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Latex Preservation in Polybags and Latex Concentrate Production

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Rubber collected in polybags is of poorer quality compared to premium rubbers obtained from similar latex collected by conventional methods. A study on keeping the latex fluid and well-preserved in the polybags for two to four weeks in the field was carried out. This paper describes some improvements to the existing process of collecting latex in polybags. Latices in polybags were successfully kept fluid for up to four weeks by preservative/biocide systems based on TMTD/ZnO, PRBL and PROXEL GXL. Concentrates produced from such latices were also found to store normally and had no adverse technological properties.

Collection of rubber in polybags, a method in which special polybags are left on the trees for several tappings, was first developed and reported by the Rubber Research Institute of Malaysia (RRIM) in the late sixties. With this method, tapping is carried out in the normal way, but the latex is collected in a polybag fixed to the tree. The process is repeated for several tappings over a period of two to four weeks. The bag containing the coagulated rubber is then collected and brought to the factory for it to be processed into bulk rubber.

There are advantages and disadvantages of collecting rubber in polybags. It is known to result in the production of lower quality rubber compared to the premium rubbers obtained from similar latex collected by conventional methods. The loss factor is therefore a major consideration.

A preliminary investigation has been carried out on the feasibility of preserving latex fluid in polybags and producing it into latex concentrate. This paper reports on the methods and biocide systems found effective for the process and the properties of the subsequent concentrates.

Latex collection in polybags minimises tapping and collection costs which form a major portion of the overall production expenditure. It has also been suggested as a method to extend latex flow-time and for high-yielding trees where the traditional tapping cups have been found to be inadequate. In recent years, the shortage of plantation workers has resulted in some producers resorting to this method of latex collection.

MATERIALS AND METHODS

Latex

Polybag latex trials were carried out at the RRIM Experiment Station, Sungei Buloh, Selangor, for fifteen to thirty days.

The polybag collection set designed by the Tapping Section of the RRIM consists mainly of the polybag, collection bowl and supporting wire.

Chemicals

The chemical biocide systems used were those based on tetramethyl thiuram disulphide/zinc oxide (TMTD/ZnO, 1:1)[1,2,3] triazine/benzotriazole derivative (PRBL)[4] and 1,2-benzisothiazolin-3-one (PROXEL GXL)[5].

Each system was prepared as a dilute dispersion or solution for addition to the latex. In combination with ammonia, they acted as secondary preservatives.

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TABLE 1. PREPARATION OF COMPOSITE PRESERVATION SYSTEMS

Preservation system		System A/150 g latex		System B/150 g latex	
Type	Chemical	%	Weight (g)	%	Weight (g)
NH_3/TZ	Ammonia	0.300	0.4500	0.500	0.7500
	TMTD	0.025	0.0375	0.025	0.0375
	ZnO	0.025	0.0375	0.025	0.0375
	Water	6.317	9.4750	6.117	9.1750
NH_3/PRBL	Ammonia	0.300	0.450	0.500	0.750
	PRBL	0.100	0.150	0.100	0.150
	Water	6.267	9.400	6.067	9.100
NH_3/PROXEL GXL	Ammonia	0.300	0.450	0.500	0.750
	PROXEL GXL	0.100	0.150	0.100	0.150
	Water	6.267	9.400	6.067	9.100

Dosages of Preservatives

The optimum dosages of preservatives were screened and established after a series of initial trials in the field to ensure good latex preservation.

To determine the amount of preservatives to be added to the latex, the average yield of the tree had to be assessed. The yield of a tree varied between 100 g and 300 g during the year under normal tapping conditions and a yield of 150 g of latex per tree per tapping was taken as the average.

Details of the chemical preparation are shown in *Table 1*. In all cases, about 10 ml of prepared solution containing the appropriate amount of preservatives was added. Two modes of addition were used:

- *System A* — preservatives added at every tapping
- *System B* — preservative added once every three tappings

To treat 1000 trees, 10 litres of bulk solution were required for *System A* and 30 litres for *System B*. As an example, the bulk solution for the NH_3/TZ system was prepared as shown in *Table 2*.

Since TMTD and ZnO are powders insoluble in water, care was taken when preparing the bulk solution. Water was slowly added to TMTD/ZnO and mixed to form a paste. When a uniform light dispersion had been achieved, the required amount of ammonia solution was added.

Trial 1

A trial was carried out to assess the effectiveness of preservation of latex in polybags over a period of thirty days. The polybag set was fixed to every tree in place of the normal latex cup one day before tapping. On the first day of tapping, 10 ml or 30 ml of bulk (preservative) solution was added to the polybag 2 h or 3 h after tapping was completed.

TABLE 2. PREPARATION OF BULK SOLUTION OF NH_3/TMTD/ZnO PRESERVATION SYSTEM

Chemical	System A		System B	
	%	Weight (g)	%	Weight (g)
Ammonia	0.300	450	0.500	2 250
TMTD	0.025	37.5	0.025	112.5
ZnO	0.025	37.5	0.025	112.5
Water	6.317	9 475	6.117	27 525

TABLE 3. CHEMICAL TREATMENT OF FIELD LATEX

Reference	Treatment of field latex	Duration on trees (days)
A	Control (0.7% NH_3)	—
B	0.5% NH_3 + 0.05% TZ	17
C_1	0.5% NH_3 to 0.05% TZ	30
C_2	0.5% NH_3 + 0.10% PRBL	30
C_3	0.5% NH_3 + 0.10% PROXEL GXL	30
D_1	0.5% NH_3 + 0.05% TZ	15
D_2	0.5% NH_3 + 0.10% PRBL	15
D_3	0.5% NH_3 + 0.10% PROXEL GXL	15

The preservatives were poured by means of a dispenser into the opening of the polybag by lifting the bowl of the polybag set. The latex was then mixed thoroughly with the preservatives by shaking the polybag. In *System A,* 10 ml of the preservative was added to the polybag on every tapping day, whereas in *System B,* the next addition of preservative was only done on the fourth tapping day. Latex was thus accumulated in the polybag until the quantity was sufficient for collection, normally between fifteen and thirty days.

Trial 2

A second trial on polybag latex preservation was carried out using the preservation systems shown in *Table 3.* The duration of the trial was fifteen to thirty days. Addition of preservative was as in *System B, i.e.* once every three tappings with the trees tapped once every three days.

Preparation of Latex Concentrates

After collection, the latex was centrifuged using a commercial Alfa-Laval LRH 410 model centrifuge machine. No over-night maturation was required since the latex had already matured in the polybags.

For bowl or separating efficiency testing, latex in the polybag treated with TMTD/ZnO was compared with HA and LA/TZ controls. Bowl or separating efficiency was calculated using the formula:

$$E = \frac{C(F - S)}{F(C - S)} \times 100$$

where E is the bowl efficiency; C, S and F are the dry rubber content (d.r.c.) values of the concentrate, skim and field latices, respectively.

Concentrates from field latices collected in polybags presented in *Table 3* were subsequently treated as shown in *Table 4.*

TABLE 4. TREATMENT OF LATEX CONCENTRATES

Reference[a]	Treatment of concentrate
A	0.7% NH_3 + 0.02% Ammonium laurate
B	0.2% NH_3 + 0.025% TZ + 0.05% Ammonium laurate
C_1	0.2% NH_3 + 0.025% TZ + 0.05% Ammonium laurate
C_2	0.2% NH_3 + 0.05% PRBL + 0.05% Ammonium laurate
C_3	0.2% NH_3 + 0.05% PROXEL GXL + 0.05% Ammonium laurate
D_1	0.2% NH_3 + 0.025% TZ + 0.05% Ammonium laurate
D_2	0.2% NH_3 + 0.05% PRBL + 0.05% Ammonium laurate
D_3	0.2% NH_3 + 0.05% PROXEL GXL + 0.05% Ammonium laurate

[a]The formulations are given in *Table 3*.

Technological Evaluations

The latex concentrates were evaluated in terms of latex properties, chemical stability, film properties, latex processibility and vulcanisate properties.

For the control, a high-ammonia latex concentrate prepared from one-day-old field latex from the same source was used.

RESULTS

Trial 1

It is not possible to preserve latex on the tree effectively for a long period of time using ammonia alone, without a secondary preservative. Without secondary preservatives such as TMTD/ZnO, PRBL or PROXEL GXL, the ammonia level had to be more than 0.2% (w/w). Trials were initially carried out in the field to determine the optimum concentrations of ammonia and secondary preservatives necessary to stabilise latex collected in polybags effectively on the tree for at least one month. The optimum levels of preservatives to be added to the polybag at every tapping in order to keep the latex in the polybags stable are shown in *Table 5*.

TABLE 5. PRESERVATION SYSTEMS FOR LATEX COLLECTED IN POLYBAGS

Preservation system	NH_3 (%)	Secondary preservative
NH_3/TZ	0.3	0.05% TMTD/ZnO
NH_3/PRBL	0.3	0.10% PRBL
NH_3/PROXEL GXL	0.3	0.10% PROXEL GXL

Initially, preservatives were added to the polybag during every tapping. Since addition of preservatives involves more labour and is time consuming, it is an advantage to reduce the frequency of addition. Ideally addition of preservative is once a month on the first day of tapping, but this is not possible due to the volatile nature of ammonia.

After a series of trials, it was found that preservatives could be added effectively once every ten days when the ammonia concentration was increased to 0.5% (w/w). Depending on the frequency of tapping, *i.e.* alternate-day, third-day or fourth-day tapping, the preservatives could be applied as shown in *Table 6* to maintain the stability of latex in the polybag for one month.

Trial 2

Field latex accumulated in polybags was treated with chemical preservatives once in about ten days (three tappings on d/3 tapping frequency) with optimum dosage levels. Collection of the preserved latex in polybags was done after fifteen days and thirty days where samples were taken and tested for bacterial counts and volatile fatty acid production. It was observed that 0.5% NH_3 and 0.5% TMTD/ZnO gave better preservation when compared to PRBL or PROXEL GXL systems. Preservation with 0.5% NH_3 alone failed to stabilise the latex in the polybag due to the escape of ammonia causing reduction in its concentration in the polybag and allowing ammonia-resistant bacteria to proliferate. On the other hand, the incorporation of secondary preservatives kept the volatile fatty acid (VFA)

TABLE 6. PRESERVATION SYSTEMS FOR LATEX IN POLYBAGS AT D/2, D/3 AND D/4 TAPPING FREQUENCIES

Preservation system	NH_3 (%)	Secondary preservative	No. of tappings/addition		
			d/2	d/3	d/4
NH_3/TZ	0.5	0.05% TMTD/ZnO	4	3	2
NH_3/PRBL	0.5	0.10% PRBL	4	3	2
NH_3/PROXEL GXL	0.5	0.10% PROXEL GXL	4	3	2

number at not more than 0.08 and their bacterial populations remained at about 10^5 bacteria per millilitre latex *(Table 7)*. Although the bacterial populations that survived were mainly acid-producing bacteria, they were biochemically inactive. This was indicated by the arrest of VFA build-up in the preserved latex.

Latex Properties

The latex concentrates were prepared using the treatments shown in *Table 4*. The ammonia level was adjusted to 0.2% and the concentrates were further treated with 0.05% ammonium laurate to boost the mechanical stability time (MST). A sample of HA concentrate was prepared from the same source of field latex and used as the control. The concentrate samples were tested for their properties after up to six months' storage *(Table 8)*. It was shown that latex collected in polybags gave well-preserved concentrates. Properties such as potassium hydroxide (KOH) number, MST, colour of latex film and alkalinity appeared to be satisfactory.

TABLE 7. BACTERIAL COUNTS AND VOLATILE FATTY ACID NUMBERS OF LATEX AFTER COLLECTION IN POLYBAGS

Reference[a]	Duration on trees (days)	Residual NH_3 (%)	pH	VFA No.	Bacterial count (log/ml)
A	—	—	—	—	—
B	17	0.23	9.50	0.05	4
C_1	30	0.26	9.60	0.07	4
C_2	30	0.24	9.60	0.08	4
C_3	30	0.25	9.60	0.08	5
D_1	15	0.27	9.65	0.07	4
D_2[b]	15	0.20	8.55	0.20	8
D_3	15	0.26	9.60	0.08	5

[a]The formulations are given in *Table 3*.
[b]Rain spoilage, deleted from further testing.

TABLE 8. LATEX CONCENTRATE PROPERTIES AFTER SIX MONTHS' STORAGE

Reference[a]	D.r.c. (%)	TSC (%)	NH_3 (%)	VFA No.	MST (s)	pH	KOH No.	Latex colour	Film colour
A	63.70	65.06	0.74	0.01	1 475	10.55	0.57	White	Normal
B	62.70	64.20	0.23	0.03	1 902	9.70	0.69	White	Normal
C_1	62.94	64.24	0.27	0.02	1 610	9.92	0.53	White	Normal
C_2	62.53	63.81	0.25	0.03	>2 400	9.87	0.60	White	Normal
C_3	62.53	63.82	0.27	0.03	>2 400	9.90	0.63	White	Normal
D_1	63.38	64.61	0.23	0.02	>2 400	9.80	0.55	White	Normal
D_3	63.64	64.87	0.23	0.04	>2 400	9.80	0.61	White	Normal

[a]The formulations are given in *Table 3*.

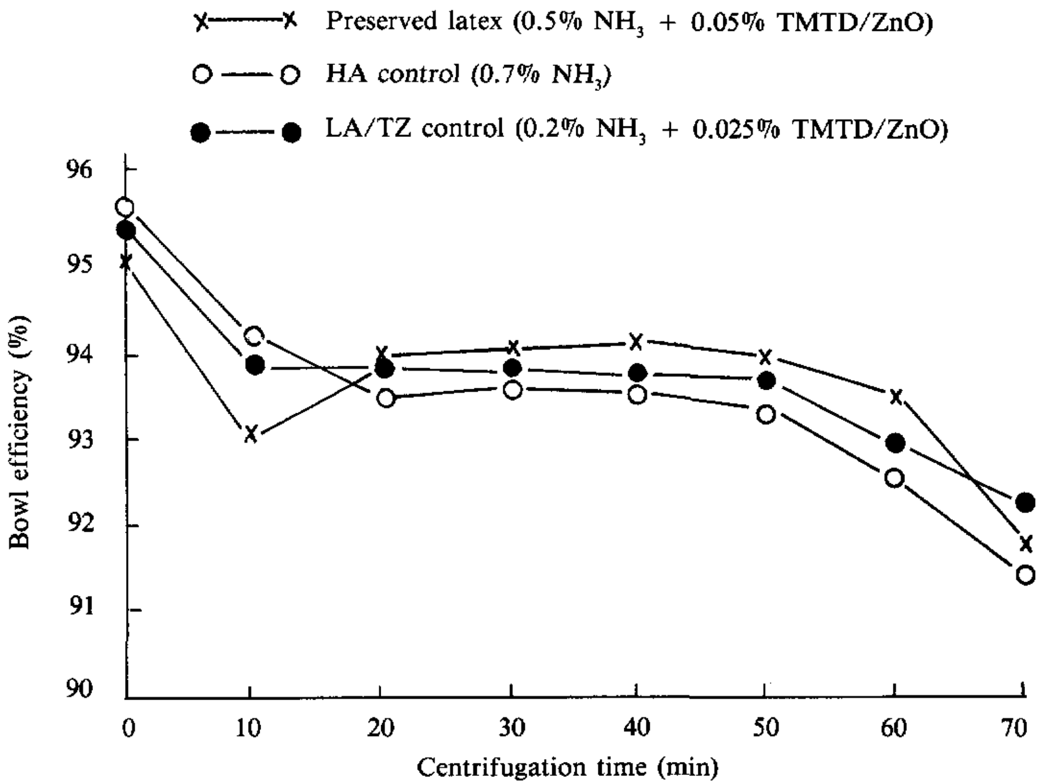

Figure 1. Bowl efficiency of preserved latex in polybags.

Bowl Efficiency

The bowl efficiency of preserved latex in polybags was monitored and found to be comparable to those of HA and LA/TZ controls *(Figure 1)*. Visual inspection of the bowls after running showed no undue accumulation of sludge or other residual materials on the plates.

Chemical Stability

The zinc stability time (ZST) and zinc oxide viscosity (ZOV) values of the various concentrates are given in *Table 9*. The ZST and ZOV of low ammonia concentrates (B, C_1, C_2, C_3, D_1, D_3) were similar. The fifteen-day concentrates *i.e.* D_1 and D_3 appeared to show higher chemical stability than the thirty-day concentrates (C_1 and C_3) in the polybags.

TABLE 9. CHEMICAL STABILITY OF LATEX CONCENTRATES IN POLYBAGS

Reference[a]	ZST (s)	ZOV (cps)	
		5 min	60 min
A	227	766	3 800
B	455	117	381
C_1	535	142	748
C_2	573	211	Gelling
C_3	710	75	1 880
D_1	710	75	205
D_3	650	87	250

[a]The formulations are given in *Table 3*.

Film Properties

Cast films from the latex concentrates in polybags were examined to find out whether the

TABLE 10. FILM PROPERTIES OF LATEX CONCENTRATES IN POLYBAGS

Reference[a]	Lovibond units	Zinc (p.p.m.)	Mg (p.p.m.)	Fe (p.p.m.)	Mn (p.p.m.)	Cu (p.p.m.)	Ash (%)	P (%)	N (%)	AE (%)	K (%)
A	3.5	14	5	10	<1	1	0.39	0.05	0.28	2.56	0.16
B	5.0	315	6	6	<1	2	0.50	0.05	0.34	2.74	0.18
C_1	5.0	590	11	7	<1	2	0.42	0.05	0.29	2.55	0.14
C_2	6.0	30	11	9	<1	<1	0.37	0.05	0.30	2.79	0.16
C_3	5.0	16	7	12	<1	<1	0.40	0.05	0.29	2.59	0.15
D_1	5.0	314	30	7	<1	2	0.42	0.06	0.30	2.56	0.17
D_3	5.0	11	6	7	<1	<1	0.42	0.06	0.30	2.56	0.17

P = Phosphorus ; AE = Acetone extract; Zn = Zinc
N = Nitrogen ; K = Potassium
Mg = Magnesium ; Fe = Iron

[a]The formulations are given in *Table 3*.

prolonged storage of the field latex had an adverse effect on the raw rubber properties. *Samples B*, C_1 and D_1 had higher zinc content (because of the zinc oxide component); *Sample* C_1 appeared to have a higher zinc concentration than *Sample B* and D_1 *(Table 10)*.

The concentrates in polybags gave slightly darker films. Other properties such as nitrogen, phosphorous, potassium, magnesium contents and acetone extract values appeared to be normal.

Latex Compound Stability

Latex concentrates are invariably used in a variety of compounding applications. An important general requirement is that the latex does not behave adversely, for example, showing high zinc oxide sensitivity (leading to thickening).

To assess compound stability, the viscosity stabilities of zinc diethyldithiocarbamate (ZDC) and zinc dibutyldithiocarbamate (ZBUD) accelerated compounds, based on five different compositions, were examined *(Tables 11–14)*.

The ZDC stability of latex concentrate in polybags (as in other LA concentrates) was generally poorer than that of the HA control, especially at low KOH concentrations. This is expected as low-ammonia concentrates are generally more prone to thickening than HA latex. Of interest is the comparison of various low-ammonia concentrates. The fifteen-day concentrates were marginally more stable than the thirty-day concentrates. Stability systems containing ZBUD showed a higher sensitivity to thickening. A combination of stabilisers was required to stabilise the latex compound.

Vulcanisate Properties

A S/ZDC/ZnO (1:1:1) formulation was used. The latex compounds, stabilised with 0.5% KOH and 0.15% potassium caseinate, were allowed to mature for four days at 28°C – 30°C. Dipped films were prepared using a coagulant of 20% calcium nitrate in industrial methylated spirit (IMS). The wet gels were then leached for 15 min at 50°C and vulcanised for 15 min at 100°C. The vulcanisate properties appeared to be satisfactory. The data in *Table 15* indicate that vulcanisation behaviour was not affected.

TABLE 11. FORMULATION FOR ZDC COMPOUND STABILITY

Item	Dry weights of Formulations 1-5				
	1	2	3	4	5
Latex	100	100	100	100	100
10% KOH	—	0.3	0.5	0.5	0.5
10% Potassium laurate	—	—	—	0.5	—
10% Potassium caseinate	—	—	—	—	0.15
50% Sulphur	1	1	1	1	1
50% ZDC	1	1	1	1	1
50% Zinc oxide	1	1	1	1	1
Water	(to 55% TSC)				

TABLE 12. ZDC COMPOUND VISCOSITY

Sample	Formulation[a] 1	2	3	4	5
A					
Initial	44	30	28	30	31
1 day	44	30	30	32	32
3 days	46	29	28	32	31
6 days	46	30	29	32	32
B					
Initial	44	46	46	44	49
1 day	47	45	46	42	50
3 days	240	143	68	57	58
6 days	3 100	716	137	57	58
C_1					
Initial	31	41	37	40	44
1 day	32	41	39	39	42
3 days	338	194	69	56	48
6 days	8 350	2 140	201	92	57
C_2					
Initial	37	38	38	40	42
1 day	38	39	38	39	40
3 days	312	64	38	39	41
6 days	Gelled	840	59	46	43
C_3	36	36	35	38	37
1 day	35	34	32	33	36
3 days	141	64	37	36	38
6 days	Gelled	584	54	42	40
D_1					
Initial	36	34	33	54	36
1 day	32	32	31	31	33
3 days	318	68	47	46	39
6 days	Gelled	650	105	76	46
D_3					
Initial	35	33	35	34	34
1 day	34	31	38	33	35
3 days	256	62	37	36	36
6 days	8 910	696	80	64	44

[a]The formulations are given in *Table 3*.

TABLE 13. FORMULATIONS FOR ZBUD COMPOUND STABILITY

Item	Dry weights of Formulations 6–10				
	6	7	8	9	10
Latex	100	100	100	100	100
10% KOH	—	0.3	0.5	0.5	0.5
10% Potassium laurate	—	—	—	0.5	—
10% Potassium caseinate	—	—	—	—	0.15
50% Sulphur	1	1	1	1	1
50% ZBUD	1	1	1	1	1
50% Zinc oxide	1	1	1	1	1
Water	(to 55% TSC)				

TABLE 14. ZBUD COMPOUND VISCOSITY

Sample	Formulation[a]				
	6	7	8	9	10
A					
Initial	33	30	29	32	32
1 day	34	34	30	38	34
2 days	34	34	31	38	33
3 days	34	34	31	38	32
B					
Initial	46	43	46	44	54
1 day	4 700	862	232	70	68
2 days	Gelled	Gelled	1 730	84	72
3 days	—	—	3 460	107	74
C_1					
Initial	38	40	40	42	46
1 day	Gelled	2 080	316	94	64
2 days	—	Gelled	2 430	180	73
3 days	—	—	3 250	69	51
C_3					
Initial	34	34	34	37	38
1 day	8 200	916	66	44	41
2 days	Gelled	Gelled	402	52	49
3 days	—	—	609	69	51
D_1					
Initial	32	33	32	34	38
1 day	6 450	528	67	63	46
2 days	Gelled	Gelled	552	113	50
3 days	—	—	2 010	169	51
D_3					
Initial	34	34	34	34	38
1 day	5 020	670	71	67	48
2 days	Gelled	Gelled	1 170	288	112
3 days	—	—	3 420	469	194

[a]The formulations are given in *Table 3*.

TABLE 15. VULCANISATE PROPERTIES OF LATEX CONCENTRATES IN POLYBAGS

Property	Sample[a]						
	A	B	C_1	C_2	C_3	D_1	D_3
Tensile strength (MPa)	36.0	37.1	34.8	33.2	33.6	35.3	35.2
EB (%)	960	970	970	970	950	990	960
Relaxed modules (MR100)	0.64	0.59	0.58	0.61	0.60	0.60	0.60
Modules at 500% (MPa)	2.38	2.58	2.45	2.32	2.45	2.27	2.52
Aged 14 days at 70°C							
Tensile strength (MPa)	21.6	20.2	17.7	17.3	16.0	15.9	19.8
EB (%)	850	870	890	920	890	850	900
Relaxed modules (MR100)	0.50	0.52	0.47	0.42	0.43	0.44	0.47
Modules at 500% (MPa)	2.31	2.32	1.99	1.89	1.99	1.98	2.09

[a]The formulations are given in *Table 3.*

DISCUSSION AND CONCLUSION

The collection of rubber in polybags in which a special polybag apparatus is left on the tree to accumulate coagula from several tappings over a period of two to four weeks has its advantages and drawbacks.

Collection in polybags may increase the effectiveness of the tapper, overcome the problem of labour shortage by reducing collection frequency, improve cleanliness of the coagulum and provide a larger reservoir for higher yielding trees where traditional tapping cups may be inadequate. The possible drawbacks include loss due to theft, higher cost of bags in the long run and of more importance is the production of a lower quality rubber.

The present study indicates that preserving latex in a fluid stage in polybags in the field for up to thirty-days is a technical possibility.

The concept of latex preservation in polybags is meant to arrest bacterial growth while the bacterial population is still low. With the LA/TZ field latex treatment, control of VFA was excellent in all trials. Field latex was kept stable for up to thirty days and the resulting concentrates had good storage properties and processing characteristics.

The trials also showed that preservation systems using ammonia/PRBL and ammonia/PROXEL GXL were effective for latex preservation in polybags, although requiring higher dosages.

Concentrates derived from latex collection in polybags have shown no abnormal properties. The respective concentrates showed good preservation as indicated by the data on storage. The VFA numbers were low (<0.05) and mechanical stability time exceeded 1500 s. Properties of the rubber films obtained from these concentrates were quite similar to those of the control and the vulcanisation behaviour was considered to be normal and satisfactory.

In conclusion, latex preservation in polybags offers an alternative method for rubber tapping and collection. It combines the advantages of collection of latex in polybags with the realisation that the latex can be processed into a premium latex concentrate.

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