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EFFECT OF METHODS OF FERMENTATION ON TEMPERATURE, ACIDITY AND QUALITY OF COCOA (*Theobroma cacao L.*) BEANS

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Among the methods of cocoa bean fermentation, heap method is the most common in small farms in Ghana and other West African countries. However, processing by this method requires a certain minimum quantity of wet beans in order to generate heat in the mass sufficiently and thereby to ensure adequate fermentation. The size of heap often has a bearing on acidity of the processed beans, too large quantities often leading to higher acidity. The present experiment was taken up at the Cocoa Research Institute, Tafo, Ghana, to study the effect of heap sizes on temperature, pH and quality of beans. Variations in temperature during fermentation has been reported earlier by Kenten and Powel (1960) and Wood (1975). Wood (1975) also reported the changes in pH of cocoa at various states of fermentation.

Materials and Methods

Heaps of wet beans were maintained at three sizes, 50, 150 and 450 kg. Thermometers were inserted into the heaps with the bulbs reaching the bottom, middle and top of every heap and temperatures were recorded thrice daily at 8 am, 12 noon and 4 pm. The heaps were turned twice on alternate days and were dismantled for drying on the seventh day. Temperature changes of beans in the trays were also recorded at these intervals. In this method, twelve trays were arranged one over the other and temperatures were recorded in the top, middle and bottom trays. Beans were allowed to ferment in the trays for four days and were then taken out for drying on the fifth day.

For determination of pH of pulp and cotyledon, samples of beans were drawn every day from about the middle of the heap. In the case of tray fermentation, samples were drawn only from the central–lower part of the top tray as the settings could not be disturbed till the fifth day. Ten beans from each sample were peeled and the testa with pulp was collected to which 90 ml of boiling water was added, stirred well and pH was determined using a pH meter. The cotyledons were homogenised in 40 ml of distilled water, heated to boiling, cooled and pH was determined. After completion of fermentation the beans were separately sun-dried and random samples were drawn from each lot for grading by cut test.

Results and Discussion

Temperature

Data on temperature changes are presented in Table 1. In the heaps, temperature rose from around 26°C to a peak of 40°C on the fourth day. Size of

heap did not appear to affect the peak temperature level. After attaining the peak, there was a drop in temperature on the fifth day and this was followed by increase in temperature up to 48°C. This trend of temperature drop was observed in all heaps and at all depths. On the seventh day, temperature dropped again in all lots. The overall trend of temperature changes agrees with that stated by Wood (1975) wherein the peak temperature ranged between 48° and 50° C after the first bean mixing in heap fermentation. It then dropped to 45°-48°C at the close of fermentation. The final temperature observed in the present study were in the range from 41°C—48°C at the bottom and top respectively of the mass. This slight deviation is attributable to the rise in temperature being dependent on microbial fern entation of the sugary pulp which may vary with the nature of the original microbial population and with the aeration status in the ferment. The location of measurement did not have persistent effect on temperature except in the heap of 50 *kg* where bottom temperature was consistently lower during the entire period of fermentation. The trend of temperature changes in tray fermentation was different from those in heaps. Though there was a tendency for decrease after reaching the peak the magnitude was only to the extent of 1°C. The temperature thus remained practically constant throughout the entire period of fermentation after reaching the peak. The major treatment difference were the relatively lower peak temperature and the lack of wide temperature flutuations in tray fermentation.

pH

Data are presented in Tables 2 and 3

i Pulp

pH of pulp ranged from 3.9 to 4.6 during fermentation. The general trend was that of a more or less steady increase as fermentation progressed. The differences among the heaps and between the two methods of fermentation were small and inconsistent.

ii Cotyledons

Changes in pH of cotyledons during fermentation were marked. It dropped from around 6.5 initially to 4.7 on the fourth day and remained more or less steady therafter The final pH of cotyledons after completion of fermentation showed practically little difference among heap sizes and methods of fermentation. The trend of changes, however, varied among treatments in the case of heaps. But the differences were only marginal in tray fermentation. These results were in accordance with the observations made by other investigators (Wood, 1975).

Grading

Data on the grading of cocoa beans are given in Table 4. The beans in all treatments could be classed into colour classes, namely, brown, pale purple and purple. There were no slaty beans. The percentages of beans in above classes varied slightly but all lots could be grouped under grade I.

Table—1

Changes in temperature (°C) of cocoa beans in heap and tray fermentation

Method of fermentation.	Location of temperature reading in the ferment	Days arter setting and hours of reading o1 temperature																		Remarks
		lst day			2nd day			3rd day			4 th day			5 th day			6th day			7 th day	
		12 noon	4PM	SAM	12 noon	4PM	8 AM	12 noon	4PM	8AM	12 noon	4 PM	8AM	12 noon	4PM	8 AM	12 noon	4 PM	8 AM	12 noon	
A Heap-	Top	26	27	37	44	44	49	42	48	59	49	49	47	47	45	48	50	49	46	46	
50 kg	Middle	26	27	38	42	42	48	49	46	49	48	48	47	47	45	50	48	48	46	46→	Drying
	Bottom	26	27	36	38	41	41	45	45	47	47	47	45	45	44	46	46	40	44	43	
Heap-	Top	26	27	40	43	45	49	48	47	50	49	49	47	47	46	50	50	49	47	46	
150 kg.	Middle	26	27	42	43	46	48	49	48	50	50	50	48	48	47	51	50	50	48	48→	Drying
	Bottom	26	27	33	34	36	47	41	45	49	48	47	47	47	45	46	45	45	43	41	
Heap-	Top	26	29	30	34	37	42	45	43	50	50	50	49	48	45	48	49	50	48	47	
450 kg	Middle	25	27	33	30	30	37	39	41	48	49	49	48	45	45	47	47	47	46	46→	Drying
	Bottom	25	27	30	31	33	37	39	41	44	46	46	48	46	46	50	49	50	48	47	
B Tray	Top	27	27	31	35	37	44	47	47	47	46	46	46	46	46	46	46				
	Middle	27	28	36	40	43	47	48	48	48	48	47	47	48	48	48	48→	Drying			
	Bottom	26	28	35	39	46	66	46	4G	46	49	46	46	46	47	45	44				

* Turning of the beans in heaps

Table 2

Changes in pH of pulp in tray and heap fermentation

Heap size	Days after setting						
	1	2	3	4	5	6	7
Heap-50 kg	4.0	3.9	4.2	4.2	4.4	4.6	4.3
Heap–150 kg	4.1	4.2	4.1	42	4.3	4.6	4.3
Heap-450 kg	4.0	4.0	3.9	4.1	4.2	4.4	4.3
Trays	—	3 9	4.0	4 3	4.4	44	—
			→Heaps turned		→Heaps turned		

Table 3

Changes in pH of cotyledon in tray and heap fermentation

Heap size	Days after setting						
	1	2	3	4	5	6	7
Heap-50 kg	6.4	5.8	5.0	4.7	4.7	4.8	4.7
Heap–150 kg	6 5	6.4	4.7	4.7	4.6	4.6	4.8
Heap-450 kg	6.3	65	5.5	4.8	4.6	4.7	4,7
Tray	—	6,2	5.7	5.1	4.9	4.9	—
			→Heaps turned		→Heaps turned		

Table 4

Effect of methods of fermentation and heap size on the grade of dried beans

Heap size	Percentage of beans			
	Brown	Purple	Deep purple	Slaty
Heap-50 kg	34	53	13	0
Heap–150 kg	39	45	16	0
rieap-450 kg	44	41	15	0
Tray	36	64	0	0

Summary

The trend of variation in temperature, and pH of cocoa beans in heap and tray methods of fermentation was studied at the Cocoa Research Institute of Ghana. Heaps of sizes having 50 kg, 150kg, and 450 kg and the standard tray method of fermentation were tested and the grades of dried beans obtained from the different methods were compared. In the heaps, a higher peak temperature was reached as compared to the trays. The beans in the heaps followed regular fluctuations in temperature during fermentation while the temperature fluctuations were low in the trays. The final pH values of pulp and beans were not much affected by the method of fermentation and heap size However, the decrease in pH of cotyledons was slower in the largest heap The fermentation methods and heap sizes did not markedly affect the grade of the dried beans

സംഗ്രഹം

മൂന്ന് വലിപ്പത്തിലുള്ള കൂന സംസ്ക്കരണം, തട്ടു സംസ്ക്കരണം, എന്നിവയിലെ താപനില, അമ്ലക്ഷാരമാനം, ഉണങ്ങിയ കുരുവിന്റെ ഗുണനിലവാരം എന്നിവ സംബന്ധിച്ച പഠനങ്ങളിൽ കൂന സംസ്കരണത്തിൽ താരതമ്യേന ഉയർന്ന താപനിലയും ഊഷ്മാവിൽ വ്യക്തമായ വ്യതിയാനങ്ങളും കാണുകയുണ്ടായി. എന്നാൽ അൽപം താഴ്ന്ന താപനിലയും പൊതുവെ കുറഞ്ഞ വ്യതിയാനങ്ങളുമാണ് തട്ടു സംസ്ക്കരണത്തിൽ കണ്ടത്. സംസ്ക്കരണ സമ്പ്രദായങ്ങളും, സംസ്ക്കരിക്കപ്പെട്ട കുരുവിലെ പരിപ്പ്, പരിപ്പ് എന്നിവയിലെ ക്ഷാരാമ്ലമാനത്തേയോ, ഉണങ്ങിയ കുരുവിന്റെ ഗുണത്തെ സാരമായി സ്വാധീനിക്കുന്നതായിതെളിഞ്ഞില്ല.

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