Studied on Virgin Coconut Oil (VCO) and Olive Oil (OO) as an Alternative for Stabilizer of Radiation Vulcanized Natural Rubber Latex (RVNRL) Preparation

Kajian Minyak Kelapa Dara (VCO) dan Minyak Zaiton (OO) Sebagai Alternatif Bahan Penstabil Dalam Penyediaan Getah Lateks Asli Tervulkan Penyinaran (RVNRL)

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Abstract

This paper presents the effects of virgin coconut oil (VCO) and olive oil (OO) as an alternative stabilizer in the radiation vulcanized natural rubber latex (RVNRL). Potassium laurite (KL) as a stabilizer considered as a control of RVNRL sample were compared to mixed ratio 1:1 KL: VCO and 1:1 KL: OO stabilizer formulation. Total solid content (TSC) and tensile strength (TS) results showed no significant different between the formulations. Mechanical stability time (MST) indicates higher stability of RVNRL with addition of VCO. The fatty acid composition in VCO indicate VCO was acting well as stabilizer for latex stabilizer formulation.

Keyword: stabilizer, Virgin Coconut Oil (VCO), Olive Oil (OO), potassium laurite (KL)

Abstrak

Kertas kerja ini membentangkan kesan minyak kelapa dara (VCO) dan minyak zaitun (OO) sebagai alternatif bahan penstabil dalam penyediaan susu getah asli tervulkan penyinaran (RVNRL). Kalium laurat (KL) sebagai penstabil dianggap sampel RVNRL kawalan dibandingkan dengan nisbah campuran 1: 1 KL : VCO dan 1: 1 KL : OO formulasi penstabil. Jumlah kandungan pepejal (TSC) dan ujian kekuatan tegangan (TS) tidak menunjukkan perbezaan ketara bagi formulasi yang berlainan. Masa kestabilan mekanikal (MST) menunjukkan kestabilan yang lebih tinggi RVNRL dengan penambahan VCO. Komposisi asid lemak dalam VCO menunjukkan VCO bertindak penstabil yang baik bagi formulasi bahan penstabil dalam susu getah.

Kata kunci: penstabil, Minyak Kelapa Dara (VCO), Minyak Zaiton (OO), kalium laurat (KL)

INTRODUCTION

The improvement of the radiation technique of Radiation Vulcanization of Natural Rubber Latex (RVNRL) technology to the related industries has been carried out. Development of new stabilizer and the stringent environmental regulation was investigate using laurite together with existed stabilizer. It was suggested that in the case of carboxylated soap stabilized latex compound, caprylate soap were recommended to be used in solving some physical properties of latex. The main fatty acid found in virgin coconut oil (VCO) is lauric acid which is the most important fatty acid used to prepare latex stabilizer (Tongkhundam, J. et al. 2010). It can be assumed that using VCO or OO for latex as stabilizer preparation would solve the problems as well was acting as the stabilizer. Using VCO and OO instead of lauric acid should decrease material expense since both are cheaper than lauric acid and it was also easily available.

In this study, the effect of VCO and OO as an alternative stabilizer to replaced potassium laurate were investigated in order to know the physical and mechanical strength of the latex. Thus, quality control analysis has been done to all of the latex sample to identify the difference in the physical and mechanical characteristic. The quality control involved are the Total Solid Content (TSC) and Mechanical Stability Time (MST). The determination of mechanical strength are based on the tensile strength of the film made.

EXPERIMENTAL

2.1 Material

The high ammonia NR latex used in this studies was obtained from Biotech Instruments Sdn. Bhd.,Serdang, Selangor. For formulation purpose, there was 1,6-hexanediol diacrytlate (HDDA) as sensitizer, Pottasium Laurate (KL), Virgin Coconut Oil (VOC) and Olive Oil (OO) as stabilizer and Irganox 1520 (40%) as an antioxidant.

2.2 Preparation of RVNRL

In this experiment there are 3 types of sample that was prepared using the same formulation, but with different addition of stabilizer which are OO and VOC. The source of radiation used is Gamma radiation. The dose of radiation used is minimum 12kGy and maximum is 15kGy.

Based on the RVNRL formulation from the table 1, 2 and 3; the 450 g of raw latex that are used was stir using magnetic stirrer for 30 minutes to give the stability of the latex before other mixture was added. In table 1, 0.68g of potassium laurate only was used to act as a control. The potassium laurate are mixed with 5.65 g antioxidant Irganox 1520 (40%), 5.65 g HDDA and 69.11g amount of water to dilute the mixture. Then, the mixture solution was emulsify using emulsifier model SILVERSON L 5 M – A at 10 minute to mix it. The emulsify solution then added to the raw latex slowly drop by drop using glass rod in order to give the solvent mix with the raw latex. The mix latex was then stirred for about 3 hours before expose for gamma radiation. The sample was radiated with minimum 12kGy to make the latex crosslinking.

The step involved for table 2 and 3 is same but with addition of olive oil and virgin oil as stabilizer instead of using only potassium laurate.

Table 1. RII formulation with the addition of potassium laurate (control)

Materials	TSC, %	PHR	Wet Weight, g	Actual Weight, g
Latex	61.25	100	163.27	369
Potassium Laurate	20	0.06	0.3	0.68
Antioxidant Irganox 1520 (40%)	40	1	2.5	5.65
HDDA		2.5	2.5	5.65
Water			30.58	69.11
Total	52	103.56	199.15	450

Table 2. RII formulation with the addition of potassium laurate and olive oil

Materials	TSC, %	PHR	Wet Weight, g	Actual Weight, g
Latex	61.25	100	163.27	369
Potassium Laurate	20	0.06	0.3	0.34 + 0.34 olive oil
Antioxidant Irganox 1520 (40%)	40	1	2.5	5.65
HDDA		2.5	2.5	5.65
Water			30.58	69.11
Total	52	103.56	199.15	450

Table 3. RII formulation with the addition of potassium laurate and virgin oil

Materials	TSC, %	PHR	Wet Weight, g	Actual Weight, g
Latex	61.25	100	163.27	369
Potassium Laurate	20	0.06	0.3	0.34 + 0.34 virgin oil
Antioxidant Irganox 1520 (40%)	40	1	2.5	5.65
HDDA		2.5	2.5	5.65
Water			30.58	69.11
Total	52	103.56	199.15	450

2.3 RVNRL Film Preparation

The films were prepared by dipping RVNRL on a glass plate (12 x 18 cm^2). The films were left to dry until transparent through heated in an oven at 100ºC for an hour. The films needed to storage in room temperature at least 16 hours before they were cut into dumbbell shape for tensile test measurement.

2.4 Physical Properties Test

2.4.1- Total Solid Content (TSC)

TSC influence the latex compound in 2g sampling. It is reflect to the amount of purity of the latex. The amount of TSC will affect latex for tensile sample preparation during dilution process.

2.4.2- MST

The MST was prepared by weighted 80g of latex in the MST beaker. The beaker then was put on the MST machine. The MST machine was set up 14000 rpm. A glass rod was dipped into the beaker when the height of the latex is half the original height and wipes it on the palm of the hand to observe the presence of flocculum.

2.4.3 Tensile Properties

The dumbbell shape test pieces were measure for tensile properties (tensile strength,Ts; Modulus at 500%,M500; and Modulus at 700%,M700).

RESULT AND DISCUSSION

Based on the result obtained (Table 4), the TSC value is closed to the specification. There are no significant difference between RVNRL with the presence of VOC and OO as a stabilizer. This is because of the homogeneity of the mixed dispersion. Mixing of mixed dispersion into the latex is just like adding one more dispersion. This indicates that the efficiency of RVNRL is enhanced by OH radicals produced by radiolysis of water effect of dispersion preparation techniques during ion exchanging process until the uniform distribution of those species on latex and chemical interaction particles was reached.

Table 4. Result of Total Solid Content (TSC), % for RVNRL

Sample	**Stabilizer**	**TSC, %**
RVNRL	Potassium Laurate (control)	53.28
	Potassium Laurate + Olive Oil	52.17
	Potassium Laurate + Virgin Oil	53.67

Irradiation causes changes in the colloidal properties of the latex and the mechanical properties of the latex film (Makuuchi, 2003). Based on the table 5 shows that the MST for control is 1380 seconds while for OO and VOC are 840 seconds and 1140 seconds respectively. Thus, based on the result obtained, the time taken for flocculation to occur in sample that contain VOC is most likely closed to control (potassium laurate) compared to OO. This is because; the chemical bond of OO maybe loose after radiation is applying to it. Hence, it affects the stability of latex. A very high MST causes uneven films in the dipping products. Thus, the most likely stabilizer that can be used to determine the stability of latex instead of using potassium laurate is VOC because it MST is closed to control.

According to Makuuchi (2003), the strength of the RVNRL film is realized by the two factors which are intraparticle crosslinking (chemical crosslinking) and interparticle entanglement (physical crosslinking). In this experiment intraparticle crosslinking is not be considered as the dose apply to the sample is same. Hence, only interparticle entanglement is focus because it is dependent on the free rubber chain ends at the surface of each latex particle. These chains interpenetrate during the film formation and contribute to the strength of the film by means of entanglements. The interparticle entanglement mainly depends on the two processing factors which are leaching conditions of the latex film and also drying conditions of the latex film. Rubber particles in the latex are covered with water-soluble non-rubber components that inhibit better fusion of the rubber particles. Leaching results in the removal of the adsorbed components and enhances the fusion of the particles. The heating enhances fusion of the rubber particles and increased chain entanglements of the rubber molecules. This indicates that the tensile strength of the RVNRL films depends on the degree of drying.

Table 5. Result of Mechanical Stability Time (MST) for RVNRL

Sample	Stabilizer	MST, sec
RVNRL	Potassium Laurate (control)	1380
	Potassium Laurate + Olive Oil	840
	Potassium Laurate + Virgin Oil	1140

According to Makuuchi (2003), the strength of the RVNRL film is realized by the two factors which are intraparticle crosslinking (chemical crosslinking) and interparticle entanglement (physical crosslinking). In this experiment intraparticle crosslinking is not be considered as the dose apply to the sample is same. Hence, only interparticle entanglement is focus because it is dependent on the free rubber chain ends at the surface of each latex particle. These chains interpenetrate during the film formation and contribute to the strength of the film by means of entanglements. The interparticle entanglement mainly depends on the two processing factors which are leaching conditions of the latex film and also drying conditions of the latex film. Rubber particles in the latex are covered with water-soluble non-rubber components that inhibit better fusion of the rubber particles. Leaching results in the removal of the adsorbed components and enhances the fusion of the particles. The heating enhances fusion of the rubber particles and

increased chain entanglements of the rubber molecules. This indicates that the tensile strength of the RVNRL films depends on the degree of drying.

Based on table 6, the tensile strength for control is 21.28 MPa, while the tensile strength for film containing olive oil and virgin oil are 21.50 MPa and 20.14 MPa respectively. Thus, it can be clearly seen on the figure 1 that shows a slightly decrease in tensile strength of film for virgin oil. Although it is said to be different, it is still considered close to the control. This may be an effect of saponification method that was not done in this experiment. In addition, the result obtained may be causes by some errors while handling the testing machine. A uniform and excellent quality film structure cannot be expected to form from the latex because breakage of the film with stress initiates from these weak spots. Thus, the steps involve in preparing sample for preparing rubber film is critical step as it may cause limitation to obtained good quality of film.

Table 6. The summarization of tensile strength based on median

Sample	Thickness (mm)	Mod @ 500% (MPa)	Mod @ 700% (MPa)	Tensile Strength	Elongation @ Break (100%)
Potassium Laurate (control)	0.291	2.04	7.11	21.28	946
Potassium Laurate + Olive Oil	0.308	2.01	7.63	21.50	950
Potassium Laurate + Virgin Oil	0.304	1.95	7.16	20.14	940

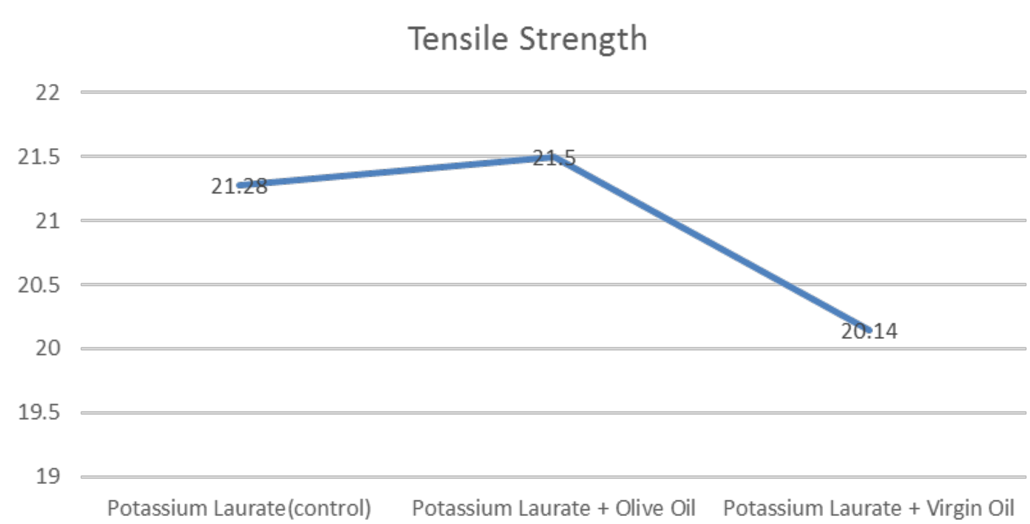

Figure 1. Graph of tensile strength vs. types of stabilizer used

CONCLUSION

Based on the result discussed for this early stage experiment, the TSC obtained for RVNRL for the samples tested is closed to the specification of Raymintex. The MST obtained of potassium laurate for both raw latex and RVNRL is proved to exceed the specification of Raymintex also. For OO and VOC, the expectation result cannot be obtained as larger amount of oil need to be used. The tensile strength of RVNRL for OO and VOC is actually closed to the control. As a conclusion, using oil to replace the used of potassium laurate as stabilizer in latex is possible because the resulted obtained when compared to potassium laurate is quite closed to each other. In this experiment VOC has the highest possibility to the used as an alternative stabilizer compared to OO. This is due to MST obtained which indicates lower stability of latex with the addition of OO. However, the oil cannot be used directly in latex. It must undergo saponification method as done in the previous study to obtained better result.

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