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COMPARATIVE CHEMISTRY AND MICROBIOLOGY OF COCOA FERMENTATION IN INDIA*

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ABSTRACT

Indian cocoa beans are usually acidic due to defective harvesting, fermentation and drying. An improved processing method was developed to overcome the acidity problem. Microbiological and chemical changes occurring during the processing of cocoa beans have been compared and discussed.

INTRODUCTION

Acidity in cocoa beans is a serious defect as it imparts raisin/fruity off flavour to the finished chocolate. The pH of good quality processed beans should be in the range of 5.3 to 5.7. The problem of acid beans has also been reported from Sri Lanka, New Guinea and Malaysia (Liau, 1976, 1978).

Improved processing methods of fermentation and drying to overcome acidity was reported by Balasimha et al. (1980). Microbiological and biochemical changes occurring during cocoa processing are reported in this paper.

MATERIALS AND METHODS

After pod breaking fresh beans were transferred to fermentation boxes of 75 × 45 × 45 cm size with a capacity to hold about 80 kg wet beans.

The improved method of fermentation in this study involved repeated turnings of beans on fifth and sixth day (five times) with one turning each on second and fourth day (Balasimha, et al., 1980). This was followed by slow drying for first two days and continuous drying later. The traditional method in box fermentation is two turnings on second and fourth days. The fermentation box in the present study was improvised with gaps at the side to provide good aeration (Balasimha et al., 1980; Shamsuddin, Idruz and Hassan, 1978).

Ten gram sample was ground in 90 ml boiling water, cooled and pH was estimated using an Elico pH meter. Fat was extracted in petroleum ether with 40 washings in a Soxhlet Apparatus. Total phenols were extracted in hot methanol and determined by Folin–Denis reagent (Farkas and Kiraly, 1962). For anthocyanin determination one gram sample was ground in 25 ml methanol containing 1% HCl (V/V), filtered and read at 530 nm in a spectrophotometer and expressed in absorbance units.

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Total acidity was determined by titrating the aqueous extracts against 0.01 N NaOH with phenolphthalein as indicator.

For microbiological enumeration ten gram beans with pulp was transferred to a 250 ml flask containing 100 ml sterile distilled water and shaken for 10 minutes. The dilution plating method was followed. The yeast agar, actetobacter agar, tryptone agar and nutrient agar media were employed for isolation and enumeration of yeasts, acetic acid, lactic acid bacteria and bacillus respectively.

RESULTS AND DISCUSSION

The quantitative enumeration of microflora is given in Table I. Many types of yeasts were involved in fermentation converting pulp sugars to ethanol which is essentially an anaerobic process. During the initial stage of fermentation (up to 2 days) yeasts were found to be abundant and the population declined thereafter.

The bacterial counts on nutrient agar (NA) medium decreased gradually and the colonies appeared were the species of *Bacillus*. Microscopic examination of pulp extract revealed the presence of rod shaped bacteria in chains in large numbers during the later stage of fermentation. The acetic acid bacteria *(Acetobacter sp.)* are involved in the conversion of ethanol to acetic acid and it is further oxidised to carbon dioxide and water. Small pin head colonies were observed frequently in large number in different media, which on isolation failed to grow. They are probably thermophillic lactic acid bacteria, but further investigation of these organisms is necessary. Similar observation was reported by Carr, Davies and Dougan (1979) from Malaysia and Ghana.

The total acidity and pH values were monitored during fermentation and drying and compared with traditional method (Fig. 1). It was observed that the acidity levels were lower in improved methods. The moisture level remained between 44–48% throughout the fermentation period. The temperature was maintained at a higher level (42–44°) in

Table I. *Chemical and microbiological changes during fermentation and drying*

Days	Total phenol (mg/g dry wt)	Anthocyanin (A 530 nm)	Yeast (10^5)	Bacteria (10^5)
		FERMENTATION		
1	28.08	1.75	29.2	22.3
2	49.60	1.50	32.0	30.6
3	33.12	0.62	13.3	11.6
4	39.83	0.65	12.4	18.5
5	38.59	0.52	15.2	10.5
6	23.36	0.28	15.5	1.3
	DRYING			
Artificial drying		*Sun drying*		
1	14.25	1	10.00	
2	9.75	2	12.25	
3	13.50	4	13.75	

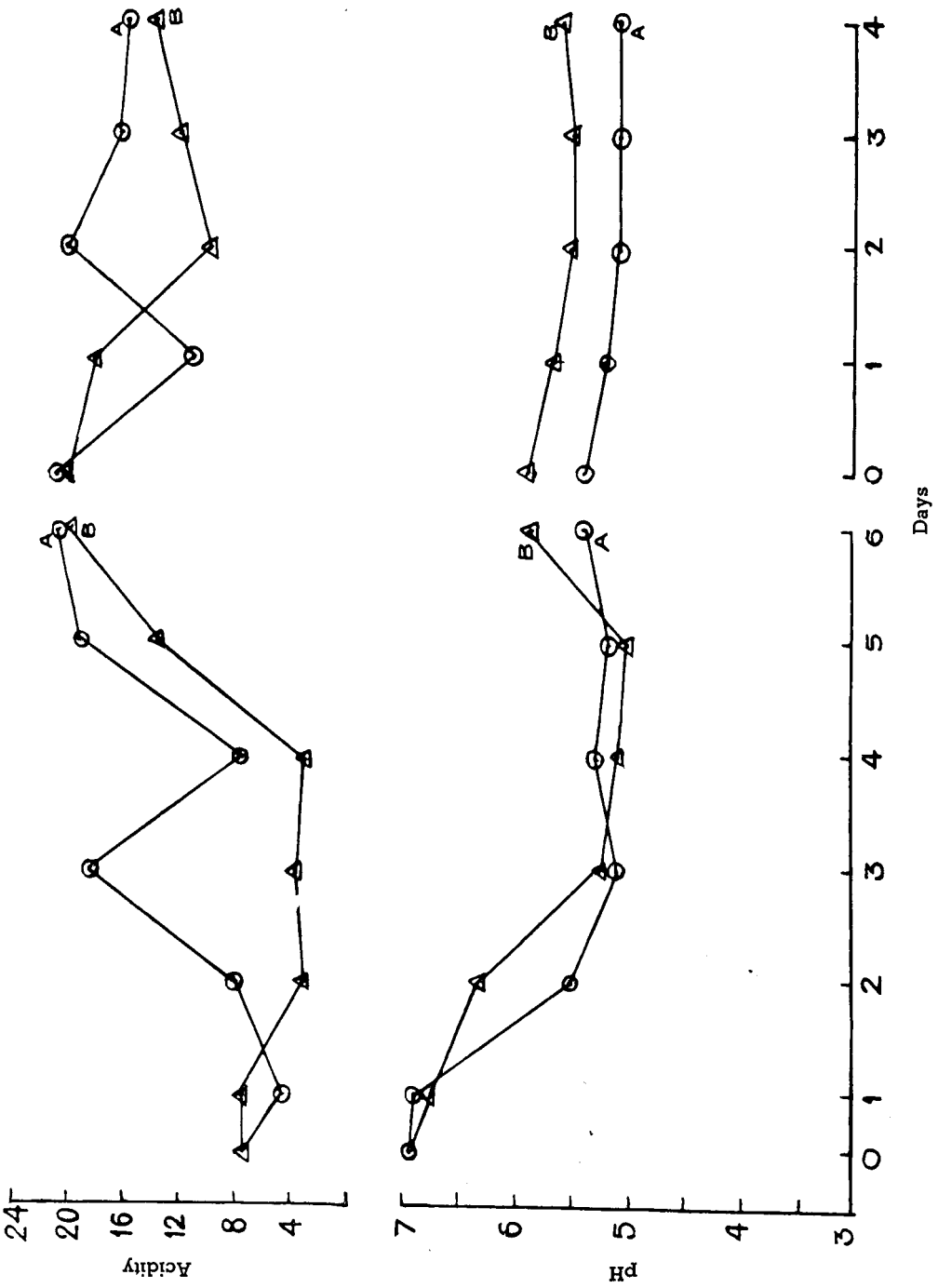


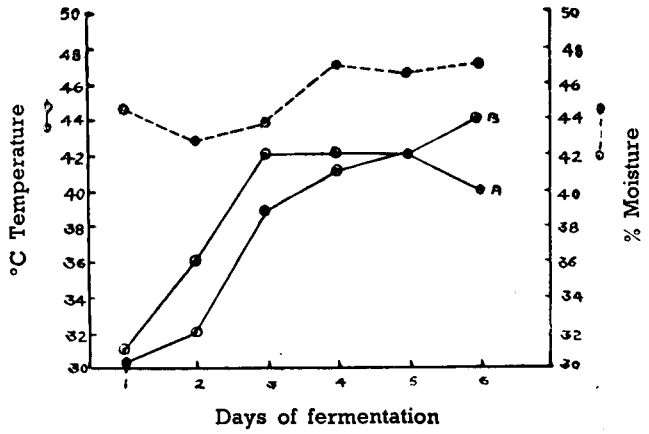
FIG. 1. FERMENTATION

the improved method which was optimum for aerobic oxidations and biochemical changes taking place in the beans (Fig. 2).

Phenol content declined gradually during fermentation, but sharply during drying. The anthocyanins also decreased during the course of fermentation (Table I). The subjective evaluation of cocoa bean flavour is largely due to the presence of polyphenols and anthocyanins. It is reported that anthocyanins reflect quality (astringency) more than that of polyphenols (Rohan, 1963). The purple bean colour gradually turns brown. In fact, the cocoa beans which are purple are not preferred for chocolate preparations and if anthocyanins are more than 10 per cent, it is not acceptable.

During fermentation and drying, moisture, aeration and temperature are vital for the development of precursors of flavour and quality (Liau, 1976, 1978). The high quality of beans obtained from this study might be because these three factors were taken into account (Table II). The repeated turning in later stages of fermentation and use of side ventilated boxes not only brought down acidity

FIG. 2. TEMPERATURE AND MOISTURE LEVEL IN IMPROVED METHOD OF FERMENTATION



but gave uniformly processed beans. The shell per cent by and large is dependent upon the bean size i.e., it is inversely related to bean size (Rohan, 1963). Moreover, it is dependent on genetical as well as environmental factors.

The slow drying initially also favoured optimum biochemical changes especially anthocyanic breakdown and oxidation of excess acetic acid. Rapid artificial drying caused unwanted fruity flavour due to excess of acetic acid (Powell, 1953). In fact, sun drying is the best because it is slow and the temperature is low. But this is not practically feasible in all seasons especially in peak harvesting season which coincides with monsoons. In such cases slow artificial drying at 50°C for 8 hr. each day for first two days followed by continuous drying should give quality cocoa beans.

Table II. *Chemical and physical characteristics of processed cocoa beans samples*

Sample	Shell (%)	100 bean wt. (g)	pH	Total phenol (%)	Reducing sugar (mg/g dry wt)	Fat (%)	Comment
Vittal*	19.2	97.8	5.2	0.82	8.75	55.5	Traditional processing
Vittal*	17.3	104.9	5.5	0.68	9.51	51.6	Improved processing (artificial drying)
Vittal*	18.2	105.8	5.7	1.38	7.05	49.7	Improved processing (sun drying)
Puttur	20.3	95.5	4.9	0.60	9.00	50.4	Obtained from CAMPCO, Puttur
Ernakulam	—	—	5.2	0.60	9.50	44.5	Obtained from M. S. Ramaiah and Sons, Bangalore
Bangalore	22.9	84.7	5.4	—	—	49.8	
Cap Comorin	24.8	85.1	4.9	—	—	43.8	

* Institute experiments

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REFERENCES

BALASIMHA, D., BHAT, N. T., BOPAIAH, B. M. and MURTHY, K. N. 1980. Removal of cocoa bean acidity by improved processing. PP. 91–98. In *Proceedings of Third National Symposium on Plantation Crops* ed. K. V. George. Indian Society for Plantation Crops, Kasaragod, India.

CARR, J. G., DAVIES, P. A. and DOUGAN, J. 1979. Cacao fermentation in Ghana and Malaysia with special reference to acidity. In *Proceedings of the Seventh International Cocoa Research Conference*. 5–12 November 1979, Douala, Cameroon.

FARKAS, G. L. and KIRALY, Z. 1962. Role of phenolic compounds in the physiology of plant disease and disease resistance. *Phytopath. Z.* 44: 105–150.

LIAU, H. T. L. 1976. Raw cocoa processing: acidity and flavour. East Malaysia Planter's Assoc. Cocoa-Coconuts Seminar, Taiwan, 184–196.

LIAU, H. T. L. 1978. The criteria and mechanism for the removal of cocoa bean acidity. pp. 425–439. In *Proceedings of the International Conference on Cocoa and Coconuts*. Kaula Lampur.

ROHAN, T. A. 1963. *Processing of Raw Cocoa for the Market, FAO*. Rome. pp. 207.

POWELL, B. D. 1953. The rapid artificial drying of cocoa beans and chocolate flavour. *Trop. Agric.* 35: 200–204.

SHAMSUDDIN, S., IDRUZ, A. Z. and HASSAN, M. H. 1978. Preliminary efforts to improve the quality of cocoa beans. pp. 416–424. In *Proceedings of the International Conference on Cocoa and Coconuts*, Kaula Lampur.