J nat Rubb Res, **11**(4), 256–264

Physiological Characteristics of Latex of the IRRDB 1981 Hevea *Germplasm*

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Five physiological parameters of latex, namely total solid content, sucrose inorganic phosphorus, contents of thiol groups and plugging index were studied on Wickham and germplasm clones. Results showed difference in profiles of physiological characteristics of latex of the germplasm and Wickham groups.

*The germplasm clones were significantly higher than the Wickham clones in sucrose content of latex and plugging index (PI), but the latter (Wickham clones) were higher in the contents of thiol groups (R-HS) and inorganic phosphorus (Pi). Significant positive correlations were found between yield and R-SH ($r=0.31$ **, $df=86$) and between yield and Pi ($r=0.40$ ***, $df=86$), while a significant negative correlation was found between yield and PI ($r=0.31$ **, $df=86$) in the germplasm.*

Principal component analysis of the five physiological parameters of latex showed that the germplasm group was well separated from the Wickham group. There was no distinct separation among the three geographical groups of the germplasm.

In 1981, the International Rubber Research and Development Board (IRRDB) carried out an expedition in three states of Brazil, namely Acre, Mato Grosso and Rondonia aimed at broadening the genetic base of *Hevea* in the East[1,2]. Between 1984 and 1987, the Rubber Research Institute of Vietnam (RRIV) received 3672 genotypes from the *Hevea* Germplasm Centre located in Malaysia. Out of these, 2972 genotypes survived[3,4]. Part of the collection has been evaluated and reported for agronomic characteristics in clonal trials[4,5].

Jacob *et al.* [6,7] postulated that the cytoplasmic nature of latex as reflected by its biochemical and biophysical parameters, could provide useful data on state of health of laticiferous system and on clonal typology. It would therefore be interesting to study some of these parameters and compare differences or similarities between the germplasm and Wickham materials.

Physiological characteristics of the latex of germplasm studied are presented in this paper.

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MATERIALS AND METHODS

Five physiological parameters of latex, namely plugging index (PI), total solid content (TSC), sucrose content (SUC), inorganic phosphorus content (Pi) and content of thiol groups (R-SH) were studied using 88 germplasm and 26 selected Wickham clones in a small-scale clone trial (SSCT) sited in Lai Khe Station, RRIV.

The SSCT was established according to a randomised complete block design with three replications and each genotype was represented by eight trees per plot per replication. Yield measurement commenced when 70% of the trees reached a tappable size of 45 cm of circumference from the stock union. The tapping system used was ½S d/3 without stimulation. Mean yield over one year of tapping was used for the present study.

The physiological parameters were studied on trees during the first year of tapping. For sampling of latex, the fraction of latex flowing between the fifth and thirty-fifth minutes of tapping was collected in a small tube packed in ice. Latices from three trees per plot were collected, pooled and homogenised thoroughly and carefully to make a sample which was chilled to block the continuity of the metabolism *in vitro*[6]. The sample of latex was then used to determine TSC and to prepare a trichloroacetic extract (TCA) for determination of sucrose, thiols and inorganic phosphorus. PI was determined according to Milford *et al.*[8] with the modification that dry rubber weight was used instead of volume in order to make possible study of the large number of trees and to overcome difficulties in taking measurement of volume due to very low latex production from the germplasm clones. Other physiological parameters of latex (TSC, SUC, Pi and R-SH) were sampled and analysed according to the procedures of micro diagnosis of latex developed by IRCA[9].

Statistical Analysis

Means and standard deviations were computed for the various physiological parameters by materials of different origins (Acre, Mato Grosso, Rondonia and Wickham). Significant groupings were carried out using Duncan's Multiple Range Tests for means of the various germplasm groups. Correlations among the characters (including latex yield) of the germplasm and the Wickham materials were also performed separately. Principal component analysis was adopted on the multivariate data sets collected to provide some ideas of genotypic groupings and their possible phylogenetic relationships.

The above statistical analyses were carried out using selected procedures of SAS package[10].

RESULTS AND DISCUSSION

Latex Physiological Profile of the New Germplasm

The physiological characteristics of latex of the germplasm and Wickham clones are summarised in *Table 1*. The germplasm clones were significantly higher than the Wickham clones in SUC and PI, but lower in R-SH and especially very low in Pi *Table 1*. In general, geographical groups of the germplasm were not different from one another, especially Mato Grosso and Rondonia in these parameters.

TABLE 1 MEAN VALUES FOR PHYSIOLOGICAL PARAMETERS OF LATEX OF THE GERMPLASM

Germplasm	No of. clones	TSC (%)	SUC (mM)	R-SH (mM)	Pi (mM)	PI
Acre	8	34.37 b (1.11)	11 58 a (1.42)	0.48 a (0.03)	4.51 b (0.71)	4.58 a (0.77)
Mato Grosso	44	37.69 a (0.42)	9 55 a (0.70)	0.39 b (0.01)	4.32 b (0.29)	4.98 a (0.19)
Rondonia	36	37 49 a (0.43)	11.90 a (0.71)	0 41 b (0.01)	4 30 b (0.30)	4.28 a (0.17)
Wickham	26	36.79 a (0.56)	8.26 b (0 61)	0 53 a (0.02)	17.63 a (0.95)	2 99 b (0.14)

TSC. Total solid Content; SUC: sucrose; R-SH: Thiol; Pi· Inorganic phosphorus; PI· Plugging index.
Mean values followed by the same letter in the same column are not significantly different at P≤0.05
Figures in brackets denote standard errors.

TABLE 2 SIMPLE CORRELATION COEFFICIENTS BETWEEN PHYSIOLOGICAL PARAMETERS OF LATEX OF THE GERMPLASM

Parameters	TSC	SUC	R-SH	Pi	PI
SUC	− 0 115^{NS}				
RSH	− 0 407***	0.448***			
Pi	− 0.371***	0.250*	0 574***		
PI	0 319**	− 0 088^{NS}	− 0 198 a	− 0.139^{NS}	
Yield	− 0.192 a	− 0 136	0.306**	0.403***	− 0.309**

a P ≤ 0.10; *P ≤ 0 05; ** P ≤ 0 01; *** P ≤ 0.001, Df = 86
NS : Not significant at P ≤ 0.05

For the germplasm clones significant positive correlations were found between yield and R-SH, and Pi; while a significant negative correlation was also found between yield and PI (*Table 2*). Significant correlations were observed among these physiological parameters of latex in the germplasm. However, for the Wickham clones no significant correlation was detected between yield and the physiological parameters studied. There was also no significant correlation detected among those physiological parameters except for relationship between sucrose and R-SH or Pi and R-SH (*Table 3*).

It is clear that in a given environment, latex production on tapping in rubber trees depends on the duration of the latex flow and on the regeneration of latex between the two consecutive tappings. The parameters investigated are either related to latex flow or latex regeneration or both, except for PI, which is an end phenomenon of latex flow[7].

Regarding the activity of the latici ferous system of the germplasm in the regeneration of rubber, the lower content of R-SH and extremely low content of Pi may reflect the inadequate synthesis or supply of those substances in the laticifers. In other words, the germplasm probably has a less active laticiferous system for latex productivity. Jacob *et al.*[6,11] reported that a laticiferous system operating weakly has a low Pi latex content. Limitation to latex regeneration by the inadequate supply of Pi and R-SH is supported by highly significant and positive correlations between yield and Pi and R-SH in the germplasm (*Table 2*), and the less effective utilisation of sucrose as rubber precursor leading to higher sucrose

TABLE 3 SIMPLE CORRELATION COEFFICIENTS BETWEEN PHYSIOLOGICAL PARAMETERS OF LATEX OF THE WICKHAM CLONES

Parameters	TSC	SUC	R-SH	Pi	PI
SUC	-0.218^{NS}				
R-SH	0.107^{NS}	0.492^{**}			
Pi	0.375^{*}	0.168^{NS}	0.111^{NS}		
PI	-0.212^{NS}	0.178^{NS}	0.195^{NS}	-0.067^{NS}	
Yield	0.139^{NS}	-0.317^{NS}	-0.018^{NS}	0.199^{NS}	-0.296^{NS}

* $P \leq 0.10$, ** $P \leq 0.01$; Df = 24 ; Others are not significantly different at $P \leq 0.05$
NS : Not significant at $P \leq 0.05$

content of the laticifers (*Table 1*). The germplasm genotypes were brought directly from the jungle where they might not have been subjected to selection for yield through latex extraction, therefore probably have less active laticiferous systems for latex biosynthesis.

Regarding the flow of latex, PI was significantly higher in the germplasm compared to the Wickham clones; and there was a significant and negative correlation between PI and production (*Table 1* and *2*). High plugging indices in the germplasm may reflect difficulties in latex flow and may be of genetic nature of the wild genotypes evolving in the absence of latex extraction and towards effective mechanism of preventing the species from excessive loss of latex on wounding. It was well established that PI is a clonal characteristic, negatively correlated to yield [8,12-14] and genetically controlled[15]. Meanwhile, the Wickham clones have been subjected to selection for high productivity which has been known associated with low plugging indices, or, in other words, easing in the latex flow. Therefore, there might have been an unconscious selection favouring lower PI over generations of utilisation of the Wickham clones. Besides this, relatively higher values of TSC in the germplasm (MT and RO) and its significant correlation with PI suggest that high values of TSC may become a limiting factor to the latex flow because of the resulting high viscosity[7].

In general, the new *Hevea* germplasm appeared to be poor in the activity of latex regeneration and showed difficulty in the flow of latex. The limitation in the latex flow seems to be more important because highly positive responses of up to 100% or above to latex stimulation were reported in wild genotypes [16,17].

Clonal Typology of Physiological Characteristics of Latex.

Because functioning roles of various physiological parameters are complex, their interactions are not well understood and the interpretation of their effects, as single factors on productivity is not easy. However, it is possible to utilise all these parameters to study the general feature of the new *Hevea* germplasm leading to clonal typology of physiological characteristics of latex[11]. It could give better understanding of physiological profile of wild genotypes and help in classification of them based on parameters studied. The study was carried out using the method of principal component analysis (PCA) of all the parameters measured.

As shown in the PCA diagram (*Figure 1*), there was a clear distinction between two groups, the germplasm's and the Wickham's, indicating their different profiles of physiological parameters of latex. However, there were also some germplasm clones which seemed to be closer to the Wickham group in terms of physiological profile. The PCA can, therefore, provide a useful tool to describe the physiological state of the new germplasm as well as a possible guide to plant breeders in evaluation and choice of wild genotypes.

Considering the geographical origin of the germplasm, there was no clear distinction among genotypes derived from different geographical origins (*Figure 2*). This implies that these germplasm genotypes may have

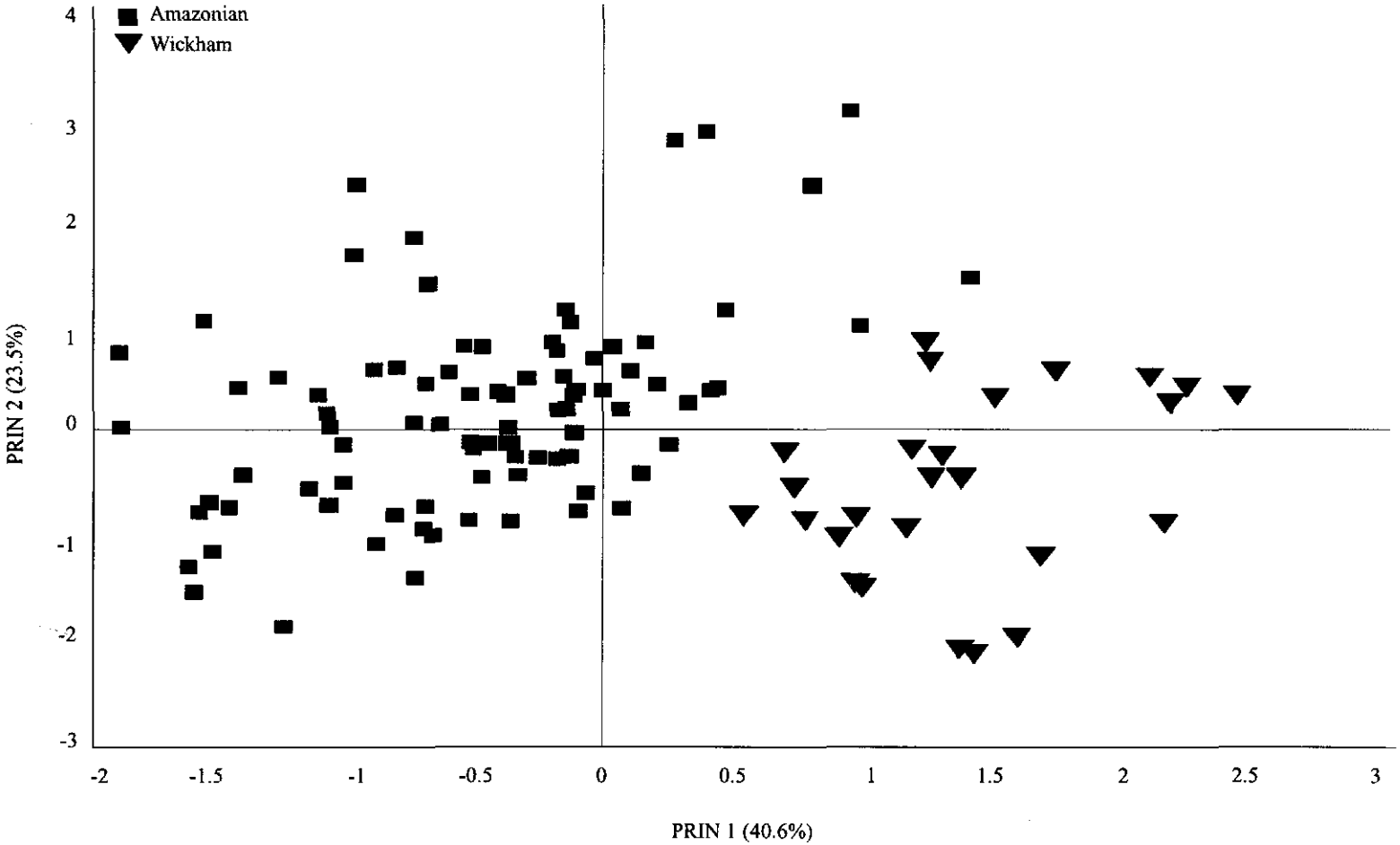

Figure 1. Principal component analysis of five physiological characteristics of latex for the germplasm and Wickham clones.

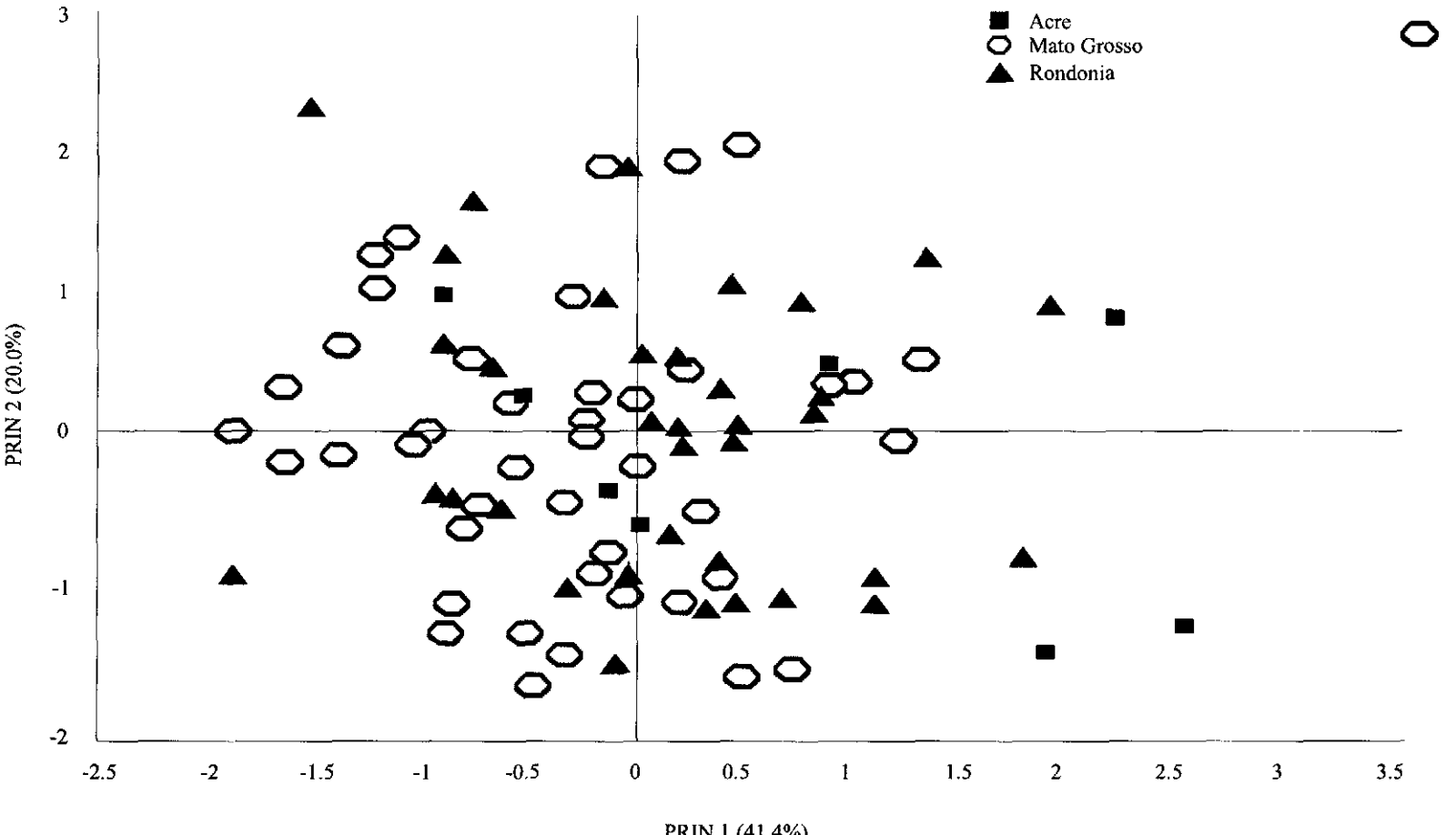

Figure 2. Principal component analysis of five physiological characteristics of latex for the germplasm clones.

the same feature of latex physiology. However, if more materials from these different geographical origins and more characteristics were included in the study, they may show out some important differences among them

CONCLUSION

The new *Hevea* germplasm is different from the Wickham clones in physiological characteristics of latex. They appear to be poor in the activity of latex regeneration and show difficulty in the flow of latex It would be necessary to increase clonal differences between germplasm clones to observe their maximal metabolic activity (production potential) by an appropriate stimulation treatment. Classification of the germplasm according to their physiological profiles can help in effective utilisation of germplasm

ACKNOWLEDGMENTS

The authors would like to thank Mr Mai Van Son, Director of the RRIV for permission to publish this paper. We would also like to thank Prof Yap Thoo Chai of Universiti Pertanian Malaysia (UPM) for his valuable comments. This research was supported by the Technical Assistance Programme to the senior author (Lai Van Lam) in the partial fulfilment of an M Sc. Programme at UPM.

Date of receipt: March 1996
Date of acceptance: March 1997

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