Characterization of New Latex-Timber Clones of Natural Rubber

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ABSTRACT: The clonal origin of the natural rubber tree has influences on the latex yield and properties of raw natural rubber (NR); therefore, study of the breeding of NR in order to select suitable rubber clones is important. With a recent increasing demand in rubberwood, yield of timber becomes a new parameter of interest for selection of the rubber clone. Studies were made on new breeds of rubber clones, identified as the RRIM 2000 series. It was found that the new clonal rubbers have a timber yield 3–5 times higher than those of average existing clones such as the Rubber Research Institute of Malaysia (RRIM) 600, while the latex yield is 3 times higher. The other important processing properties, including the mechanical stability time of the latex, Mooney viscosity, and plasticity retention index of raw rubber, are comparable to those of presently used clones and satisfy well the Standard Malaysian Rubber specification. The findings are important as they imply that the lattices and dry rubber of the new rubber clones could be used to produce rubber products without any difficulty. © 2000 John Wiley & Sons, Inc. J Appl Polym Sci 78: 1517–1521, 2000

Key words: rubber clone; natural rubber tree; latex yield; properties of raw natural rubber; rubberwood; timber yield

INTRODUCTION

It is well known that one of the important factors that could affect the properties of raw natural rubber is the clonal origin of the rubber tree. It is therefore important to select rubber clones that produce a high latex yield and rubber having the desired properties in planting of the rubber tree. The breeding program of the Rubber Research Institute of Malaysia (RRIM) started in 1928. Over the years, the Institute has successfully developed six series of rubber clones, i.e., RRIM 500, 600, 700, 800, 900, and more recently 2000 series. The breeding programs in the past were focused on latex yield. However, with the recent increasing demand in rubberwood, the focus is now on clones giving high yields both in latex and timber. Currently, the main source of rubberwood is from old rubber trees that are no longer economical for latex production. With more rubber planters in Malaysia switching from rubber to other crops such as oil palm, the rubberwood production is expected to decline in future. In view of this, rubber clones that produce high latex and timber yields, or latex-timber clones (LTC), have been successfully bred by the RRIM and planters in Malaysia are now encouraged to plant the rubber clones.

In the 1995–1997 Planting Recommendation published by the RRIM, LTC are classified into two groups, i.e., Group I and Group II. Group I (Prang Besar [PB] and 900 series) consists of clones that have proven performances for at least five years in large-scale trials and in commercial plantings. On the other hand, Group II (900 and 2000 series) includes clones selected in small-

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scale clone trials based on five years' yield record, and their performances in different climate, soil, and disease environment are not available yet. The results presented in this paper are based on the rubbers from Group II.

EXPERIMENTAL

All the trees involved in the present study were tapped on the d/2 (once every 2 days) system. The clones studied were RRIM2001, 2002, 2008, 2009, 2014, 2015, 2016, 2020, 2023, 2024, 2025, 2026, using RRIM 600 as a control. Lattices were collected 2 h after tapping and processed into SMR-CV grade rubbers. For latex concentrate preparation, the lattices were preserved with 0.7% ammonia before making them into concentrates. Other experimental details have been reported in the previous study.[1]

RESULTS AND DISCUSSION

Timber and Latex Yields of LTC

Table I shows the timber yields of rubber trees from the LTC, which vary from 0.7 to 2.8 m^3 per tree. This is about 3–5 times higher than that of RRIM 600. In the case of latex, as high as three times of that of RRIM 600, a clone widely planted in Malaysia, could be obtained.

Table I Timber and Latex Yields of LTC

	Wood Volume, m^3/tree				
Clone	Bole	Canopy	Total	Year	Latex (kg/ha/yr)
RRIM 2001	0.41	0.82	1.23	17	2850
RRIM 2002	0.44	0.66	1.10	17	2348
RRIM 2008	0.33	0.99	1.32	14	2686
RRIM 2009	0.34	0.34	0.68	14	2277
RRIM 2014	0.53	0.80	1.33	14	2007
RRIM 2015	0.43	0.87	1.30	14	2760
RRIM 2016	0.43	0.85	1.28	14	2582
RRIM 2020	0.36	0.63	0.99	14	2232
RRIM 2023	0.35	0.46	0.81	14	2822
RRIM 2024	0.52	0.74	1.26	14	2685
RRIM 2025	0.63	1.24	1.87	14	2700
RRIM 2026	0.66	0.45	1.11	14	2204
Average latex yield in Malaysia (estate and smallholder)					1100

Table II DRC of Field Latices from LTC

	DRC			
	Below Average, <34	Average, 34–38	Above Average, 38–41	High, >41
Clone	—	600, 2009, 2014	2023	2001, 2002, 2008, 2015, 2016, 2020, 2024, 2025, 2026

Dry Rubber Content (DRC)

DRC is a parameter that affects the efficiency in the preparation of latex concentrate and the yield of dry rubber. Table II indicates that most of the latices from LTC are of high DRC. Only two clones give average DRC values, which are in the same range as the control sample, i.e., RRIM 600. High yield clones appear to produce high DRC lattices, above 41%. Although natural rubber tree is known to produce high DRC latex when it is first tapped, regular tapping of the tree gradually reduces the DRC to a steady level. Since all the trees have been regularly tapped, the high DRC of the field latices is therefore a characteristic feature of LTC. None of the clonal latices has a DRC below 25%, a level where the latex is unsuitable for latex concentrate preparation.

Mechanical Stability Time (MST)

This parameter measures the colloidal stability of latex concentrate. A low MST implies that the latex is unstable, and therefore will easily flocculate or coagulate when subjected to mechanical agitation during processing. The minimum requirement for latex concentrate, according to ISO 2004, is 650s. The MST value of a freshly prepared concentrate is normally low but it increases

Table III MST of Latex Concentrates from LTC

	Mechanical Stability (s)			
	<650	650–900	900–1200	>1200
Clone	0	600, 2001, 2014, 2023	2002, 2015, 2016, 2024, 2026	2008, 2009, 2025

Table IV Mooney Viscosity (V_R) of Constant Viscosity Rubber from LTC

	V_R				
	Soft, <45	Medium-Soft, 45–55	Medium, 55–65	Medium-hard, 65–75	Hard, >75
Clone	2023	2009	600, 2001, 2014	2024	2002, 2008, 2015, 2016, 2020, 2025, 2026

gradually with storage time under ambient conditions within a period of four weeks. This has been attributed to the formation of fatty acid soaps in the latex upon the hydrolysis of the naturally occurring lipids.

Table III shows that most of the concentrates have good MST and in fact better than the control sample. All the MST measurements were carried out on three-month-old concentrates without any addition of soap or other stabilizers except ammonia. The latices are therefore suitable for the production of reasonably stable concentrates.

Mooney Viscosity

This parameter relates to the processability of raw rubber. It provides an indication of the amount of mechanical work required on the raw rubber to give mixes with consistent rheological properties. It is apparent that a considerable variation is shown by the different clones. There are very few soft or medium soft clones, and more samples have the V_R value above 75. (See Table IV.)

Plasticity Retention Index (PRI), Ash, Volatile Matter, and Nitrogen Content of Constant Viscosity (CV) Rubber

The PRI value is a measure of the resistance of rubber to molecular breakdown at elevated temperature. It is the percentage of retention of Wallace plasticity value after heating at 140°C for 30 min. These values shown in Table V are well above 80%, which are above the minimum requirement under the Standard Malaysian Rubber (SMR) specifications. This indicates that all the raw rubbers contain sufficient antioxidant required to protect the rubber from excessive oxidation.

Table V PRI, Ash, Volatile Matter, and Nitrogen Contents of CV Rubber from LTC

Property	Range Found	SMR CV Specs
PRI	80–96%	Minimum 60%
Ash	0.2–0.4%	Maximum 0.5%
Volatile matter	0.3–0.5%	Maximum 0.5%
Nitrogen content	0.3–0.4%	Maximum 0.6%

The ash component of natural rubber is mainly derived from mineral constituents such as compounds of potassium, sodium, phosphorous, and calcium. On the other hand, most of the nitrogenous materials in natural rubber are due to the presence of proteins. Proteins have been known to increase the moisture absorption and modulus of natural rubber. Water is the main component in the volatile matter. High volatile matter could promote mold growth and causes undesirable odor to the rubber. The values for ash, volatile matter, and nitrogen contents of the samples are also within the limits of SMR specification, as indicated in Table V.

Molecular Weight Distribution

There are three types of molecular weight distributions of natural rubber, i.e. (1) distinctively bimodal distribution with peaks of nearly the same height, (2) distinctively bimodal with

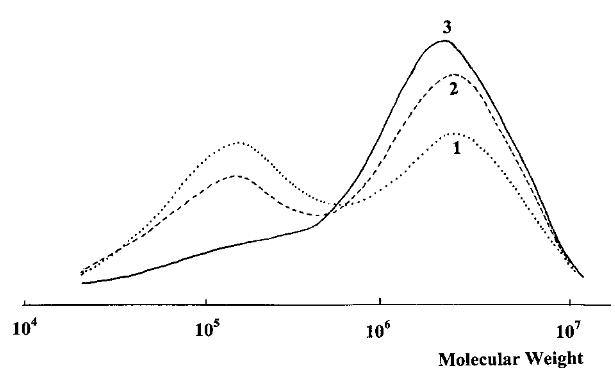

Figure 1 Types of molecular weight distribution of natural rubber.

Table VI Molecular Weight Distribution of Natural Rubber from LTC

Sample	Distribution Type	Molecular Weight[a]		
		$M_n \times 10^6$	$M_w \times 10^6$	$M_p \times 10^6$
RRIM 2001	3	0.57	2.11	2.67
RRIM 2002	3	0.77	2.23	2.88
RRIM 2008	3	0.74	2.13	2.67
RRIM 2009	2	0.47	1.95	2.72
RRIM 2014	2	0.48	2.03	2.91
RRIM 2015	3	0.73	2.12	2.75
RRIM 2016	3	0.95	2.24	2.65
RRIM 2020	3	0.76	2.24	2.95
RRIM 2023	2	0.34	1.74	2.99
RRIM 2024	3	0.75	2.17	2.68
RRIM 2025	3	0.66	2.18	2.87
RRIM 2026	3	0.81	2.22	2.75
RRIM 600	2	0.43	1.97	2.99

[a] M_n: number average molecular weight; M_w: weight average molecular weight; M_p: peak value in high molecular weight region.

smaller peak in the low molecular weight region, and (3) skewed unimodal distribution with shoulder or plateau in the low molecular weight region.[2] These are shown in Figure 1. The various molecular weight values of the rubber are shown in Table VI. Most of the samples examined showed unimodal molecular weight distribution with the peak value centered at high molecular weight region. Only one sample showed a bimodal distribution with a distinctive peak at low molecular weight region. This explains why most of the sample exhibited high Mooney viscosity values. This, however, is not the major problem as the molecular weight distribution and the viscosity of the rubber could be modified by blending the latex with those of lower molecular weight.

CONCLUSION

The latex-timber clones could produce much higher timber and latex yields than the widely planted RRIM 600. In addition, the latices and dry rubbers produced by the LTC were found to be of good quality, similar to those found in the previous studies of the older clones. These findings are important as they implies that the latices and dry rubbers obtained could be used to produce rubber products without any difficulty.

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