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Processing of Natural Rubber Latex Concentrate (NRLC) Using A Novel Method of Creaming Based on Tamarind Kernel Powder (TKP) and Cassava Processing Effluents (CPE)

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Abstract:
The purification and concentration of Natural Rubber Latex (NRL) can be achieved through the process of creaming. This is usually carried out by the addition of small quantities of some water-soluble colloids or creaming agents. Such include ammonium alginate, sodium alginate, sodium cellulose glycollate, methyl cellulose, aluminum cellulose glycollate, pectins, extract of carragheen moss, glue, gelatine, gum Arabic, gum acacia Senegal, locust bean gum, gum tragacanath, tamarind Kernel Powder, gum Karaya, and Polysaccharides such as maize, sorghum, rice, yam, potato starch and cassava starch. Many of such creaming agents are made from chemicals that are finite, imported, and therefore very expensive and some are toxic to human health and wellbeing. The production of such chemicals leads to a lot of environmental pollution and its attendant degradation and health virus, not to mention their exorbitance. These imported creaming agents are now beyond the reach of smallholder farmers and cottage industrialists. The use of vegetative creaming agents such as locust bean, polysaccharides, tamarind kernel powder, etc. has been reported and practiced and the results have been very good and encouraging (BIS 2001, Blackley, 2010). Fresh, natural rubber latex (FNRL) (with 40% rubber and 60% water) can be processed into concentrated natural rubber latex (CNRL). This is done to meet industrialists' demand, increase its economic value, increase its dry rubber content (DRC) and ease transportation costs. Also, dipped goods usually require a high concentration of DRC and purification too. Products such as hand gloves, condoms, balloons, pillows, mattresses and suckers, teats, and catheters are usually made from concentrated latex. Methods such as centrifugation, evaporation, electro-decantation and creaming are the methods used for purifying and concentrating FNRL. However, due to the cost of most chemicals imported into the country and the high cost of machines also imported, many entrepreneurs have tried to develop green rubber processing methods. These methods do not require the use of big bogus expensive machines. The main object of this project is to develop a system to prepare cream-concentrated natural rubber latex (CNRL) without using sophisticated machines and importing expensive chemicals. We will work on a simple, cheap, green, environmentally and health-friendly method to produce cream CNRL. The main parameters of the cream CNRL such as DRC, Total Solids Content (TSC), Volatile Fatty Acids (VFA), Alkalinity and mechanical stability time (MST) of the cream CNRL, would be tested and evaluated. The use of vegetative creaming agents like those listed above has long been practiced and reported Tamarind kernel powder (TKP) and Cassava Processing Effluents powder (CPE) would be used as the dual or joint creaming agents in a synergy.

Keywords: *Cassava, creaming, fresh, green, novel*

1. Introduction

There are several methods for the purification concentration of Field Natural Rubber Latex (FNRL) latex. The concentration of NRL latex entails removing a substantial amount of serum (which is made up of water and water-insoluble materials). The process of purification and concentration makes NRL richer in rubber or dry rubber content (DRC). Also, concentration increases DRC, manufacturers' preference, economy in transportation and a more pure product for the making of dipped goods (BIS, 2001; Blackley, 2010; Freeman, 2010).

2. Methods of Purifying and Increasing NRL Concentration

Methods of purifying and increasing NRL concentration include evaporation, electro-decantation, centrifuging and creaming. In this write-up, we will look at the creaming principle and process. The creaming principle and process are based on the fact that NRL is a dispersion of very fine colloidal particles of rubber hydrocarbon in a serum. In colloidal dispersions, the dispersed particles usually cream or sediment under the influence of gravity. In the case of NRL, the rubber particles being higher than the serum usually tend to cream up or aggregate. The velocity of creaming depends upon a number of factors, which can be derived from Stroke's law, as shown below:

$V = 2g\ (Ds - Dr)r^2/9\eta$

Where:
v = velocity of the rising particles (m/s)
g = gravitational force (m/s^2)
Ds = density of serum (g/ml)
Dr = density of rubber particles (g/ml)
R = effective radius of rubber particle (m)
while η = viscosity of serum (centipoise)

Looking at the expression above, the velocity of creaming can be increased by increasing the particle size of the difference between the density of rubber and serum or by reducing the viscosity of the serum (BIS, 2001; Blackley, 2010; Freeman, 2010; Agbenro & Eichie, 2019).

The composition of FNRL depends on factors such as the type of soil, system of tapping, type of manure and inorganic fertilizer, and seasons. FNRL can be contaminated by micro-organisms due to the presence of nutritious substances, which are non-rubber particles (Vallat et al., 2014). These micro-organisms eat up the non-rubber constituents and hence generate VFA, which destabilizes or causes auto-coagulation of the latex particles. Ammonia is used to boost the negatively charged latex, stabilizing and preserving the NRL. FNRL can be converted into CNRL in a bid to maintain the constant quality of CNRL and enhance its economic potential for transportation from the fields to industries and its usability for manufacturing diverse dipped goods. NRL is obtained from the Natural Rubber tree and it is

a milky white colloidal liquid. The major rubber-producing tree of economic importance is called Hevea Brasiliensis. Table 1 shows the composition of FNRL.

Property	% by Weight of NRL
Rubber hydrocarbon particles	34.53 – 42.67
Proteins	2.10 – 3.20
Sugars	1.25 – 2.30
Ash	0.45 – 1.32
Lipids	0.12 – 0.53
Others	1.51 – 3.52
Water	53.12 – 65.44

Table 1: The Properties of FNRL

The concentrated natural rubber latex (CNRL) contains a DRC of about 56 – 60%, which is useful for making dipped goods such as balloons, condoms, teats, suckers, hand gloves, catheters, foams, pillows, mattresses, etc. Various methods of creaming are evaporation, centrifugation, electro-decantation and creaming. A cheap and inexpensive method of preparing CNRL is creaming. Such a creaming system utilizes chemicals to aid the efficiency of the process. Such chemicals include sodium alginate, ammonium alginate, poly (vinyl) alcohol, sodium carboxymethyl cellulose, methyl cellulose, carboxymethyl cellulose, locust bean gum, tamarind kernel powder, casein, gum Arabic, gum karaya (Freeman, 2010; Agbenro & Eichie, 2019). However, although a great majority of these creaming agents are polysaccharides in nature, not much use has been made of cassava processing effluents (CPE). CPE is obtained from the processing of cassava into garri (a local food made from cassava and roasted in large frying pans and consumed all over West Africa) and has very rich stabilizing, emulsifying and swelling properties as a polysaccharide (Freeman, 2010; Agbenro & Eichie, 2019; Vallat, 2014). It is also very abundant, versatile, available, and not only cheap but can easily be processed into powder for use as a creaming aid. Creaming aids such as potassium oleate and potassium hydroxide will be used to make the system more efficient. Factors influencing the creaming process include the age of latex, temperature, alkalinity, agitation, addition of soap and viscosity of creaming agents are generally added to FNRL as a 3% solution in water. Most of the agents are soluble in warm water and hence their solutions can be prepared by adding the agent into the required quantity of warm water at about 50 – 60% and stirring until a clear solution is obtained. The solution is then sieved and cooled to room temperature before adding to FNRL (Vallat, 2014: Smithipong, 2014: Smithipong, 2016). Tamarind Kernel Powder (TKP) and Cassava Processing Effluent Powder (CPE) are not soluble in cold water. The powders are first allowed to swell in water for 20 minutes before making it into a slurry. The slurry is then boiled for about an hour and the loss in volume is made up by adding the required quantity of water. It is then sieved to remove uncooked materials. For 200 kg of latex, 600g of TKP and 600g of CPE powders cooked in 20 litres of water will usually be enough. Freshly prepared creaming agent solution shall be used. Soaps such as potassium oleate or even commercial washing soaps will also be used. A 100% solution of soap will be prepared. For 200kg of FNRL, 100g of soap dissolved in 1 litre of water will be used (7,8). Finally, the important properties of NRL of both TKP and CPE will be compared and contrasted. These properties are DRC, TSC, VFA, NST (mechanical stability time) and alkalinity.

3. Materials and Methods

3.1. Materials

Fresh Natural Rubber Latex (FNRL) was kindly collected from Rubber Research Institute of Nigeria (RRIN), Benin City Tamarind Kernel Powder (TKP) and Cassava Processing Effluent (CPE) was purchased from local markets, while potassium oleate and potassium hydroxide and ammonia used were of laboratory analytical grades.

Material	Parameter	Source
Fresh Natural Rubber Latex (FNRL)	TSC 38.44% DRC 29.34%	RRIN, Benin City
Centrifuged Concentrated Natural Rubber Latex (CCNRL)	TSC 62.82% DRC 60.44%	RRIN, Benin City

Table 2: Properties of NRL

3.2. Preparation of Cream Concentrated NRL Using TKP and CPE

3g of TKP and 3g of CPE will each be cooked in 100 ml of water for an hour. The loss in volume during boiling will be made up by adding the required quantity of water. After boiling, the slurry will be sieved to remove uncooked materials and allowed to cool to room temperature. Freshly prepared creaming agent solution shall be used. A 10% solution of soap will be added and 1g of potassium oleate will be dissolved in 10ml of water (8). Various solutions of 1,2,3,4 and 5ml of the TKP and CPE solutions will then be added into a beaker containing 25ml of FNRL and will be stirred for about 30 – 40min. The mixture will then be left for 2 days (48 hours) – 3 days (36 hours), unperturbed. The onset of separation of the rubber and serum layers will be noticed and observed for several days, weeks and months. When separation is complete, the aqueous serum phase will be run-off, and only the upper rubber fraction will be left.

3.3. Testing, Analyses and Characterization of FNRL and the Cream Concentrated NRL (Both TKP and CPE)

Such NRL properties are Total Solids Content (TSC), Dry Rubber Content (DRC), Alkalinity (%), Volatile Fatty Acids (VFA), and Mechanical Stability Time (MST).

3.3.1. Dry Rubber Content (DRC), (According to ISO 126)

10±1g of NRL Concentrate was put in a dish, and 20g/cm² acetic acid solution was added gently along the inner edges of the dish while revolving it slowly. When the serum is clear, the collection of the small particles of coagulated rubber will be done by rubbing with the bulk. The coagulated rubber will be soaked and washed with many changes of water till the water is no longer acidic to litmus, after some 5 – 10 mins. The sheet will then be dried at 70±5°C till all white particles disappear.

3.3.2. Alkalinity (%), (Test According to ISO 125)

A test portion of latex is titrated with acid to a pH of 6 in the presence of a stabilizer, i.e., potassium oleate and potassium hydroxide, to prevent coagulation. Methyl red will be used as the visual indicator. The alkalinity is calculated from the quantity of acid used up.

3.3.3. Mechanical Stability Time (MST), (ISO 35)

A test portion of NRL will be diluted to 55% by mass of the TSC and stirred at high speeds. The time required to initiate visible flocculation will be recorded. This gives an indication of the MST.

3.3.4. Total Solids Content (TSC), (ISO 124)

2g of NR will be poured into the dish after determining its exact mass by weighing it approximately to the nearest 0.1mg. The dish will then be placed in the oven at 105±5°C for 2h or until the test portion has lost its whiteness. Remove the dish from the oven and allow it to cool to room temperature.

3.3.5. Volatile Fatty Acids (VFA) (Test According to ISO 506)

A portion will be coagulated with ammonium sulphate and a portion of the resultant serum will be separated and acidified with tetraoxosulphate (iv) acid. The acidified serum is steam distilled and the volatile acids present in the test portion will be determined by titrating the distillate with a standard volumetric barium hydroxide solution.

4. Expected Results

The use of Tamarind Kernel Powder (TKP) as a creaming agent has been practiced in many third-world countries for quite a long time (3,4,8). However, although numerous pieces of literature exist on the use of polysaccharides as creaming agents, Cassava Processing Effluent (CPE) has not been used as a creaming agent hitherto. It is expected that the FNRL, with a DRC of about 40% and water of about 60%, will be transformed to cream-concentrated natural rubber latex (CCNRL) with a DRC of about 60% and water of about 40%. Also, the VFA, Alkalinity and MST will show considerable improvement over that of FNRL. The creaming phenomenon starts when FNRL is added to a cream agent and two layers of latex gradually appear. The upper layer is CCNRL and about 0.6 – 0.7% ammonia is added for its preservation. The lower fraction is the serum and this can be from the cream latex by gravity and the action of a creaming agent.

4.1. The Characteristics of CCNRL

Table 3 shows the different properties of FNRL and CCNRL. When FNRL is transformed into CNRL by creaming with TKP and CPE, we will expect the TSC and DRC values of the CCNRL to be clearly higher than those of FNRL. However, no significant changes are expected in alkalinity and VFA between FNRL and CCNRL. The CCNRL will be allowed to stand for two days (48 hours) to 3 days (72 hours), using an optimum creaming solution concentration of 4ml. The alkalinity indicates the level of ammonia in latex and the VFA indicates the degradation of latex by micro-organisms.

Property	FNR	Expected CCNRL (TKP and CPE)
TSC (%)	38.44	56.23, 56.21
DRC (%)	29.34	54.23, 55.25
Alkalinity (%)	0.68	0.15, 0.13
VFA	0.044	0.030, 0.033

Table 3: Parameter of FNRL and the Expected Parameter of (TKP and CPE CCNRL) Preliminary Results

With the expected results above, it is highly hopeful that Cassava Processing Effluents (CPE) will eventually become a good candidate for creaming FNRL.

5. Conclusion

The project will seek to produce cream-concentrated natural rubber latex (CCNRL) from fresh, natural rubber latex (FNRL). This will be done by using Tamarind Kernel Powder (TKP) and novel material, Cassava Processing Effluent (CPE). These two produced concentrates will be compared and contrasted properties-wise. It is expected that CPE will produce concentrates that will not only match those of TKP but even better ones. Also, CPE is so very much available, abundant, cheap and environmentally and healthy and also enhances green chemistry. It is also cheap and affordable and

easily processed. It will also make life easy for smallholder farmers and small and medium-scale industrialists. Also, it will save the millions of dollars spent in importing chemicals that are not only finite, but some are toxic and hence health challenges, and also reduce environmental pollution a great deal.

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