Property variation of centrifuged latex at different maturity stages in glove manufacturing

I.D.H.C. Iddamalgoda, N.S.Withanage, N.R.Weerawansa
Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka

A.P. Atthanayaka
Rubber Research Institute, Thelawala road, Rathmalana

and

P.H.S. Kumara
Lalan Rubbers (Pvt) Ltd

Introduction

In the glove manufacturing industry, quality of the centrifuged latex is highly concerned. Properties of the centrifuge latex can be deviate from the acceptable level with the maturity. Therefore study of the variation of both chemical and physio mechanical properties of centrifuge latex with the maturity is very much important for the manufacturers of latex products (Riyajan, 2009). Normally it is not possible to obtain the required amount of field latex for the centrifugation due to the rainy season in the country. But the manufactures of latex gloves have to maintain their production without discarding any order of the buyers. To overcome this problem, manufacture has to concentrate an alternative way for the glove manufacturing. Therefore low matured latex is also used in some extent while mixing with the matured latex during the compounding.

Main objective is to determine the usage of low maturity latex (before 21 days maturity) for the production of house hold glove manufacturing while studying the properties of centrifuged and compounded latex at different maturity stages.

Methodology:

Centrifuged latex was obtained from the Centrifuge unitof Lalan Rubbers pvt Ltd at Warakapola. Freshly produced centrifuged latex was selected to conduct the research activities. Different maturity periods were set as treatments for research study and seven treatments were applied to get results. During this experiment, changes of both chemical and physiomechanical properties of centrifuged latex were evaluated at different maturity stages. Experiment was started after 5 days maturity of centrifuged latex and continued up to 65 days maturity periods.

Table 01: Treatment combination of the research

Treatments	Description (Maturity days)
Treatment 01	05
Treatment 02	15
Treatment 03	25
Treatment 04	35
Treatment 05	45
Treatment 06	55
Treatment 07	65

Centrifuge latex was obtained according to ISO 123:2001 sampling procedure from the latex storage tank. Latex was taken from the top, middle and bottom part of the centrifuged latex storage tank. Then they were homogenized and three replicates were taken to continue the test procedures. Total solid content(TSC), dry rubber content(DRC), viscosity, alkalinity, mechanical stability time(MST), volatile fatty acid content(VFA), non-rubber content and KOH number were measured as chemical properties of centrifuged latex by following ISO standards.

To evaluate physiomechanical properties, 10 kg of centrifuged latex were separated and latex compound was prepared according to the standard house hold glove formulation at Lalan Rubber factory. Tensile strength, tear strength, aging properties and crosslinking density were measured as physio mechanical properties. The experiment was conducted in Complete Randomized Design with three replicates. Minitab 16 statistical software was used to analyze the variance of the quantitative characters followed by the Tukey test at the 0.05 probability level as mean separation technique.

Results and discussion

The results obtained in the study and there explanations can be summarized as follows.

Table 02: Chemical properties variation with maturity

Treatment	Description (Maturity day)	Measured values						
		Viscosity (cps)	Alkalinity (%)	DRC (%)	MST (s)	VFA	TSC (%)	KOH
1	05	76.00[a]	0.650[b]	60.29[a]	272.7[d]	0.0153[c]	62.07[a]	0.50[f]
2	15	64.66[b]	0.590[d]	60.41[a]	1035.0[c]	0.0183[b]	61.97[a]	0.50[f]
3	25	60.33[c]	0.586[d]	60.22[a,b]	1160.0[b,c]	0.0216[a]	61.83[a]	0.69[c]
4	35	54.66[d]	0.619[c]	60.00[b]	1240.0[a,b]	0.0213[a]	61.26[b]	0.67[d]
5	45	57.66[c]	0.593[d]	60.33[a]	1261.7[a,b]	0.0220[a]	61.85[a]	0.68[c]
6	55	58.50[c]	0.589[d]	60.17[a,b]	1363.0[a]	0.0216[a]	61.80[a]	0.71[b]
7	65	50.00[e]	0.723[a]	59.37 [c]	1234.3[b]	0.0226[a]	60.94[c]	0.71[b]
	Standard	50-60	<0.75	60.0	>600	<0.02	61.5	<1

Treatment level	Description (Maturity days)	Means of tensile strength	Means of 100% modulus	Means of 300% modulus	Means of Elongation @ break	Aged tensile strength
1	5 days	19.96$^{b\,c}$	1.3846^{a}	3.8024^{c}	538.4^{b,c}	21.61^{d}
2	15 days	19.43$^{c\,d}$	1.42980^{a}	7.1604^{a}	425.3^{e}	26.77^{a}
3	25 days	19.98$^{b\,c}$	1.115^{b}	3.5224^{c}	569.3^{a}	20.17^{e}
4	35 days	20.81^{b}	1.0652^{b}	5.5456^{b}	523.2^{c}	20.36^{e}
5	45 days	18.54$^{d\,e}$	1.0956^{b}	2.7886^{d}	452.6^{d}	21.13^{d}
6	55 days	18.10^{e}	0.8828^{c}	2.7886^{d}	551.2$^{a\,b}$	23.63^{c}
7	65 days	22.45^{a}	1.0802^{b}	5.3224^{b}	518.2^{c}	24.65^{b}

Table 03: Physio mechanical properties variation with maturity

Viscosity of the centrifuged latex decreased with the maturity time. According to the literature hydrodynamic influence, DRC and temperature affect to deviations of viscosity value (Sashidaran, 2005). Alkalinity was also maintained at the standard level. DRC is also maintained at standard level for the centrifuged latex and deviation can be seen in 65 days DRC value. Addition of ammonia could be a reason to that result. MST values are maintained at standard level from 15 days maturity to 65 days maturity period. Lipid hydrolysis of the latex was a prominent reaction that contributing higher fatty acid (HFA) to the medium. Then these HFA can contribute to increase the stability of MST in the latex sample. VFA and KOH were gradually increase with the maturity time and maintained in the standard range. Acid content of the centrifuged latex can be increased due to activities of the microbes (Bleckley, 1997). Microbes can feed on proteins and other non-rubber particles while producing fatty acid.TSC values were maintained in the acceptable range of the centrifuged latex. But some fluctuations could be seen in TSC at 35 and 65 days values due to addition of ammonia liquid in to the latex. Non rubber content of the centrifuged latex was below the acceptable range (less than 01) of the centrifuged latex.

According to the results, there was a significant difference (P=0.000) in physio mechanical properties and aging properties of the Latex with the maturity times. The standard values for

tensile strength before and after aging for household gloves are minimum 10 MPa (N/mm^2) and minimum 7.5 MPa respectively. According to the results both unaged and aged tensile strength values were higher than standard values. Maximum tensile strength can be seen in 65 days matured latex film. Crosslinking density was between 1×10^{17} - 3×10^{17} crosslinks/g after 25 days maturity.

Conclusions

The results achieved through the research showed that the chemical and physio mechanical properties of 15 days matured centrifuged latex were also in the ideal range for the house hold glove manufacturing. Therefore, it is not needed to delay the production until 21 days maturity of centrifuged latex and then it will help to reduce the cost of storage, improve the cash flow and to increase the efficiency of production.

Further, ideal chemical and physio mechanical properties were showed up to 65 days maturity of the centrifuged latex. Therefore, centrifuged latex could be used between the 15 to 65 days maturity range for the house hold glove manufacturing.

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