EVALUATION OF RELATIVE EFFICIENCY OF THREE METHODS OF DRY RUBBER CONTENT DETERMINATION IN HEVEA BRASILIENSIS MUELL. ARG.

K. O. OMOKHAFE*, O. J. OGBEBOR, I. NASIRU, U. N. OKWU

Rubber Research Institute of Nigeria, P.M.B. 1049, Benin City, 300001, Nigeria.
*: Author for correspondence, E-mail: kenomokhafe2001@yahoo.com

ABSTRACT

Three methods of estimating the percentage recovery of dry rubber content (DRC) were evaluated to determine the relative efficiency of each of the field (air-dry) methods, Total Solids Content (TSC) as well as the standard laboratory method, which is International Standard Organisation (ISO) 126. The experimental design was randomized complete block of five experimental clones of Hevea brasiliensis, three replications and ten trees per replicate. The air-dry, TSC and ISO 126 methods were applied on each clone following the procedure of Aniamaka and Olapade (1990). Dry rubber content (%) in each method was calculated and analyzed using factorial and correlation analyses. There was significant variation due to effect of clone, method, and interaction between clone and method. The ISO 126 had the least DRC estimate of 37.85% followed by TSC and air dry method at 38.98% and 42.77% respectively.

Keywords: Hevea, latex, dry rubber content

INTRODUCTION

Natural rubber remains indispensable for production of resilient and heat resistant polymeric products. Among such items are tyre, tube, bearings, condoms, gloves, balloons, rubber bands, etc. Hevea brasiliensis provides up to 90% of world requirement of natural rubber (Premakumari and Sarascathymma, 2000). More than fifty high rubber yielding clones of Hevea brasiliensis have been developed and recommended for planting in several rubber producing countries.

Natural rubber consists of the water, rubber particles and other components such as proteins, lipids, carbohydrates and minerals (Akinlabi et al, 2005). Among these constituents, rubber particles are responsible for the resilience for which natural rubber is of high value. The proportion of rubber particles is referred to as dry rubber content (DRC). Evaluation of DRC is carried out through two methods, which are the DRC of bulk cup-lumps or percent recoverable DRC from a known weight of wet rubber lump. Plant breeders prefer the bulk weight of cup-lump as it estimates the total DRC capacity of the clones. In this case, cup-lump is the total coagulated latex obtained from a tree in a single instance of tapping. The DRC of cup-lump is reported as gram for tree per tapping (Omokhafe and Alika, 2003). The second method of estimating clonal DRC is expressed as a percentage (Karunayake et al, 1999). This is more popular among chemists who are involved in farm-gate processing into crumb, sheet, crepe or concentrate. These products add value to the latex, attract economic activities on farm and help to absorb farm labour. According to Aniamaka and Olapade (1990) there are significant variations among several methods of determination of DRC of cup-lumps. Such variation will lead to errors in estimates of DRC. In order to ensure high precision in estimates of percentage DRC, this study was conducted with the aim of evaluating relative efficiency of a combination of field and laboratory methods of recoverable DRC.

MATERIALS AND METHODS

Site: The experiment was conducted at the Rubber Research Institute of Nigeria, Iyanomo, Benin City in Edo State. Nigeria.

Field layout: The experimental design was the randomized complete block with three replications and ten trees per replicate. The replications were on the columns while test clones were randomly planted on the rows in each

column. The field was planted in 1991 and opened for tapping in 1998 at ½S, $d/_2$ tapping frequency. The clones studied were NIG 801, NIG 803 and NIG 805 developed in Nigeria, PR 107 from Indonesia and RRIM 707 from Malaysia. Sampling covered a period of four months (January April, 2004).

Sampling procedure: Latex samples were taken in ten trees per replicate

Determination of DRC: The three methods applied are as follows:

i. Air dry method: Initial liquid weight of 50g latex of each tapping day of every tree was autocoagulated in a collection cup and the coagulum was hung on a metal wire. The cup lumps collected were allowed to air dry for 21 days as recommended by Omokhafe and Alika (2003) and weighed. Yield in grams per tree per tapping was calculated as $Y = M_1/M_0 \times 100$

where M_0 = the initial mass in g of the test sample

M_1 = the mass in g of the dried lump

ii. Total solids content (ISO 124): The total solids content of the latex was determined using the ISO 124 as described by Aniamaka and Olapade (1990). Initial 2.5g of latex was poured into a weighed 9cm x 1cm size of Petri dish. The content of the dish was gently swirled to ensure that the latex evenly covered the bottom. The dish was placed uncovered in an oven maintained at 100 ± 2°C until sample had lost its whiteness. This was cooled in a desiccator and weighed. Each sample was dried to constant weight with repeated weighing at intervals of 15 minutes. Total solids content (TSC) was calculated from the formula:

$TSC = (M_1/Mo) \times 100$

Where M_0 = the initial mass in g of the test sample

M_1 = the mass in g of the dry film.

iii. Standard laboratory method (ISO 126): Initial 10g of latex was weighed into a suitable container of about 50mm depth. The latex was diluted homogenously with 20ml of H_2O and coagulated with 150ml of 2% acetic acid (CH_3COOH). The coagulated rubber was pressed into a uniformly thin sheet of about 2mm thickness. The sheet was washed several times in water and then dried to constant weight at 70 ± 2°C. The DRC was obtained as described by Aniamaka and Olapade (1990) such that $DRC = (M_1/M_2) \times 100$

Where Mo = the initial mass in g of the test sample and

M_1 = the mass in g of the dried sheet.

Data analysis: Factorial analysis was conducted to evaluate the differences between means of methods and clones for percentage dry rubber content, and effect of interaction. Correlation analysis was conducted among the three methods evaluated.

RESULTS AND DISCUSSION

There was significant clonal variation for recoverable DRC in each of the three methods and combined analysis at $p \leq 0.01$ (Table 1). This is in agreement with the report of Okieimien et al (2001) where significant clonal variation was also reported. This suggested that recoverable DRC has influence of genes, which would be exploited in breeding programmes through clonal selection for high DRC.

In Table 2, the highest percentage DRC was obtained in NIG 803 which is one of the best latex yielding clones as reported by Omokhafe and Nasiru (2005). Clonal means of methods, and interaction between clone and method were significant at $p \leq 0.01$ (Table 1). Based on F-test, variation across the three methods suggested a significant difference in percentage DRC between the standard method (ISO 126) and other methods as reported by Aniamaka and Olapade (1990).

Table 1. Mean squares of combined variance analysis of percent dry rubber content of Hevea latex

S.V.	df	MS
Rep	2	0.973
Method (M)	2	99.584**
Clone (Cl)	4	66.734**
Cl x M	8	37.065**
Error	28	0.445

**: Significant at $p \leq 0.01$ (F-test)

The lowest percentage DRC was obtained using ISO 126 at 37.85% while the highest value was obtained with air-dry method at 42.77% (Table 2). This presents a margin of 3.78% as an overestimate of recoverable DRC using air-dry method, which is the usual method of determination of DRC at farmers' level. It is possible to provide a correction factor to ensure that field percentage DRC conforms to actual DRC. This is important since standard laboratory method (ISO 126) is often too cumbersome for farmers to apply. In this case, a correction factor could be developed, which is 0.88 at 37.85/42.77. The discounting factor for recoverable DRC is also important to Plant Breeders who wish to report percentage DRC with high precision. Evaluation of clonal DRC for the purpose of clonal selection and recommendation is often based on air dry method as applied by Omokhafe and Emuedo (2006), Omokhafe and Nasiru (2004).

The significant interaction between clone and method at $p \leq 0.01$ (Table 1) suggests

Table 2. Clonal means of dry rubber contents (%) of *Hevea* latex in three methods.

	Methods+			
Clone	Air dry	ISO 126	TSC	Clonal mean
NIG 810	42.35(2)	41.0(2)	38.83(4)	40.73(3)
NIG 803	49.02(1)	39.69(3)	39.96(2)	42.89(1)
NIG 805	41.07(3)	29.57(5)	39.31(3)	36.65(5)
PR 107	40.67(5)	43.98(1)	40.38(1)	41.68(2)
RRIM 707	40.72(4)	35.02(4)	36.4(5)	37.38(4)
Overall mean	42.766	37.852	38.976	39.86

+: *Figures in parenthesis represent ranks.*

that the estimate of recoverable clonal DRC could be influenced by the method applied. However, correlation coefficients among the three methods were not significant using the t-test (Table 3). This suggests that the bases of the significant interaction may be mainly due to non-linear relationship. This trend will be investigated in further studies. The TSC recorded higher estimate of percent DRC at 38.98% than the ISO 126 at 37.85% (Table 2). The margin of difference was 1.13% with correction factor of 0.98 at 37.85/38.98. Technically, the TSC is less cumbersome compared to ISO 126. Laboratory estimates of the TSC could be corrected by a factor of 0.98 to obtain actual percent DRC of comparable precision as the ISO 126. This is important where DRC is based on specific gravity as reported by Mak *et al* (2007) and Chetha *et al* (2007).

In conclusion, recoverable DRC is influenced by the method applied. A correction factor of 0.88 on air-dry method will provide the level of precision desired by Plant Breeders while a correction term of 0.98 on TSC is relevant in case of laboratory scientists who prefer to use densitometer.

Table 3. Correlation coefficients of clonal distribution of dry rubber content in three methods

	Method	
Method	TSC	ISO 126
Air dry	0.36	0.21
TSC		0.42

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