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Full Length Research Paper

Comparison of two creaming methods for preparation of natural rubber latex concentrates from field latex

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Natural rubber latex (NRL) concentrates are important raw materials which are being used for the manufacture of products such as gloves, condoms, foams, balloons, catheters, baby soothers, dental dams, latex thread or elastic. Creaming is one of the methods for obtaining latex concentrate from field latex. This paper compares a synthetic creaming agent (sodium alginate) with an agricultural one (Tamarind seed powder), in the production of latex concentrates from field latex. From the results, the value of dry rubber contents (DRCs), which is the major parameter for evaluating extent of latex concentration, was slightly higher for concentrate obtained by Tamarind seed powder (60.10%) than that by sodium alginate (59.10%). This could be attributed to greater water-absorbing capacity of the former than the latter. Overall, the property of latex concentrates obtained from both creaming agents compared favourably with literature.

Key words: Natural rubber, field latex, latex concentrates, creaming, dry rubber contents, Tamarind seeds, sodium alginate.

INTRODUCTION

Natural rubber latex (NRL) is obtainable from different species of plants/trees of which the species originally indigenous to Brazil, popularly called *Hevea brasiliensis*, is the most important source, commercially and industrially. It is called 'plant milk', because, first and foremost, the latex is gotten from plant, and physically, it is a cloudy, white liquid, similar in appearance to cow's milk (Yip and Cacioli, 2002). Apart from being a carrier medium of various nutrients, the latex is thought to act as the protective fluid against insect predators for the tree (Dean, 1987). Fresh latex as collected from the tree is called "normal" or "field" latex and is composed of about 38 to 40% solids (Table 1) with a density of 0.980 typically (Yip and Cacioli, 2002; Jayanthy and Sankaranarayanan, 2005; Popović et al., 2005).

Field latex is immediately preserved using ammonia (the quantity depending on the delay between harvesting and processing into concentrate but usually not exceeding 1%) in order to prevent bacterial contamination or at least to limit its effects (Resing, 2000; Rubber Board, 2008). The bacterial attack often occurs on the protein constituents which act as colloidal stabilizer to keep the latex water dispersible, thus preventing its coagulation. The composition of fresh latex is rather complex due to its origin and relative proportions of certain constituents (e.g. proteins, pH, minerals, total solid content, dry rubber content, salt content, moisture content and density). These parameters are determined to check the variation of latex based on factors such as season, tapping system, among others (Esah, 1990; Madhu et al., 1994). The rubber constituent (the elastic component in NRL) which is essentially cis-1, 4-polyisoprene is the main reason for which the rubber tree has been desired for ages. This component can be processed from field latex into either of two types of raw materials, namely the liquid latex concentrate and solid dry rubber (Yip and Cacioli, 2002). Dry rubber is obtained by coagulation which entails treating the latex with suitable agents such as acetic or formic acid to yield crepe or crumb. This is washed extensively, and then thoroughly dried at about 100°C prior to packaging in form of bales (e.g. Standard Malaysian rubber grades) and sheets (e.g. ribbed smoked sheet grades) for use in manufacture of wide range of products such as tyre, bulb seal, o-ring, gasket, bumper and fender. Among various types of elastomers, dry natural rubber is one of the most widely used for industrial and household applications

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Table 1. Composition of field natural rubber latex.

Constituent	% Composition
Rubber particles (cis-1, 4-polyisoprene	30.0-40.0
Protein	2.0-3.0
Water	55.0-65.0
Steril glycosides	0.1-0.5
Resins	1.5-3.5
Ash	0.5-1.0
Sugars	1.0-2.0

(Allen and Jones, 1988; Sirisinha et al., 2003).

Liquid latex concentrate is concentrated latex having dry rubber content of about 60%. The earliest purpose for concentrating latex was to get the purest rubber content of the field latex necessary for industrial products like tyres, bands, carpet lining, diving gear, adhesives, etc. (Havinga and Heijden, 1997; Elvers et al., 1993). Current applications of latex concentrates include the manufacture of gloves, condoms, foams, balloons, catheters, baby soothers, dental dams, latex thread or elastic (Yip and Cacioli, 2002). Latex concentrate can be obtained from the field latex by creaming, centrifuging, electrodecantation or evaporation (Skeist, 1990; Cheng, 1988). Creaming is a chemical process involving the addition of creaming agents into the vessels containing field latex to hasten phase separation. It depends on the difference in specific gravity between water (1.0) and rubber polymer (0.91) and can be used for concentrating 30% field latex to 60% and higher. Centrifuging is a mechanical process for concentrating field latex. Like creaming, the operation also relies on the difference in specific gravity between water and the rubber polymer and can be used for concentrating 30% field latex to 60% and higher (Vanderbilt, 2008). Electrodecantation, an electrolytic method of creaming, relies on the fact that latex particles carry a negative charge and so will migrate towards a positive electrode; if the electrolysis is carried out through a semi-permeable membrane, the concentrate will rise to the surface where it can be creamed off.

Evaporation is a reversible process of concentrating 30% field latex to 80% concentrated latex or more total solids which have the consistency of a paste. The process begins with the addition of a stabilizer followed by controlled evaporation from off the surface of a heated revolving drum, the bottom of which is in contact with the latex. In a new approach, Veerasamy et al. (2008) designed a membrane latex concentrator to concentrate field latex by membrane separation. They concluded that the method is environmentally friendly, as the latex concentrate goes to latex product manufacturing factory as a raw material while the serum could be utilized for useful biochemical extraction leading to a zero discharge scenario. The creaming method is popular as it often avoids the use of sophisticated tools thus offering a simple and cost-effective route for obtaining latex concentrate. Different methods of creaming have been reported in the literature (Stevens, 1934; Rhodes and Sekaran, 1937; Dafader et al., 1996; Peethambaran et al., 2003).

In this paper, two creaming agents, namely seed powder from Tamarind tree and sodium alginate were simultaneously compared in terms of the yield and some selected physico-chemical properties of the resulting latex concentrates. This aspect has not been reported in the previous literature reviewed. It is, therefore, expected that the findings from this work would make a new contribution to existing body of knowledge on natural rubber latex concentrates.

EXPERIMENTAL

Materials

Field natural rubber latex was kindly provided by Rubber Research Institute of Nigeria (RRIN), Iyanomo, Benin City. Tamarind seeds were extracted from the fruits purchased from a local market, in Bosso, Minna, Nigeria. Reagent grade sodium alginate (minimum assay, 99.0%), which is a product of JT Baker, a Division of Mallinckrodt Baker, Inc. USA, was used.

Preparation of latex concentrates using tamarind seeds

The tamarind fruits were soaked in water for 5 h and the resulting softened pulp was washed off to release the seeds. After repeated washing in water, the seeds were sun dried for 2 h following which they were transferred into a convection oven set at 50°C for further drying for 21 days in order to reduce the moisture contents to the barest minimum possible. Consequently, the husk became brittle and was easily separated from the kernels by pounding in a wooden mortar. The kernels were ground in a local milling machine to obtain powder, which was then sieved to obtain a fine powder. 3.0 g of the tamarind powder was dispersed in distilled water (100 cm^3) (pH 7.88) in a beaker and the dispersion was boiled on a hot plate for 1 h with continuous stirring, thus yielding a solution. 0.75 cm^3 of the tamarind solution (creaming agent) was transferred into a 500 cm^3 beaker containing 250 cm^3 of the latex. The beaker was covered and left to stand undisturbed in a safe place for 48 h. After 48 h, phase separation occurred. Water being slightly denser than rubber existed at the bottom of the beaker while rubber particles swelled and rose to the top and were separated.

Preparation of latex concentrates using sodium alginate

3.0 g of sodium alginate (BDH) was dissolved in distilled water (100 cm^3). 1.25 cm^3 of the prepared solution of sodium alginate (pH 8.58) was transferred into a 500 cm^3 beaker containing 250 cm^3 of latex. The beaker was covered and allowed to stand undisturbed for 2 days. After 2 days, the latex separated into two layers, having rubber particles at the top and water at the bottom of the beaker.

Characterization of the latex concentrates

The total solid content (TSC) (ISO, 2008) and dry rubber content (DRC) (ISO, 2005) were determined in accordance with ISO

Table 2. Determined characteristics of natural rubber latex obtained from different processing technologies.

Latex type	Properties				
	TSCs (%)	DRCs (%)	Moisture (%)	ρ (g/cm^3)	pH
Field latex	41.10	36.20	72.10	1.16	11.15
Latex concentrate/Sodium alginate	61.40	59.10	2.30	0.94	8.96
Latex concentrate/Tamarind seeds	61.50	60.10	1.13	0.94	9.60

methods, while density (Annual Book of ASTM Standards, 1973) was determined according to ASTM D1959-69. For measurement of pH, the pH electrode was first equilibrated in de-ionized distilled water in a beaker for about 3 h. It was then standardized by inserting it for a while in buffer solutions of pH 4 and 9, respectively. Afterwards, the electrode was finally inserted into the aqueous dispersed latex sample and the pH reading taken.

RESULTS AND DISCUSSION

The results of characterizations of the field latex as well as of latex concentrates derived from both creaming methods were as shown in Table 2. The field latex is a watery, milky-like liquid with a pungent smell. The smell was attributed to the ammonia solution previously added to the latex for preservation purpose (Resing, 2000; Rubber Board, 2008). Expectedly, the field latex sample gave the highest pH value (11.15), indicating a relatively high level of alkalinity, because of its correspondingly high ammonia content. The lower pH values of the both samples of latex concentrates relative to that for field latex was hence attributed to loss of ammonia content due to evaporation during the creaming process.

Physically, the latex concentrates were generally tacky semi-solid in consistency with some lumps and, a little brownish in colour. The appearance of the lumps and colour change from milky-like to slight brown in the latex concentrates as against field latex was suggested to be the outcome of the ammonia content depletion accompanying the latex creaming process. The remainder of ammonia in the latex concentrate now insufficient naturally would make the latex easily susceptible to bacterial attack and leading to coagulation, as indicated by formation of lumps in the latex concentrates. As also seen from Table 2, the pH value of sodium alginate-based latex concentrate was less than that of tamarind–based type. This indicated that the latex concentrate obtained by sodium alginate process has less residual ammonia content compared to latex concentrate from tamarind-based creaming process. A possible explanation suggested for this difference was that, in the aqueous solution, sodium alginate used could have partially hydrolysed into its corresponding weak organic acid which in turn neutralized part of the ammonia content. This implied that, besides the normal loss of ammonia content from the latex during creaming, the neutralization process as stated above additionally contributed to depletion of ammonia content in sodium alginate-based concentrate.

In case of tamarind-based latex concentrate, the only factor adduced for loss of ammonia from latex is the creaming process. Hence, it would be expected that residual ammonia content in the sodium alginate-based latex concentrate should be less, indicated by a correspondingly less pH value, than that in the concentrate that is tamarind-based. However, the pH and density values for latex concentrates from both creaming methods are close with similar values in literature (Vanderbilt, 2008) for latex concentrates obtained by other methods. As observed (Table 2) the density of the field latex was only slightly below that of water, which should be due to its high moisture content relative to the latex concentrates. The total solids contents (TSCs) (61.40%, 61.50%) and the dry rubber contents (DRCs) (59.10%, 60.10%) from this study were found to be in close agreement with the literature values (Yip and Cacioli, 2002; Veerasamy et al., 2008; Rhodes and Sekaran, 1937) of latex concentrates. As seen from the results (Table 2), the values for TSC and DRC, respectively were found to be a bit higher in the tamarind-based latex concentrate than what was obtained for the latex concentrate obtained by sodium alginate.

Since the aim of creaming is to produce latex with increased values of such parameters (Yip and Cacioli, 2002), this means that creaming is more effective using tamarind seed powder than using sodium alginate. Expectedly, as shown in Table 2, the values of TSCs and DRCs are the lowest for the field latex. At this level, there is presence of a relatively high quantity of non-rubbery constituent and also dirt contents (Esah, 1990). The moisture content of the field latex was far greater than the both latex concentrates, since the properties of the freshly tapped latex has not been modified in any way at this stage to reduce its inherent water content. According to literature (Esah, 1990), the moisture contents for field latex can vary with season and are usually much higher when tapping is done during the raining season due to increased moisture absorption from the environment. The fact that the latex concentrates from both creaming methods showed lower moisture contents than similar value of field latex, is an evidence that the process of creaming must have involved loss of moisture contents from the field latex.

Conclusions

Creaming of field NR using sodium alginate and powdered seeds of tamarind plant were comparatively employed successfully to obtain latex concentrates. DRCs value was slightly higher for process based on tamarind plant (60.10%) than for sodium alginate (59.10) (standard deviation, approximately 0.7). Given the fact that tamarind seeds are renewable materials which can be grown agriculturally to satisfy desired demand, the prospects for using them seems more attractive than using sodium alginate. The advantages of the former are, firstly, effluents resulting from this are not likely to cause environmental hazards, since they must be biodegradable like most plant-based materials.

On the other hand, sodium alginate, being a chemical is potentially unsafe. Secondly, the tamarind seed is renewable by simply growing the plants agriculturally unlike sodium alginate of which the sodium metal component is a finite resource material. Thirdly, a wide plantation of tamarind plants will provide a means of employment with attendant boost to national economy and conserving our foreign reserved currency used in importing the sodium alginate.

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