contents and can safely be used as animal feed (Table 2). GLC analysis also shows that the RBSO contains eight fatty acids, viz., Lauric, Myristic, Palmitic, Stearic, Oleic, Linoleic, Linolenic and Arachidic.

It also reveals that all the four clones contain substantial amounts of unsaturated fatty acids (83-89%), i.e., RRIM-600 (88.6%), RRIM-605 (82.9%), GT-1(83%) and PB-255 (84.2%) which are presented in Figure-1. It indicates that RBSO may be edible due to high unsaturated fatty acids but it needs further detailed investigation. It has been proved by a recent study that the unsaturated fatty acids reduce cardiovascular problems.

Figure 1 also shows that RBSO contains 17-22%, of saturated fatty acids which can be used for industrial purposes. It is noteworthy that palmitic and stearic acids are important ingredients for good soaps. Stearic acid in the form of zinc, calcium, and magnesium and aluminium stearate is much used in manufacturing different cosmetics, like bath soaps and talcum powder, etc. Stearine (mixture of palmitic and stearic acids) is used in manufacturing candles, saving soaps and emulsifying agents, etc.

The percentages of six minerals (N, P, K, Na, Ca and Fe) of de-oiled seed-cakes of the four clones found by Quantitative Analysis (Pearson 1976; Allen 1986; Vogel 1971) are

Table 2. Percentage of protein and other constants of de-oiled rubber seed-cake

Parameter	% of rubber seed-cake			
	RRIM-600	RRIM-605	GT-1	PB-255
Moisture content	0.22	0.26	0.29	0.52
Ash content	1.97	1.66	1.78	1.95
Protein	38.99	32.60	35.95	29.11

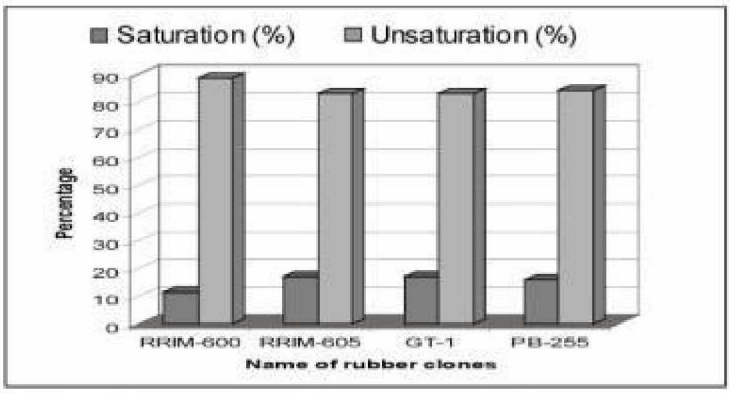

Figure 1. Percentages of saturated and unsaturated fatty acids found in seed oils of four rubber clones.

presented in Table 3. The average N, P & K contents were found to be 4.7-6.2%, 0.26-0.31% and 1.1-1.6% which are comparable to those in ground nut (7.1%, 1.3%, and 1.2%) and cotton seed (3.8%, 1.1% and 1.4%), (Kaul and Das 1986). It is evident that N, P & K are used as fertilizer to the soil. Other three minerals sodium, calcium and iron were found to be 0.38-0.58%, 2.7-3.1% and 0.01-0.02% respectively.

Prospect of Rubber Seed Oil (RBSO) in Bangladesh

Although rubber plantations were started in the nineteen sixties and not a very recent practice in Bangladesh, it has little studies on oil from rubber seed and other diversified uses. Knowing the total acreage of rubber plantations and the seed oil production per unit area, the country can estimate the value of the total produce and can assess its prospect as well. Accordingly, future plans and programmes may be undertaken for necessary seed production and also for proper utilization of the seed oil. It has been reported by Nandy (1990) that depending on the clones and the plantations raised in different dendro-ecological zones, about 400-450-rubber trees/ha were planted in the country. Mannan (1999) reported 5-7

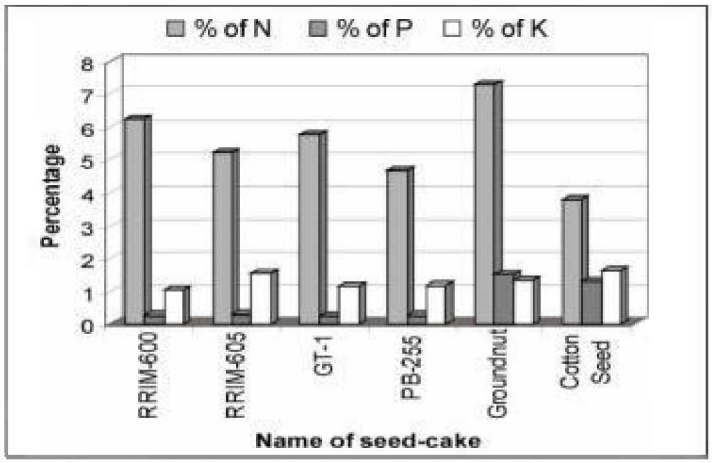

Figure 2. Percentages of N, P & K found in seed cakes of the four clones compared to groundnut and cottonseed.

Table 3. Percentage of different minerals of de-oiled rubber seed-cakes.

Minerals	Four different rubber clones of Bangladesh			
	RRIM-600	RRIM-605	GT-1	PB-255
Nitrogen	6.24	5.22	5.75	4.66
Sodium	0.48	0.39	0.38	0.58
Potassium	1.06	1.57	1.16	1.18
Calcium	2.78	2.66	3.11	2.84
Iron	0.02	0.01	0.01	0.01
Phosphorous	0.27	0.31	0.26	0.27

kg seeds are produced per tree, then about 2,000-3,000kg seeds may be obtained from one hectare of plantation.

About 37,646 hectares of rubber plantations have so far been raised under BFIDC Rubber Estates, CHT Development Board, Duncan Brothers, James Finley, Naptune Tea and Private Small Holders (Islam 2010). If only 25,000 hectares (two-third of the total) are considered mature for seed production, then about 50,000 tons of seeds can be obtained from the existing plantations, assuming an average of 2,000 kg seeds/ha. Then these seeds can produce at least 7,500-10,000 tons of oil, if only 15-20% oil/kg-seed (or 28-44% oil/kg-kernel) are taken into consideration. It shows that at least 40,000 tons of rubber seeds and 8,000 tones of RBSO could be produced per year in the country. This 8,000 tons of RBSO worth of Tk. 80.00 crore (@Tk.100/kg) could save the valuable foreign exchange of Tk.104.00 crore for importing same quantity of soybean oil (@ Tk. 130/- per kg) or palm oil of Tk. 96.00 crore (@ Tk. 120/- per kg).

As per the present study, about 58% of the seeds are the kernels. It means an estimated quantity of 23,200 tones of kernels/year may be produced from the existing plantations. If this entire amount of seed-kernels (or oil-cakes) could be utilized as alternative animal feed, it will be of great benefit. Since the seeds are easily available, the per-unit cost of the feed will substantially be reduced and hence the poultry/animal meat. Moreover, it will save the valuable foreign exchange for importing the essential ingredients of the poultry/animal feed.

Each rubber garden can easily make a separate processing plant/unit within the garden. They can also utilize the existing working force of the gardens with some extra payment. If the workers are allowed to collect and process the seed separately it will also be a source of another income for them. Certainly, this will create new flow of economic activity toward employment generation and poverty alleviation of the country.

Recommendation

It may be recommended that proper initiatives in production, collection and preservation of rubber seed can ensure raw materials supply. Extraction of lipid, utilization of oils for edible purpose, use of seed cakes as animal seed would play a significant role in the national economy of Bangladesh. A further detailed study may be undertaken for quality improvement of seed oil and seed cakes of the product for sustainable management.

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