LATEX CHARACTERISTIC AND RUBBER PROPERTIES OF IRR 400 SERIES CLONE

ANDI WIJAYA[1], ARIEF RACHMAWAN[1], SYARIFAH AINI PASARIBU[1]
[1]Sungei Putih Research Center, Indonesian Rubber Research Institute
Galang-Deli Serdang, PO BOX 1415 Medan 20001

ABSTRACT

A. Wijaya, A. Rachmawan, S.A. Pasaribu. 2018. Latex Characteristic and Rubber Properties of IRR 400 Series Clone. Rubber cultivation (*Hevea brasiliensis*) in Indonesia using grafted techniques (also known as clonal plants) have been done since in 1916 to obtain high productivity and latex quality for the rubber industry. This study aimed to investigate the latex characteristic and rubber properties from selected clones. The clones were IRR 425, IRR 428, IRR 429, IRR 431, and IRR 434. Latex was collected from some rubber trees which had a d/2 tapping frequency system on BO-1 panel and then it was analyzed in accordance with Standard Indonesian Rubber (SIR) spesifications. Rubber compound also was prepared using ACS-1A to find out physical properties of each rubber clone. The result showed that IRR 425 had the highest of dry rubber content about 36,11% whereas IRR 428 was found to be lower about 27,45%. Rubber properties of IRR 429 showed good values in modulus 300%, tensile strength, elongation, tear strength, and hardness i.e. 2,15 Mpa, 17,20 Mpa, 680 Mpa, 40,47 Mpa, and 41, respectively. All rubber clones fulfilled the spesifications for SIR 10.

Keywords: *Hevea brasiliensis*, Standard Indonesian Rubber, rubber clone, rubber properties, IRR 400 series.

A. INTRODUCTION

The utilisation of grafting material on rubber plant or also known as clonal rubber plant was carried out in 1916 to produce superior clones and create a competitive plantation industry (Daslin, 2014). The importance of the quality of natural rubber latex from clonal plant also provided an overview of the quality of rubber products as well, thus creating products that could compete widely in the market. Amu (2007) reported that the right material of clone (natural rubber) is responsible for natural rubber-based products, both engineering rubber products and tires that currently reached 70% production globally. Oktavia, et al. (2014) in his study also reported that to get the optimum smoked rubber sheet (RSS) had to be supported by superior clone of plant material.

The 400 series of IRR rubber clone is a clone of the selection results of Sungei Putih Research Center, Indonesian Rubber Research Institute. The genetic material selected was the result of a crossing in 1996/1997 which produced 101 progenies (F1 plant). Progeni which was selected based on the characteristic of growth and production was then referred to as 400 series IRR clones. Currently, the 400 series of IRR rubber clone had been planted in the preliminary testing area which was built since 2004 (Pasaribu, et al., 2015).

Natural rubber has good mechanical and dynamic properties, such as low heat build-up, high green strength, tack and cohesive properties, excellent adhesion to steel cool, high tear strength and low rolling resistance (Amu, 2007; Datta, 2004). Due to the superiority of natural rubber, global consumption is still in demand. According to the International Rubber Study Group (2017) natural rubber consumption experienced an increase about 12 million tons in 2016, this was also followed by an increase in natural rubber production for the same value.

Many researches on the characteristic of rubber clones have been conducted which aimed to determine the initial properties of rubber for processing into technical specification rubber (Standard Indonesian Rubber) and concentrated latex. Some studies had been reported that the rubber properties associated with clone types were Po, PRI, and viscosity values (Ahmad, 2017; Eng, et al., 2001; Anas, 1994, Daslin and Anas, 2003). The characteristics of latex diagnosis from rubber clone had also been reported by Yuan, et al. (1998) and Nair, et al. (2004) for tapping management and increasing latex production. This study aimed to determine latex characteristic and rubber properties of IRR 400 series clone, such as dry rubber content, Po, PRI, Mooney viscosity, and rubber compound properties (using ACS-1A compound).

B. MATERIALS AND METHODS

Sample collection

The study was conducted in February-March 2018 at the Laboratory of Technology in Sungei Putih Research Center and Laboratory of Industri Karet Deli. Latex was obtained from IRR rubber clones 400 series, namely IRR 425, IRR 428, IRR 429, IRR 430, and IRR 431 in the experimental field of Sungei Putih Research Center with 1/2S d /2 tapping frequency system on BO-1 panel. Each sample is repeated three times. Latex is then coagulated with 5% formic acid and then it was analyzed. Latex analysis method for dry rubber content according to ASTM-D 1076-88, while for Po, PRI, and mooney viscosity in accordance with the method of SNI 1903-2011.

Rubber composites preparation

The compounding of the rubber was carried out on laboratory scale of two roll-mill. The rubber was first masticated for 5 minutes. Additives were added sequentially as given in the Table 1. After the addition of all the additives, rubber compounds were kept at ambient temperature for at least 24 h before their cure properties were measured. The compounds were subsequently cured in a compression mould at 160 ºC in a hydraulic press to form test pieces for measuring the technical properties of the rubber clones, such as modulus, elongation, tensile strength, tear strength, properties of curing time, specific gravity, and hardness.

Tabel 1. Rubber compounds formulation ACS-1A

Materials	Composition (per hundred rubber, *phr*)
Crepe/rubber	100
ZnO	6
Stearic acid	0.5
MBT	0.5
Sulphur	3.5

C. RESULTS AND DISCUSSION

Hevea latex as obtained from the tree consists not only of rubber hydrocarbon particles, but also non-rubber substances which include lipids, proteins, carbohydrates, amines and some inorganic constituents. It is generally known that some of these non-rubbers can affect the properties of latex concentrates and bulk rubber derived from the field latex. Relevant field latex properties such as dry rubber content (d.r.c.) and colour of latex were therefore investigated. Results for the various clones are studied as shown in Tables 2.

Tabel 2. Characteristics of latex and bulk rubber clone 400 series

Name of Clone	d.r.c (%)	Po	PRI	Vr	Colour of Latex
IRR 425	36.11	49	83	82	white
IRR 428	27.45	48	83	82	white
IRR 429	33.60	60	79	92	white
IRR 431	33.03	49	83	79	white
IRR 434	31.37	42	85	68	white
SIR 10 (SNI 2011)	na	min. 30	min. 50	na	na

Note: na : not available

Dry rubber content.

This is a highly variable property. When a tree of any one clone is first tapped, it produces an unstable latex with a low rubber content. As the tapping is continued with a regular tapping system, the latex stability increases and the d.r.c. falls to a steady level which can vary between 25% and 45%, depending on the nature of the planting material. Changes in d.r.c. can also be brought about by other factors such as the tapping system, seasonal variation and yield stimulation (Purwaningrum, 2016; Ressing, 1995; Morris and Sekhar, 1959; Wiltshire, 1934). For example, a full-spiral cut gives a lower d.r.c. than a half-spiral cut, and alternate daily tapping results in a higher d.r.c. than daily tapping. Furthermore, intensive tapping or drastic tapping causes marked decrease in d.r.c.

The high d.r.c. occurring at the end of a dry season is an effect of seasonal variation. Although an inverse relationship between productivity and d.r.c. is generally found for any one tree, no such correlation has been reported for different clones (Resing, 1955). Lower d.r.c. is often found to result from application of yield stimulants to the tree, although d.r.c. generally increases again after some time (Abraham, et al., 1971)

In view of these variables, all the latices studied were collected from trees grown in one area, tapped on the same tapping system and with yield stimulation. Samplings were also made at intervals over a period of a month to include any variation due to seasonal changes.

Po and PRI

Initial Wallace Plasticity of dry rubber from field grade and latex grade were investigated and the results are shown in Table 2. It shows that all individual clones fulfil the specified parameters for SIR 10. The Po values for the rubber clone were found to vary from 42 to 60, and were observed to be well above the minimum limit of 30. Po is a method of measuring the hardness of NR and it is influenced by molecular weight and gel content of the NR. For SIR field grade, a rubber is considered to be too soft if the Po value is below 30 units. On the other hand Po is not specified for SIR CV hence it was not further investigated.

Plasticity Retention Index (PRI) of the samples are presented in Table 2. It reflects the resistance of the rubber to molecular breakdown when it is heated in an oven at 140°C for 30 min. The level of degradation during heating is assessed using the Wallace plasticity value. PRI is calculated from the following equation:

$$PRI = P_{30}/Po$$

where P_{30} is the aged plasticity and Po is the plasticity before ageing in the oven.

The results show that all rubber clone satisfied the Plasticity Retention Index (PRI) limit in the SIR 10 scheme. The PRI values of all the clones were 80 above the minimum limit of 50. This suggests that all clones did not affect the PRI property. It was reported (Yip, 1990) in a previous study that there are reactions that occur during PRI test; degradation, crosslinking by free radicals and a certain amount of hardening due to the aldehyde groups and the aldehyde-condensing groups.

Mooney Viscosity

Mooney viscosity is a measurement of hardness and is closely related to the rubber processability properties. It is understood that rubber with high Mooney viscosity requires long pre-mastication times whereas rubber with low Mooney viscosity requires less pre-mastication. From the 5 clones studied, the Mooney viscosity of 5 clones was found to exceed the limit specified for SIR CV. It is understood that the Mooney viscosity of rubber can sometimes change during storage and this is due to the fact that natural rubber often hardens, resulting in higher bulk viscosity (Yip, 1990). The increase in hardness on storage could be due to the presence of carbonyl groups in rubber (Yip, 1990). Obviously, latices with high Mooney rubber cannot be used for CV production. To overcome the high Mooney viscosity of rubber, it is necessary to blend clonal latices to obtain the required viscosity range for SIR CV (Sekhar, 1961).

Mooney viscosity and initial Wallace viscosity have a relation as it was reported by Ahmad (2017) that a correlation between Mooney viscosity and Initial Wallace Plasticity (Po) values is found. The increase in Mooney viscosity values is consistent with the increasing in Po values. Their relationship however is dependent on the history of the rubber samples involved since differences in processing, drying conditions and mastication could affect it. Nevertheless, in this study the samples were treated under the same conditions.

The curing characteristics consisting of maximum torque (Smax), minimum torque (Smin), ΔS (Smax-Smin), optimum curing time (t_{90}), and scorch time (ts_2) are presented in Table 3. Maximum torque values of IRR 425 compound is the smallest compared to other compounds.

Tabel 3. Rubber curing characteristics of IRR 400 series clone

Name of Clone	Smax	Smin	ΔS	t_{90} (minute)	ts_2 (minute)
IRR 425	6.95	0.46	6.49	4.26	0.88
IRR 428	7.95	0.57	7.38	5.68	0.83
IRR 429	8.18	0.95	7.23	5.68	0.86
IRR 431	8.27	1.06	7.21	4.93	0.76
IRR 434	8.13	1.10	7.03	5.84	0.81

Rubber properties of all clones are presented in Table 4. The result showed that IRR 431 had smallest values on tensile strength, elongation at break (EB), and tear strength, yet it had the highest values on modulus 300% and hardness.

Table 4. Rubber compound properties of IRR 400 series clone

Name of Clone	Modulus 300 % (Mpa)	Tensile Strength (Mpa)	EB (Mpa)	Tear Strength (Mpa)	Hardness (Shore A)
IRR 425	1.78	12.33	670	37.83	38
IRR 428	2.04	17.40	680	38.27	40
IRR 429	2.15	17.20	670	40.47	41
IRR 431	2.25	4.93	460	24.07	42
IRR 434	1.89	15.20	640	33.17	42

D. CONCLUSION

Latex derived from IRR 400 series clone had a qualified value of DRC, Po, PRI and Vr of 27 – 33%, 42 – 60, 79 – 85 and 68 – 92, respectively.

ACKNOWLEDGEMENTS

The author wish to express their gratitude to the Sungei Putih Research Center and Indonesian Rubber Research Institute for putting at our disposal their rubber plantations and laboratory facilities for this work. Appreciation goes to the entire staff of the Rubber Testing Laboratory at Industri Karet Deli for their technical assistance.

REFERENCES

Ahmad, A. 2017. Rubber properties of selected clones. Proceeding of International Rubber Conference.

Yuan, X., S. Yang, L. Xu, J. Wu, and B, Hao. 1998. Characteristics related to higher rubber yield of *Hevea barsiliensis* Juvenile-type clon Gl1. J. Rubb. Research. 1(2): 125-132

Anas, A. 1994. Po and PRI Control from SIR 10 from the production of Bukit Selasih crumb rubber factory PTPN IV in the PIR Air Molek Area C project, Riau . Thesis. Institute of Technology Industry-Glugur, Medan.

Nair, N.U., B.R. Nair, M. Thomas, and J. Gopalakrishnan. 2004. Latex diagnosis in related to exploitation system in clone RRII 105. J. Rubb. Research. 7(2): 127-137

Eng, A.H., H. Othman, H. Hasma, O. Ramli, B. Masahuling, V. Muniandy, and S. Kawahara. 2001. Some properties of natural rubber from latex-timber clones. J. Rubb. Research. 4(3): 164-176

Daslin, A. dan A. Anas. 2003. Characteristics of yield and natural rubber latex and wood from various superior generation IV clones. Proceeding. Conference of Rubber Agribusiness Supporting the Rubber and Wood Industry. Indonesian Rubber Research Institute. Daslin, A. 2014. Research progress on IRR 100 series superior rubber clones as timber and latex yielder. Warta Perkaretan. 33(1): 1-10.

Oktavia, V., E. Suroso, T.P. Utomo. 2014. Optimization strategy of field latex as raw material at rubber factory type ribbed smoked sheet (RSS). Journal of Technology Industry and Agricultural Production. 19(2): 179-193.

Pasaribu, S.A., Rosmayati, and Sumarmadji. 2015. Resistance test of rubber IRR 400 series to several isolates Colletotrichum leaf fall disease. Indonesian J. Nat. Rubb. Research. 33(2): 131-142.

Amu, A. 2007. Choice material for engineering rubber products. Proceedings. International Rubber Conference and Exhibition, Bali. ISBN 978-979-608-018-2.

Datta, S. 2004. Special-purpose elastomers. In Brendan Rodgers. Rubber compounding : Chemistry and Applications. Marcel Dekker Inc, New York: 105-132.

Yip, E. 1990. Clonal Characterisation of Latex and Rubber Properties, J. Rubb. Res, 5(1), 52-80

Sekhar, B.C. 1961. Inhibition of Hardening in Natural Rubber. Proc. not. Rubb. Conf. I960, Kuala Lumpur, 512.

Purwaningrum, Y., JA. Napitupulu, C. Hanum, and THS Siregar. 2016. Effect of rubber production system exploitation against the PB 260 clones. J. Tropic Agriculture. 3(1); 62-69. Indonesia

Resing, W.L. 1955. Variability of Hevea Latex. In Esah Yip. Archs Rubb. Cult., 32: 75.

Morris, J.E. and Sekhar, B.C. 1959. Recent Developments in the Production and Processing of Natural Rubber in Malaya. Proc. Int. Rubb. Conf. 1959, Washington D.C., 277.

Wiltshire, J.L. 1934. Variations in the Composition of Latex from Clone and Seedling Rubber. RRIM Bulletine. No. 5.

Abraham, P.O., Blencowe, J.W., Chua, S.E., Gomez, J.B., Moir, G.F.J., Pakianathan, S.W., Sekhar, B.C., Southorn, W.A. and Wycherley, P.R. 1971. Novel Stimulants and Procedures in the Exploitation of Hevea: II. Pilot Trial Using (2-Chloroethyl)phosphoric Acid (Ethephon) and Acetylene with Various Tapping Systems. J. Rubb. Res. Inst. Malaya, 23(2), 85.