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A simple method for rapid determination of residual water content in rubber cup lumps

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Abstract

Estimation of yield of rubber trees based on the dry rubber content of cup lumps is a common practice in field experiments. This leads to large errors due to the presence of moisture trapped inside the lump even after prolonged drying. The amount of water trapped inside the cup lumps can vary with the size of the lump. An experiment was conducted using cup lumps of varying sizes coagulated from fresh field latex for determination of the actual water content in them. Fresh weight of the cup lump was recorded gravimetrically immediately after coagulation. An equal amount of latex was taken in aluminium pan for acid coagulation to make rubber sheet. The dry weight of cup lumps and sheets were recorded after drying and smoking. Dry sheets always recorded less dry weight than dry cup lumps as the latter always contained some amount of moisture trapped inside. Residual moisture content of the lump was calculated from the differences in the weights of dried rubber sheets and lumps. The moisture content of the dry cup lump was not constant across their sizes; the larger the cup lump, the more the residual moisture content in lump. In dry cup lumps, the water content varied from 3-13% by dry weight. In fresh cup lumps this varied from 47-53% on fresh weight basis. Regression equations were derived between per cent residual moisture content and weight of dry cup lumps. The regression equation is suitable for determination of actual rubber content in large number of lumps. Differences in estimation of rubber content using the conventional method and the equations derived from this study and possible errors in determining the rubber yield using the conventional method are discussed.

Keywords: Cup lump, *Hevea*, rubber content, water content

Introduction

Natural rubber (*Hevea brasiliensis*) latex is normally extracted from the bark of rubber tree by tapping and collected from plantations as fresh latex or field coagula. For recording yield of experimental trees the latex is coagulated in collection cups and later collected as fresh lumps called cup lumps or cup coagula. These cup lumps are dried in a smoke house. Normally, fresh or smoke-dried cup lumps are used to estimate the rubber yield of trees.

The rubber content of latex varies among clones, seasons, age of the trees and the system of tapping. Dry rubber content (drc) in the latex and its volume determine the amount of rubber produced by a tree. The drc of natural rubber latex varies between 20 - 45% (RRIM 1973, 1980). Estimation of rubber yield based on the cup lump dry weight often leads to errors due to the presence of varying amounts of water trapped with in the dried lumps even after prolonged smoke drying. Incorrect determination of rubber content results in wrong estimation of production and affects the sale value of the rubber produce badly. Therefore, accurate determination of rubber content is necessary to evaluate the yield of a plantation or for payment of wages to tappers based on rubber yield. Cup lumps collected from a field are of different sizes and mass. Once they are smoke-dried, it is assumed that they are equally dried. However, it is likely that more amounts of residual moisture could be trapped inside a large cup lump even after prolonged drying. In

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the present study, this variation was examined and a regression equation developed based on which the actual water content of dry cup lumps of varying masses can be estimated.

Materials and Methods

Latex was collected from a field with thirteen clones: RRII 105, RRII 300, RRII 118, RRII 38, RRII 43, RRII 308, GT 1, Gl 1, PB 311, HP 20, Tjir 1, RRIM 623 and RRIM 600 in the research farm of Rubber Research Institute of India (76° 36'E, 9° 32'N). Fresh latex was brought to the laboratory in buckets from the field, sieved through 40 and 60 mesh size sieves. Cup lumps and sheets of varying masses were made using 25, 50, 100, 200, 400, 600, 800 and 1000 ml of latex. For cup lumps, the diluted latex was transferred to collection cups and formic acid in the required proportion was added to coagulate the latex (Harris and Chang, 1978; Varghese *et al*., 2000). After addition of acid, the latex was thoroughly stirred and then kept undisturbed for about four hours for complete coagulation. For sheets, several samples of different masses were prepared subsequently by coagulating required quantity of diluted latex in different containers. Coagula were removed from the containers, washed in water and sheeted using two sets of rollers of a sheeting machine. After coagulation, the wet cup lumps were removed from the collection cups and recorded the fresh weight immediately. Rubber sheets and cup lumps were washed repeatedly in tap water and soaked in 0.05% paranitrophenol solution to prevent fungal growth (Kuriakose and Thomas, 2000). After partial drying in open air, both cup lumps and sheets were hung on reapers for four days in a smoke house keeping a temperature 50 - 60° C (Nair *et al*., 1988; Kuriakose, 2002). Dry weights of the lumps and sheets were recorded gravimetrically. The fully-dried rubber sheet was considered to have the least amount of moisture trapped inside.

Water content of cup lumps was calculated as follows:

$$\text{Water content in fresh cup lump (\%)} = \frac{\text{Weight of fresh cup lump (g) - Weight of dry sheet made from same amount of latex (g)}}{\text{Weight of fresh cup lump (g)}} \times 100$$

$$\text{Water content in dried cup lump (\%)} = \frac{\text{Weight of dry cup lump (g) - Weight of dry sheet made from same amount of latex (g)}}{\text{Weight of dry cup lump (g)}} \times 100$$

Water content was finally expressed as percentage of fresh / dry cup lump weight. The values of water content (Y variable) were then regressed on the weight of the fresh / dried cup lumps (X variable) to obtain an equation for predicting moisture content of fresh and dry cup lumps.

Results and Discussion

Weight of fresh cup lumps was determined as soon as they were removed from the coagulation cups. This varied from 19.7 to 899 g for 25 to 1000 ml respectively, of field latex coagulated (Fig. 1 A). After smoke drying, the weights of cup lumps ranged between 10.8 to 490 g (Fig. 1 B). The weights of smoke-dried rubber sheets which were expected to dry the maximum ranged between 10.5 to 425.9 g (Figs. 1 A, B). The weight of dried cup lumps was always higher than the respective samples of dried rubber sheets (Fig. 1. B), indicating relatively more residual water trapped inside the dry cup lumps. Thus for the same quantity of latex coagulated, the mass of fresh cup lumps, dry cup lumps and dry sheets were different. This variation was due to the presence of large mass of water in cup lumps. This trapped moisture in dried, large-sized cup lumps could be seen as partially dried white patches when they are cut open. In large-sized cup lumps, the prolonged smoke drying for four weeks did not reduce the water content any further and complete drying could not be achieved compared to the sheets. Expulsion of water trapped in non-porous rubber mass is difficult even after long period of drying (Kuriakose and Thomas, 2000; Kuriakose, 2002).

Rubber content (%) of fresh and dry cup lumps was calculated using the dry weight of sheets as standard, assuming that a fully-dried sheet has the least amount of residual moisture in it. Rubber content in fresh cup lump ranged from 47 to 53% of total mass (Fig. 2 A) and the mean rubber content in fresh cup lump was 49.4%. The percentage of rubber content in fresh cup lump decreased with increase in the mass of the lump. In dried cup lumps, the rubber content varied from 86 to 97% (Fig. 2 C).

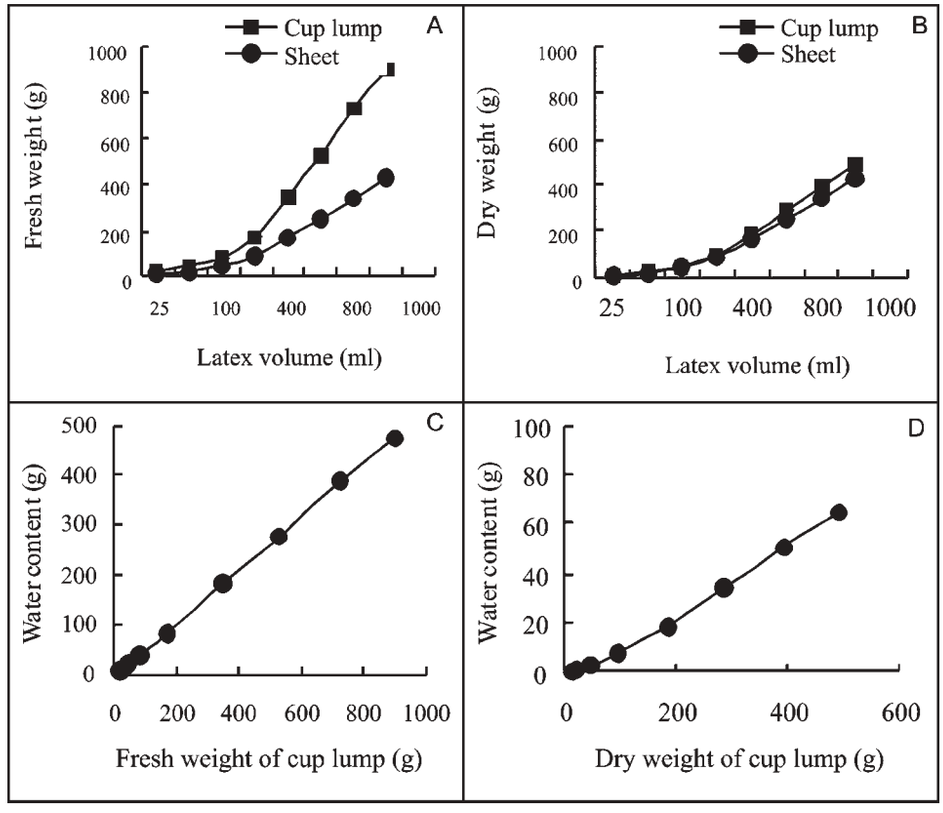

Fig. 1. Fresh weight (A) and dry weight (B) of cup lumps, sheets and water content of fresh (C) and dry (D) cup lumps

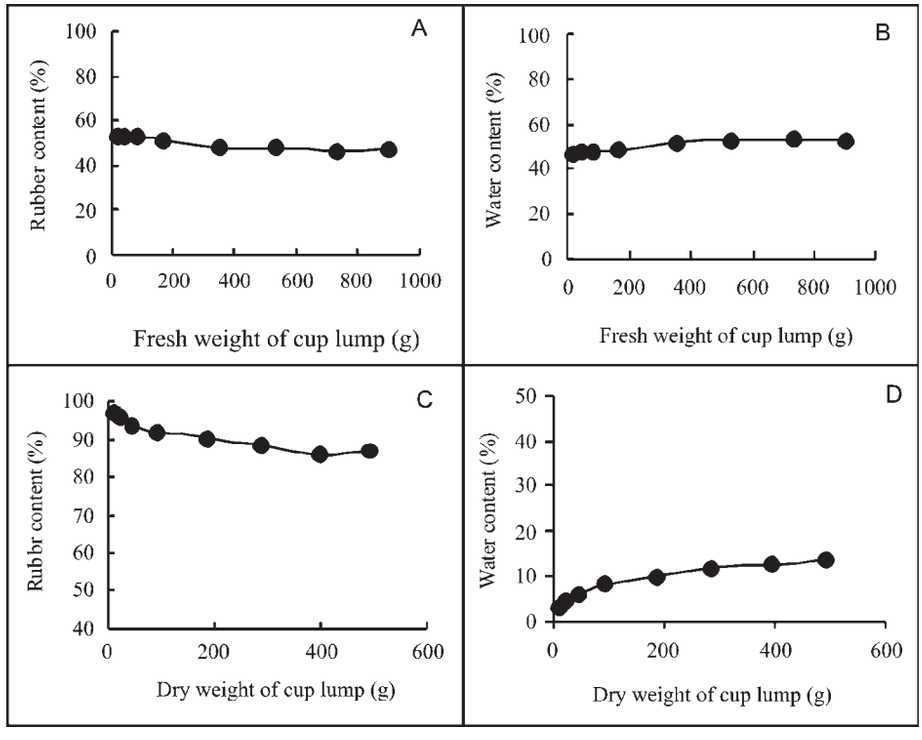

Fig. 2. Percentage of rubber content (A, C) and water content (B, D) in fresh and dry cup lumps

The mean rubber content was estimated as 90% of the total dry mass of the cup lumps and the actual rubber content showed a declining trend with increase in mass of lumps (Figs. 2 A, C). Similarly, the water content (g) was estimated in fresh and dry cup lumps (Figs. 1 C, D). A fresh cup lump weighing 19.7 g contained 9.2 g of water (46.7%) and one that weighed 899 g contained as high as 473 g of water (52.6%) inside (Fig. 2 B). In dry cup lumps, the water content varied from 0.3 to 64.7 g in cup lumps weighing 10.8 to 490 g and this variation was from 2.8 to 13.3% of the cup lump weight (Fig. 2 D).

Regression analysis of water content and cup lump weights showed a positive relationship (Figs. 3 A, B). Separate equations were derived for accurate determination of water content of fresh and dry cup lumps (Table 1). The exact water content in cup lumps of varying masses could easily be determined in large number of samples using these equations.

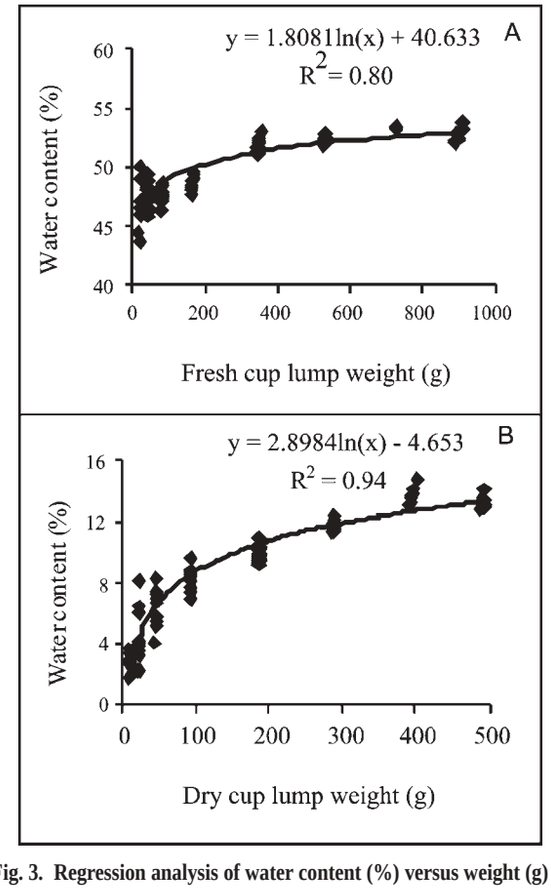

Fig. 3. Regression analysis of water content (%) versus weight (g) of lumps for fresh and dry cup lumps

Table 1. Regression equations for estimation of water content in fresh and dry cup lumps

Sl. no.	Parameter	Regression equation	R^2
1.	Fresh cup lump	$y = 1.8081 \times \ln(x_1) + 40.7$	0.80
2.	Dry cup lump	$y = 2.8984 \times \ln(x_2) - 4.7$	0.94

(y = Water content (%) ; X_1 = Fresh weight (g) of cup lump; X_2 = Dry weight (g) of cup lump)

A comparative analysis was made between the actual water content observed in cup lumps as well as water content derived through the regression equation and the water content obtained by conventional estimation method with possible extent of errors in estimating the actual rubber content of cup lumps (Tables 2, 3). Presently, the water content in fresh cup lumps is considered uniformly as 50% and that of dry cup lumps as 10% irrespective of variation in total mass of lumps and the present results showed

Table 2. Extent of error in estimating water content in fresh cup lumps using different methods (*based on sheet dry weight, **based on regression equation, ***based on conventional method of reducing 50% moisture)

Fresh weight of cup lump (g)	Actual* water content (g)	Estimated** water content (g)	Water*** content (50%) calculated (g)	Error in water content (g)	Yield status*
19.7 ± 0.14	9.27	9.06	9.85	+0.79	U.E
41.2 ± 0.19	19.67	19.52	20.6	+1.08	U.E
81.9 ± 0.23	38.90	39.81	40.96	+1.16	U.E
166.2 ± 0.12	80.75	82.93	83.1	+0.17	U.E
349.0 ± 0.10	181.28	178.82	174.5	-4.32	O.E
528.7 ± 0.90	275.76	274.92	264.35	-10.61	O.E
729.7 ± 0.10	385.71	383.67	364.8	-18.87	O.E
899.2 ± 0.30	473.32	476.21	449.6	-26.62	O.E

U.E - Under estimated / O.E - Over estimated

Table 3. Extent of error in estimating water content in dry cup lumps using different methods (*based on sheet dry weight, **based on regression equation, ***based on conventional method of reducing 10% moisture)

Dry weight of cup lump (g)	Actual* water content (g)	Estimated** water content (g)	Water*** content (10%) calculated (g)	Error in water content (g)	Yield status*
10.8 ± 0.02	0.3	0.25	1.08	+0.83	U.E
22.5 ± 0.11	1.0	0.98	2.25	+1.26	U.E
45.8 ± 0.17	2.8	2.94	4.58	+1.64	U.E
93.0 ± 0.20	7.6	8.20	9.30	+1.11	U.E
185.9 ± 0.20	18.2	19.48	18.59	-0.89	O.E
286.6 ± 0.50	33.6	33.64	28.6	-5.01	O.E
395.2 ± 1.0	53.2	51.10	39.5	-11.70	O.E
490.0 ± 0.90	64.75	65.11	49.0	-16.11	O.E

U.E - Under estimated / O.E - Over estimated

that this is highly erroneous. By the conventional method, the actual weight of small cup lumps can be underestimated and that of large cup lumps overestimated. Using the equations given here, accurate water content in smoke-dried cup lumps of different masses can easily be estimated.

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