An Alternative, Labor-Intensive Method for Guayule Latex Production in Developing Countries

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Abstract

Guayule latex is free of proteins which cause Type I latex allergy. However, the extraction, clarification and purification of this latex is a highly mechanized process, inconvenient and too expensive for rural areas in developing countries. This study evaluated different concentrations of flocculants, as a replacement of centrifugal clarification, in order to identify those that most efficiently remove non-latex particulates from latex-containing guayule homogenate without removing the emulsified rubber particles in the latex fraction. Cationic flocculants were found to be more effective than anionic ones. Concentrations above 3% flocculant decreased the amount of latex by precipitating and/or attaching rubber particles to non-latex solids. The flocculant C-591 at low concentrations was found to give the best results for both ammonium and potassium hydroxide-based homogenates, and the latex fraction could be separated at 1 x g_n using a creaming agent.

Introduction

Latex production from guayule (*Parthenium argentatum*) was developed in the 1990's[1] and has become a commercial product. Guayule not only produces good quality latex, but this latex has been demonstrated lack the proteins responsible for latex allergy in people[2,3]. This characteristic has made guayule latex especially suitable for the manufacture of medical and consumer products such as gloves and condoms. To extract latex, guayule stems and roots are first homogenized, which releases the rubber particles from the bark parenchyma cells[1]. The rubber particles are then separated, purified and concentrated using a mechanized process, with minimal labor required[1]. Mechanization is essential in industrialized regions, but is disadvantageous for rural areas in developing countries, such as South Africa, where labor intensive production offers jobs needed by the population. This study aims to develop a flocculation system to reduce fine solids from guayule homogenate, without reducing latex concentration, minimizing expensive centrifuge usage, and allowing creaming agents to be used to purify the latex fraction.

Materials and Methods

Materials:

Guayule homogenate was prepared from fresh branches using ammonium hydroxide (pH 10.5) or potassium hydroxide (pH 11). Fourteen flocculants were generously provided by Dober Innovation and Technology Center.

Flocculant testing and latex quantification:

Ten different concentrations of flocculants, 0.18% to 5.72 %, were applied to 14 mL aliquots of each homogenate and centrifuged for 15 minutes at 500 x g_n. Glacial acetic acid (0.7 ml) was added at the solution surface, followed by a second centrifugation under the same conditions (Fig. 1).

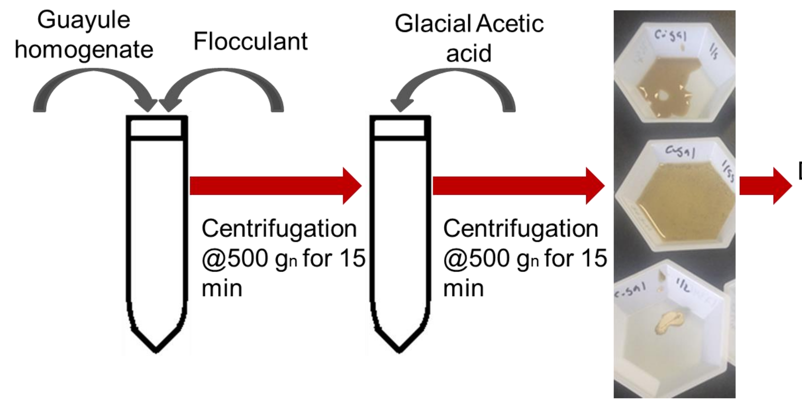

Figure 1: Representation of the step by step flocculant testing and latex quantification method.

The amounts of precipitated solids, remaining suspended non-latex particles, and floated latex were quantified. The dry weight fractions of these components were determined. Seven cationic and seven anionic flocculants were tested in triplicate. The most efficient flocculant treatment was the clarified homogenate containing the highest latex yield combined with the greatest precipitation of non-latex solids. The homogenates must be clarified sufficiently to permit the use of creaming agents to concentrate latex into a floated latex layer. Carboxymethyl cellulose creaming agent is added to the clarified homogenate to make 0.1% to separate the latex into a floated layer.

Results and Discussion

The results indicate that the cationic flocculants tested, performed better than the anionic ones. These last ones, not only flocculated some of the latex in many cases, but also did not show a common trend in the data collected. The latex content as well as solids removed by seven cationic flocculants at 10 different concentrations for ammonium and potassium–based homogenates is reported (Figs 2-5).

Low concentrations (0.18% and 0.36%) of flocculant C-519 removed the greatest percent of solids, while maintaining high latex yield for potassium hydroxide-based homogenate (Figs 2 and 3). Average latex percentages for these concentrations were 17. 2% and 11.2%, respectively, with average percentage solids removed of 22.6% and 29%. Control values were obtained in a clarified homogenate using centrifugation at 2500 x g_n for 15 min followed by the addition of acetic acid and a second centrifugation. The untreated guayule homogenate in potassium hydroxide contained 7.6% latex and 16% solids determined by centrifugation.

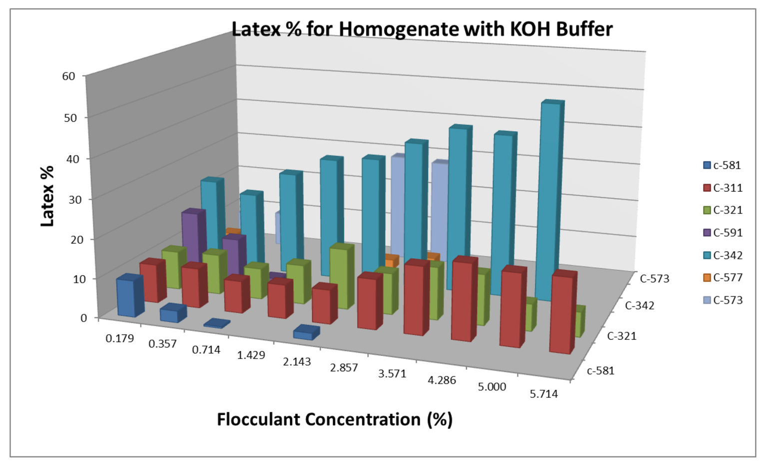

Figure 2: Average latex fraction obtained from guayule homogenate in potassium hydroxide at different concentrations of flocculants.

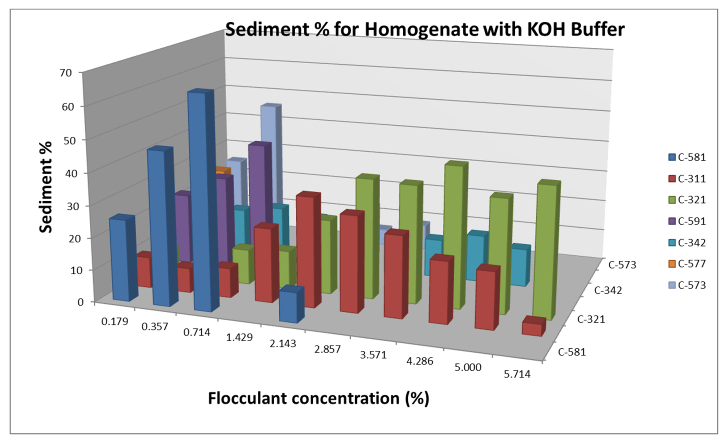

Figure 3: Average sediment fraction obtained from guayule homogenate in potassium hydroxide at different concentrations of flocculants.

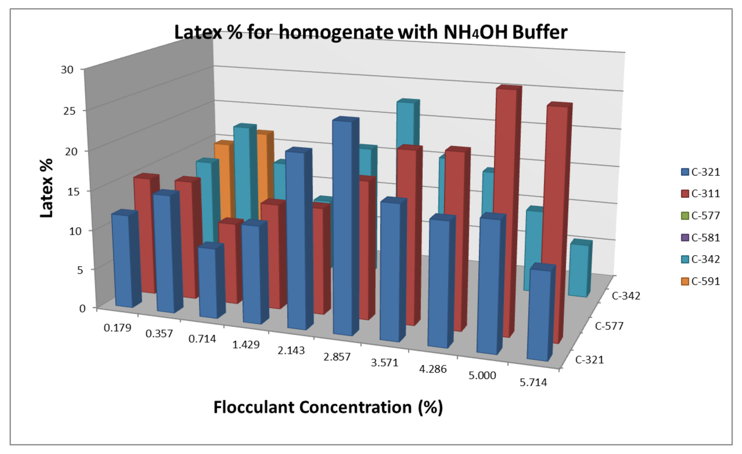

Figure 4: Average latex fraction obtained from guayule homogenate in ammonium hydroxide at different concentrations of flocculants.

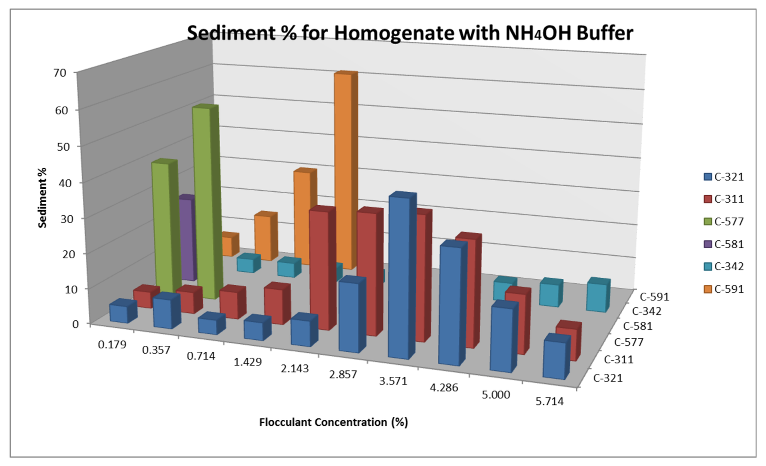

Figure 5: Average sediment fraction obtained from guayule homogenate in ammonium hydroxide at different concentrations of flocculants.

Although the results indicate that flocculant C-342 possesses the highest latex yield (Fig. 2), the latex obtained entrained a large amount of solids (Fig. 6).

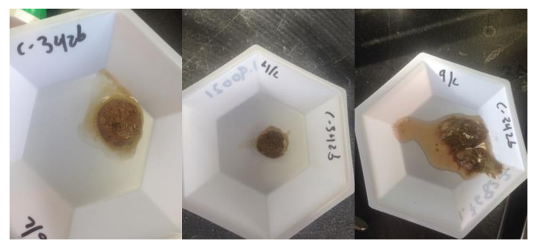

Figure 6: Dirty latex obtained with high concentrations of flocculant C-342 and high concentrations of other such as C-573.

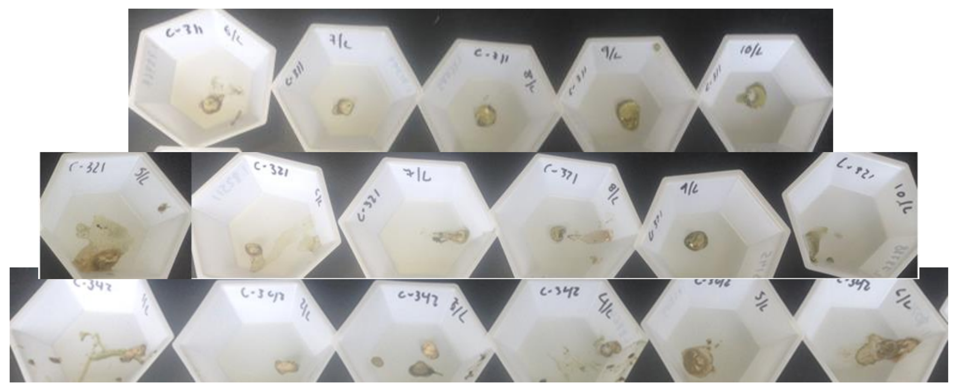

Figure 7: Dirty latex obtained with high concentrations of flocculants C-342, C-311 and C-321.

In ammonium hydroxide-based homogenate, samples treated with flocculants C-311, C-321 and C-342 retained most latex, but the latex contained non-rubber solids (Fig. 7). Based on the quality of the latex obtained and the data collected (Figs 4 and 5), low concentrations (0.18% and 0.36%) of flocculant C-519 removed the greatest percent of solids, while maintaining high latex yield from ammonia hydroxide-based homogenate. Average latex percentages for these concentrations were 14.6% and 16.5%, respectively, with average percent solids removed of 6.2% and 14%. The untreated guayule homogenate in ammonium hydroxide contained 32.8% latex and 18% solids determined by centrifugation.

Finally, the results indicate that low concentrations of flocculant C-591 gave the best results in both potassium and ammonia hydroxide-based, yet more of the available latex was extracted in potassium hydroxide-based homogenate with the aid of flocculants.

Conclusions

In general, cationic flocculants worked better than anionic ones. There was no a specific trend in the data collected for anionic flocculants and therefore, it was not possible to establish the best flocculent or concentration. The results for the seven cationic flocculants indicate that with low concentrations more latex and/or cleaner latex is obtained. C-591 at concentrations of 0.18% and 0.36% present the best results. These results reveal the possibility to use flocculation instead centrifugation to clarify guayule homogenate.

References

1 Cornish, K. Hypoallergenic Natural Rubber Products from *Parthenium argentatum* (Gray) and other non-*Hevea brasiliensis* species, U.S. Patent No. 5580942. 1996.

2 Siler, D. J., Cornish, K. and Hamilton, R. G. Absence of cross-reactivity of IgE antibodies from Hevea brasiliensis latex allergic subjects with a new source of natural rubber latex from guayule (*Parthenium argentatum*). J. Allergy and Clinical Immunology. 98: 895-902. 1996.

3 Hamilton R.G. and Cornish K. 2010. Immunogenicity studies of guayule and guayule latex in occupationally exposed workers. Industrial Crops and Products 31:197-201.

4 Cornish K., Chapman M.H., Nakayama F.S., Vinyard S.H. and Whitehand L.C. 1999. Latex quantification in guayule shrub and homogenate. Industrial Crops and Products 10:121-136.

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