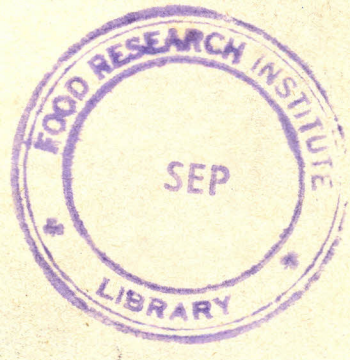
ESTABLISHMENT OF STANDARD QUALITY AND PROCESS PARAMETERS FOR "AGBELIMA" AND THE DEHYDRATED FERMENTED CASSAVA DOUGH.

1ST PROGRESS REPORT.



SOME CHARACTERISTICS OF MARKET SAMPLES OF "AGBELIMA" AND THE EFFECTS OF VARIOUS TRADITIONAL INNOCULANTS IN FERMENTING CASSAVA FOR " AGBELIMA".

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INTRODUCTION

Following the successful development of the dehydrated fermented cassava dough (Dziedzoave 1985) it became necessary to carry out further studies on the production of the product to establish certain quality standards for the product, to standardise certain process parameters that would lead to products of the desired quality and then to assess the shelf-life of the product.

In the preliminary investigations carried out during the development of the product, market samples were purchased and dehydrated to a moisture content of about 6%. Chemical analysis including proximate analysis and acidity and organoleptic tests were carried out on the fresh and dehydrated dough samples. The results showed no significant differences between the fresh and dehydrated dough samples except for the acidity which showed significant differences but then these differences were not detectible during the sensory evaluation tests. However it is expected that this difference in acidity can be corrected if the fermentation of the dough can be extended and manipulated to produce an acidity level beyond the acceptable which after dehydration would fall to the acceptable level.

Since the initial investigations did not involve the production of the dough from the starting raw material, there is need now to investigated the unit processes in the production of the dough prior to dehydration.

Casual and isolated interviews with some small-scale producers and sellers of agbelima indicated that unlike the preparation of cassava dough for gari making, preparation of cassava dough for agbelima involves the addition of an innoculum. There are different types of this innoculum and each has its peculiar mode of preparation; In some cases fresh cassava is sun-dried or soaked in water for a specified number of days and used; in others the cassava is either roasted or cooked etc. The principal aim of adding the innoculum as far as the traditional producers are concerned is to produce a product with a smooth texture. But it is suspected that other effects relating to taste and flavour are produced in addition to the improved texture by the addition of the innoculum.

The purpose of this study is to:

i) establish the levels of acidity and flavour normally acceptable to consumers of cassava dough.

ii) investigate the differences in cassava dough prepared with and without innoculum.

iii) investigate the rate of formation of acids, aldehydes and esters during the fermentation of cassava dough and to establish a process of producing a dehydrated product which possesses the acceptable acidity levels even after dehydration ration and yet has no other objectionable characteristic.

iv) carry out shelf-life studies on the product.

Outlined in this Progress Report are investigations on:

i) moisture, ester and total acid levels in some market samples of cassava dough,

ii) moisture and total acid levels of dough prepared without innoculum, compared with those of dough prepared with some selected innocula.

2 MATERIALS AND METHODS

2.1 SCREENING OF MARKET SAMPLES FOR MOISTURE, ESTERS, TOTAL ACIDS AND VOLATILE ACID CONTENT

Twenty (20) samples of cassava dough were purchased from four different markets in Accra; and stored at freezing temperature to arrest fermentation. The samples were then analysed for the various parameters.

2.1.1 MOISTURE

About 2g samples were dried in cooled weighed dishes in an air-oven at a temperature of about 105°C until a constant weight was obtained. Moisture was calculated as the loss in weight of the sample on drying (A.O.A.C. 1970, 7, 003).

2.1.2 ESTERS

The esters were determined using the A.A.C.C. (1976) methods appropriately modified to suit the sample under investigation.

A 10% (w/v) slurry of the dough sample was prepared in a 500ml flask-the particles were kept in suspension by agitating the flask by hand at ten-minute intervals for thirty-minutes. The extract was thoroughly filtered to remove all the starch, 250ml of the filtrate and a little caborundum was slowly distilled from a 500ml flask into a 200ml volumetic flask until full or almost full. It was diluted to the mark with water and mixed.

100ml of the distillate was trasfered to a 500ml flask and a few drops of phenolphthalein added; The volatile acids were exactly neutralised and a measured excess of 0.1N NaOH added.

A reflux air condenser (60cm long) was connected to the flask and the flask heated for 2hrs on a boiling water bath. It was then cooled and the excess alkali titrated against 0.1N H_2SO_4.

Each ml. of decinormal alkali used for the saponification is equivalent to 0.0088g ethyl acetate.

2.2.3 TOTAL ACIDS

Total acidity of the samples was determined using a modification of the AACC (1976) method, as described by Plahar (1983). A 10% (w/v) slurry of the sample was prepared as above but in a 250 ml. flask. The extract was filtered and aliquotes of the filtrate were used to determine titrable acidity by titrating against 0.1N NaOH standard solution. The acidity was estimated as lactic acid.

2.3 EFFECT OF ADDITION OF DIFFERENT INNOCULANTS ON THE MOISTURE AND ACID CONTENT OF AGBELIMA

2.3.1 PREPARATION OF SAMPLES FOR ANALYSIS

Fresh cassava tubers were purchased direct from the farm, peeled, washed and frozen. The tubers were taken from the freezer when required, thawed and grated.

In one set of samples (SET I), after grating, the mash was divided into 500g portions in 5 sets of beakers representing the 4 different innoculants to be used and the control sample. Each of the 5 sets consisted of 4 pairs of beakers labelled 0, 24, 48 and 72 hours, representing the expected periods of fermentation (in hrs). For each pair of beakers, one was innoculated with 25g (5% innoculant, whilst the other was innoculated with 10g (2%) or 50g (10%) as the cose may be. The control was not innoculated.

After the required period of fermentation the sample in each beaker is divided into two portions. One portion is pressed (or dewatered) whilst the other is not. Both the pressed and unpressed samples are analysed for the various parameters and the rest of the samples frozen to arrest fermentation.

In another set of samples (SET II), after grating, the mash was divided into 1 kg portions in 5 pairs of beakers again representing the 4 innoculants and the control. The beakers in each pair were innoculated as in the first set of samples. Each beaker was allowed to undergo fermentation for 3 full days but then samples for analysis were taken at 24hrs intervals from each beaker and fermentation allowed to continue in the remaining portion until the end of the 72hrs when the last sample is taken. As in the first set of samples analyses were carried out for both pressed and unpressed samples.

In a third set of samples the traditional method of pressing whilst fermentation proceeds was used. The grated mash was divided into . . .

2.2.2 PREPARATION OF INNOCULANTS

2.2.2.1 INNOCULUM I (DRIED)

Fresh cassava tubers were peeled and sun-dried for a period of 3 days after which they were milled into a fine flour and used

2.2.2.2 INNOCULUM II (WRAPPED)

Fresh cassava tubers were peeled and wrapped in a polypropylene sack and kept in a closed container in a dark cupboard for 6 days after which it was mashed by hand and used.

2.2.2.3 INNOCULUM III (SOAKED)

Already peeled and frozen tubers were cut in small chumks and soaked in water for 3 days after which they were grated and used.

2.2.2.4 INNOCULUM IV (COOKED)

Already peeled frozen tubers were thawed sliced and cooked after which they were mashed and used.

3. RESULTS AND DISCUSSIONS

3.1 MOISTURE, TOTAL ACID AND ESTER CONTENT OF SCREENED MARKET SAMPLES

From the results in Table 1 it is observed that for the 20 market samples screened. The moisture content ranged between 46.5%-52.5% with the majority of the samples (about 14) lying within the range of 48.0-49.9% moisture content. The average moisture content calculated for the 20 samples was found to be 49.11% with a standard deviation of 1.37 meaning that within the 95% confidence limits a moisture content of 46.62-51.85 is acceptable. But considering the modal range and the mean, it can conveniently be said that a moisture content of 48.0-50% is ideal for "agbelima".

Also the total acids content ranges between 1.01-2.73, on dry weight basis, with about 12 out of the 20 samples lying within the range of 1.60-1.99%. The mean total acid content is 1.82 with a standard deviation of 0.37. This implies that within the 95% confidence limits a total acid level of 1.09-2.55 can be taken as acceptable for agbelima· however considering the modal range and the mean, a value between one standard deviation on either side of the mean (ie. 1.45-2.19%) can be taken as ideal.

TABLE 1 RESULTS FOR SCREENED MARKET SAMPLES

SAMPLE	MOISTURE (%)	TOTAL ACIDS (%)	ESTERS (%)
A	48.18	1.74	0.440
B	48.75	1.93	0.373
C	48.90	1.74	0.338
D	49.60	1.94	0.310
E	52.30	1.95	0.278
F	47.57	2.36	0.141
G	48.79	1.65	0.130
H	46.62	1.97	0.123
I	47.75	1.55	0.331
J	49.07	1.98	0.345
K	48.58	1.64	0.305
L	49.34	2.15	0.352
M	48.39	2.09	0.109
N	52.34	1 01	0 117
O	48.43	2 73	0 288
P	49.68	1.77	0 103
Q	48.90	1.62	0.440
R	49.05	1.28	0.467
S	50.28	1.67	0.464
T	49.62	1.55	0.478
AVERAGE	49.11	1.82	0.297
STANDARD DEVIATION	1.37	0.37	0.132
VARIANCE	1.88	0.14	0.018
MODAL CLASS	48.0-48.9	0.90-1.09	0.30-0.39

The distribution of the values for the ester content is very hapharzard. The standard deviation of 0.132 obtained is too big compared with the mean of 0.297. The results are therefore not stastically reliable and no definite conclusion can be drawn from them until further investigations have been carried out.

3.2 MOISTURE CONTENT OF FERMENTED SAMPLES

For both set I and II samples the moisture content of the pressed samples is observed to be lower than that of the unpressed samples. But this is to be expected because pressing is a dewatering process which invariably reduces moisture content.

3.2.1 SET I SAMPLES

For the control (ie uninnoculated) dough, the moisture content of all four pressed samples, fall within the range of the market samples screened. However only 3 fall within the 95% confidence limits and none of them within the proposed ideal range. The results are shown in Table 2.

For the dough samples innoculated with innoculum I all four pressed samples fall within the range of the market samples, but again only three (3) within the 95% confidence limits and 1 within the ideal range.

With the innocullum II pressed samples, all of them fall within the 95% confidence limits whilst 2 are within the ideal range.

With the samples innoculated with Innoculum IV only one of the pressed samples showed a moisture content outside the range of the market samples screened, whilst two of the remaining three fall within the 95% confidence limits and the ideal range.

Even though these results are indicated they cannot really be used to judge the quality of the laboratory samples because the aim of pressing, during the course of the experiments was to reduce the moisture content of the samples to a level comparable to that of the market samples, However it is worth noting that the ease of pressing out the liquid was influenced to some extent by the period of fermentation. The longer the fermentation, the more difficult it was to squeeze out the liquid; and hence for the pressed samples it can be observed that the moisture content seemed to increase with the duration of fermentation. This is however not the case with the unpressed samples.

TABLE 2 MOISTURE CONTENT OF SET I SAMPLES

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES PERIOD OF FERMENTATION				PRESSED SAMPLES PERIOD OF FERMENTATION			
		0	24	48	72	0	24	48	72
CONTROL	0 %	62.22	61.02	58.73	61.27	50.38	50.52	51.60	51.92
I	5 %	59.47	59.85	60.06	60.10	48.59	50.15	51.80	52.13
II	5 %	58.27	61.20	58.68	56.90	47.47	49.57	50.94	50.95
III	5 %	61.50	61.31	63.68	62.35	48.90	49.25	50.85	53.02
IV	-	-	-	-	-	-	-	-	-

Fig. 1 shows the variation in moisture content of the set I unpressed samples with time. With the innocullum I samples, there is a gradual increase in moisture content throughout the fermentation period. .The innocullum II samples showed an initial rise in moisture content during the first 24 hrs of fermentation followed by a fall in the moisture content until the end of the third day of fermentation. On the other hand, the control showed a decrease in moisture until the end of the second day of fermentation with the final 24 hrs of fermentation seeing an increase in moisture content. With respect to the innocullum III samples a slight fall in moisture content was observed after the first 24 hrs. This was followed by a sharp increase during the next 24 hrs and then a descrease towards the end of the 3rd day of fermentation.

As can be seen the variations observed are very irregular and no immediate explanation can be offered for them until further investigation have been carried out.

3.2.2 SET II SAMPLES

Results for the set II samples are indicated in Table 3 and 4 and in figs. 2 and 3.

For the control experiment the results indicate that all the pressed samples have their moisture contents falling within the range of the market samples screened, and also within the 95% confidence limits but with only two falling within the proposed ideal range.

With the innocullum I pressed samples, results for the 2% innoculated samples, showed that, one is outside the range of the market samples, three within the 95% confidence limits and none within the ideal range. However for the 5% innoculated samples all are within the range of the market samples and the 95% confidence limits, but only one is within the proposed ideal range.

Results for the innocullum' III pressed samples, show that with 5% innoculation, all the samples except one, showed a moisture content within the range of the market samples, three within the 95% confidence limits and none within the ideal range.

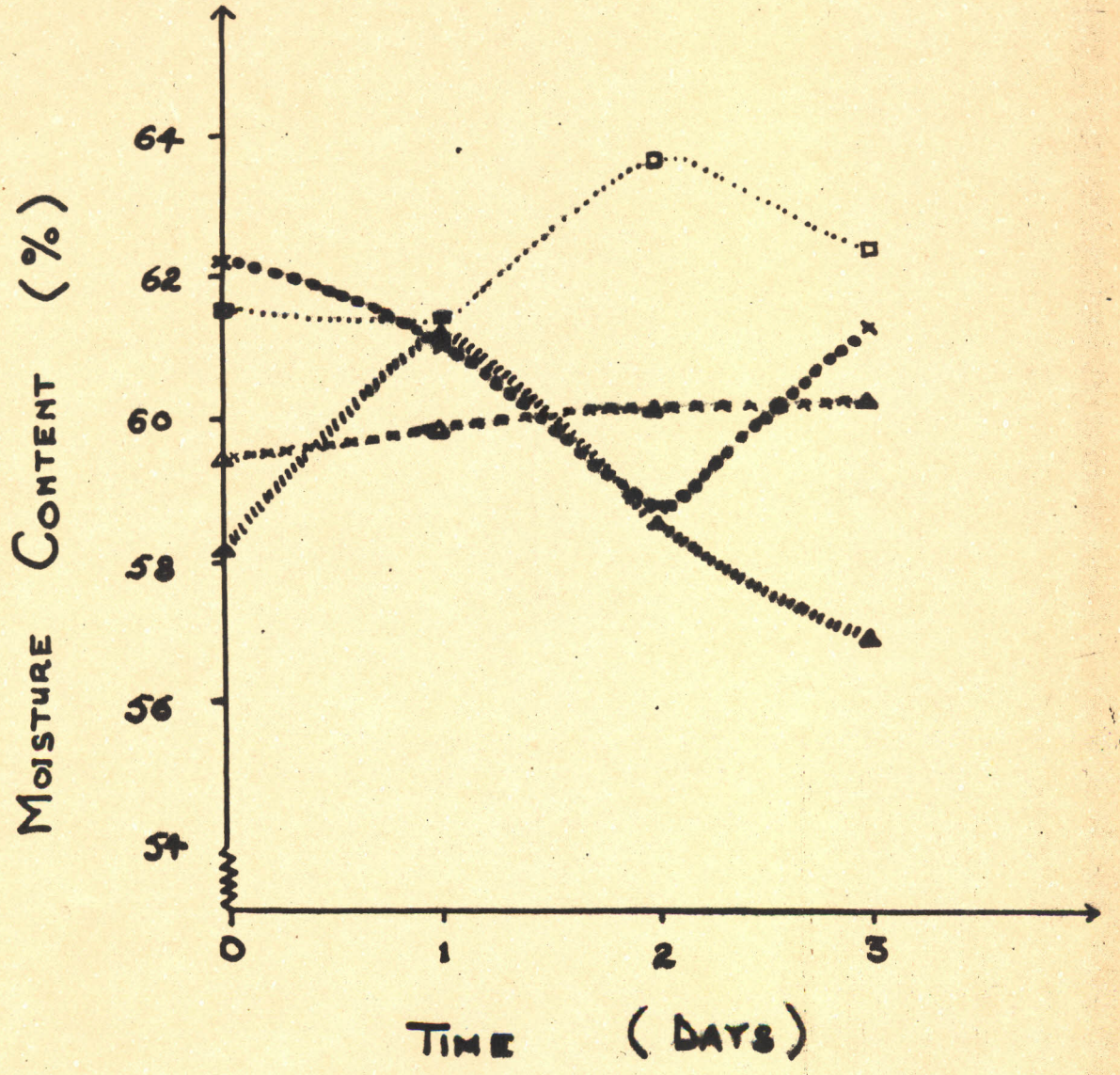

Fig 1 - Change In Moisture Content With Time For Set I (Unpressed) Samples : 5% Innoculation.

TABLE 3 MOISTURE CONTENT OF SET II SAMPLES

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES PERIOD OF FERMENTATION (IN HRS)				PRESSED SAMPLES PERIOD OF FERMENTATION (IN HRS)			
		0	24	48	72	0	24	48	72
CONTROL	0 %	61.39	60.23	58.06	57.91	50.15	49.77	48.73	51.00
I	2 %	59.45	60.83	57.51	56.24	52.84	51.65	50.21	50.75
	5 %	58.50	57.79	56.98	53.70	51.14	50.02	47.99	50.25
II	-	-	-	-	-	-	-	-	-
III	5 %	59.55	59.39	60.84	60.17	51.52	52.77	51.64	50.36
	10 %	57.97	61.68	60.89	59.11	51.65	52.66	53.90	51.44
IV	2 %	59.42	61.96	58.29	57.70	53.84	54.12	48.87	50.91
	5 %	61.89	60.05	58.67	57.25	53.99	49.63	49.38	51.68

TABLE 4 TOTAL ACIDITY OF SET I SAMPLES ON WET WEIGHT BASIS

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES PERIOD OF FERMENTATION (IN HRS)				PRESSED SAMPLES PERIOD OF FERMENTATION (IN HRS)			
		0	24	48	72	0	24	48	72
CONTROL	-	0.124	0.511	0.473	0.743	0.113	0.322	0.380	0.540
I	5 %	0.158	0.630	0.608	0.844	0.135	0.484	0.507	0.653
II	5 %	0.192	0.653	0.709	0.653	0.135	0.551	0.540	0.619
III	5 %	0.158	0.788	1.024	1.069	0.113	0.574	0.799	0.810
IV	-	-	-	-	-	-	-	-	-

The observed trend for the innocullum IV samples isn't much different. The 2% innoculated samples have two samples falling within the general range and the 95% confidence limits but only one in the ideal range: The 5% innocullated samples indicate three samples within the general range and the 95% confidence limits and two within the ideal range.

The graphs showing the variation in moisture content of set II unpressed samples with time (Figs. 2&3) present a picture much different from that of the set I samples. Unlike the set I sample, the variation in moisture content of the set II samples with time seem more regular. In Fig. 2 it can be observed that all samples showed a general decrease in moisture content with time. And in Fig. 3 with exception of the innocullum III samples which showed a slightly irregular pattern, the other two showed a gradual decrease in moisture content during the course of the fermentation.

3.3 TOTAL ACID CONTENT OF FERMENTED SAMPLES

A look at the results in Table 4 and 6 indicate that with exception of two of the 5% Innoculant III unpressed samples of set set I, the acidity of all the samples fall far below the range of market samples. This could be due to inadequate fermentation resulting from improper preparation of the various innoculla or the freezing of the tubers prior to fermentation which might have destroyed the natural microflora of the tubers.

3.3.1 SET I SAMPLES

The graph in Fig 4 indicates that there is a general trend of increase in acidity during the fermentation period. This is perfectly so for the Innocullum III samples which registered the highest acidity throughout the three days of fermentation. The Innocullum II samples showed a slight drop in acidity during the 3rd day of fermentation whilst the Innocullum I and control samples showed a slight drop during the 2nd day of fermentation followed by a sharp increase during the 3rd day.

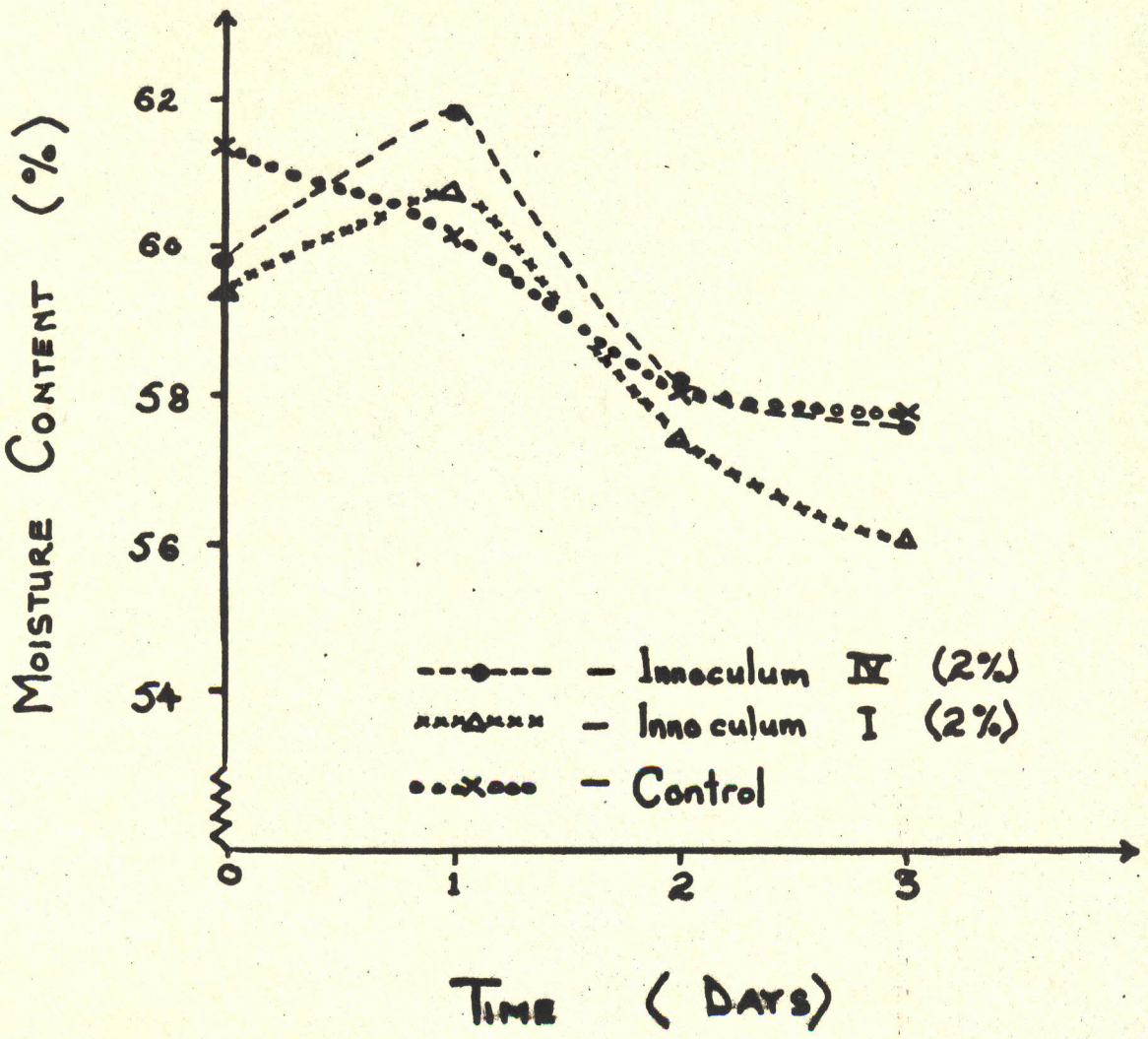

FIG. 2 - CHANGE IN MOISTURE CONTENT W TIME FOR SET II (UNPRESSED) SAMPLES : 2% INNOCULATED.

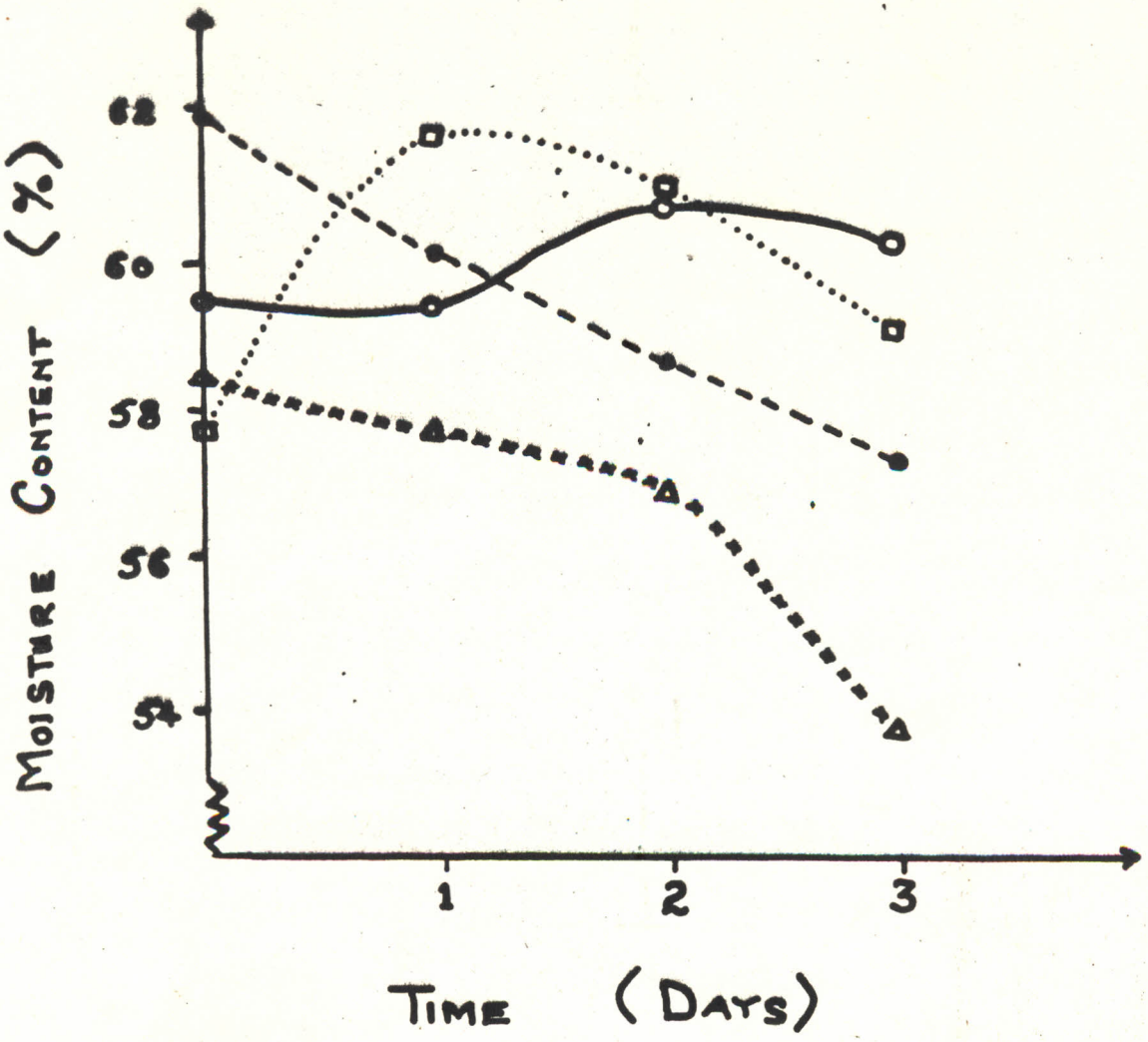

FIG. 3 - CHANGE IN MOISTURE CONTENT WITH TIME FOR SET II (UNPRESSED) SAMPLES : 5% AND 10% INNOCULATE

TABLE 5 TOTAL ACIDITY OF SET I SAMPLES ON DRY WEIGHT BASIS

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)				PRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)			
		0	24	48	72	0	24	48	72
CONTROL	-	0.328	1.310	1.145	1.918	0.228	0.650	0.785	1.123
I	5 %	0.390	1.569	1.522	2.115	0.263	0.971	1.052	1.364
II	5 %	0.460	1.683	1.716	1.515	0.257	1.093	1.101	1.262
III	5 %	0.410	2.037	2.819	2.839	0.221	1.131	1.626	1.724
IV	-	-	-	-	-	-	-	-	-

TABLE 6 TOTAL ACIDITY OF SET II SAMPLES ON WET WEIGHT BASIS

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)				PRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)			
		0	24	48	72	0	24	48	72
CONTROL	-	0.140	0.576	0.540	0.563	0.126	0.360	0.423	0.563
I	2 %	0.162	0.464	0.540	0.621	0.099	0.360	0.455	0.500
"	5 %	0.140	0.500	0.572	0.648	0.108	0.423	0.482	0.621
II	-	-	-	-	-	-	-	-	-
III	5 %	0.140	0.360	0.554	0.684	0.136	0.279	0.473	0.576
	10 %	0.140	0.383	0.531	0.675	0.132	0.329	0.410	0.522
IV	2 %	0.140	0.612	0.581	0.657	0.140	0.441	0.459	0.603
	5 %	0.131	0.509	0.648	0.621	0.149	0.440	0.572	0.603

TABLE 7 TOTAL ACIDITY OF SET II SAMPLES ON DRY WEIGHT BASIS

TYPE OF INNOCULUM USED	% OF INNOCULUM USED	UNPRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)				PRESSED SAMPLES DURATION OF FERMENTATION (IN HRS)			
		0	24	48	72	0	24	48	72
CONTROL	-	0.363	1.450	1.288	1.338	0.253	0.717	0.825	1.149
I	2 %	0.400	1.185	1.271	1.419	0.210	0.745	0.914	1.015
	5 %	0.337	1.185	1.330	1.400	0.221	0.849	0.927	1.248
II	-	-	-	-	-	-	-	-	-
III	5 %	0.346	0.886	1.415	1.717	0.280	0.591	0.978	1.160
	10 %	0.330	0.999	1.358	1.651	0.273	0.695	0.889	1.075
IV	2 %	0.349	1.609	1.393	1.553	0.303	0.961	0.898	1.228
	5 %	0.344	1.270	1.568	1.535	0.324	0.874	1.130	1.248

TABLE 8 MOISTURE AND TOTAL ACIDS CONTENT OF THE INNOCULANTS USED

INNOCULUM	MOISTURE (%)	ACIDITY (%)	
		WET WT. BASIS	DRY WT. BASIS
I	11.79	0.171	0.194
II	52.20	0.653	1.366
III	72.54	0.048	0.174
IV	72.43	0.054	0.196

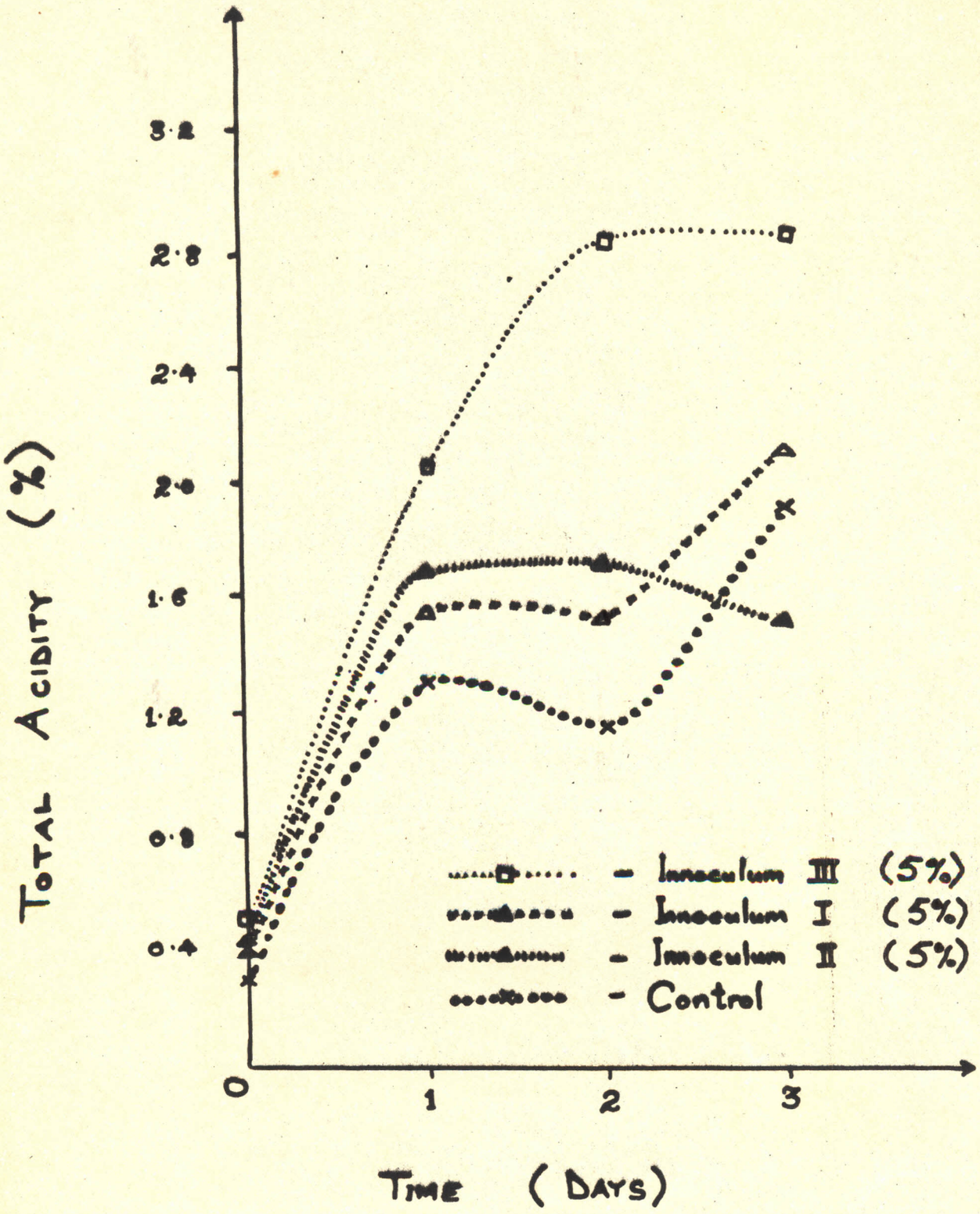

FIG. 4 – CHANGE IN TOTAL ACIDITY WITH TIME FOR SET I (UNPRESSED) SAMPLES.

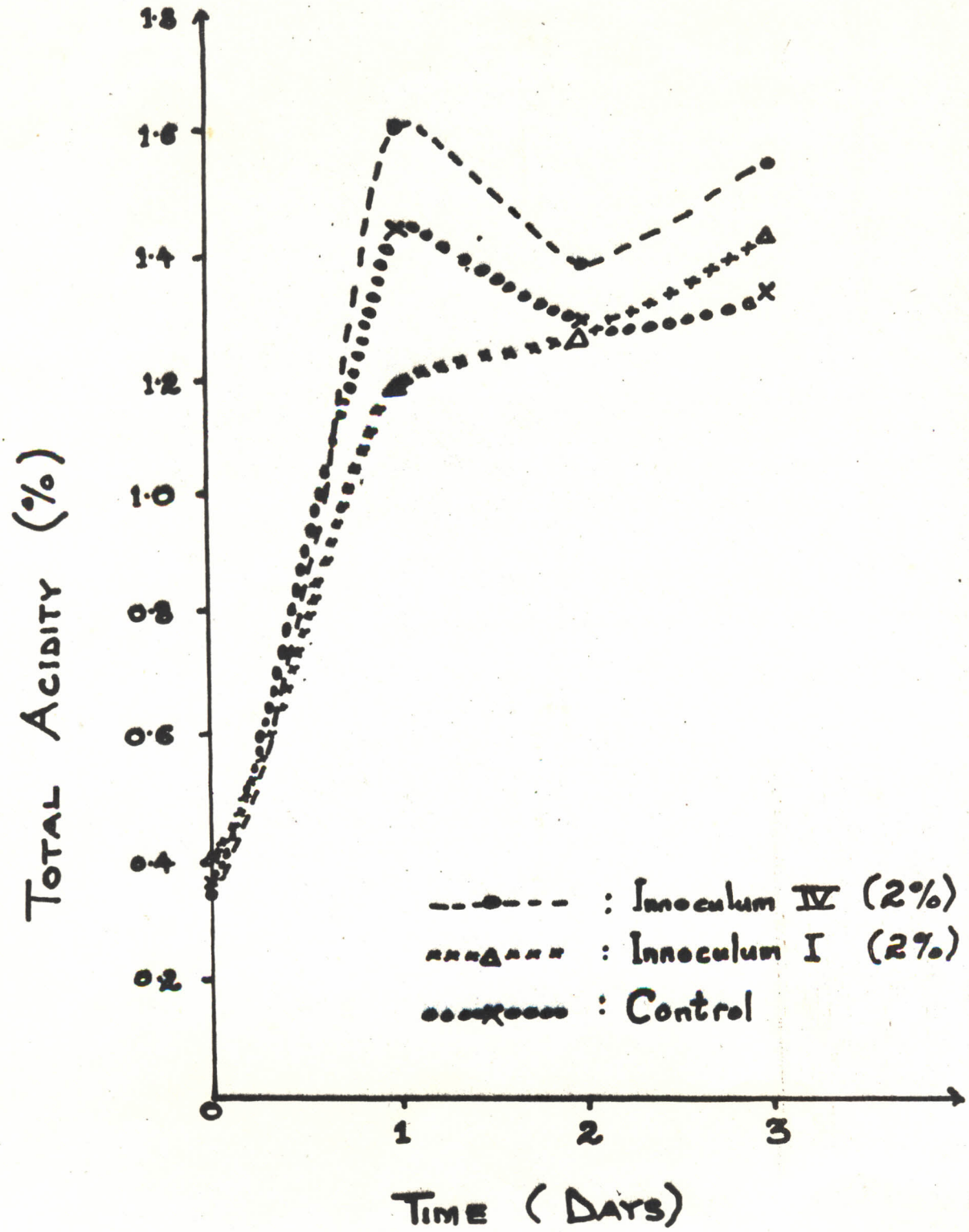

FIG. 5 - CHANGE IN TOTAL ACIDITY WITH TIM
FOR SET II (UNPRESSED) SAMPLES : 2%
INNOCULATED.

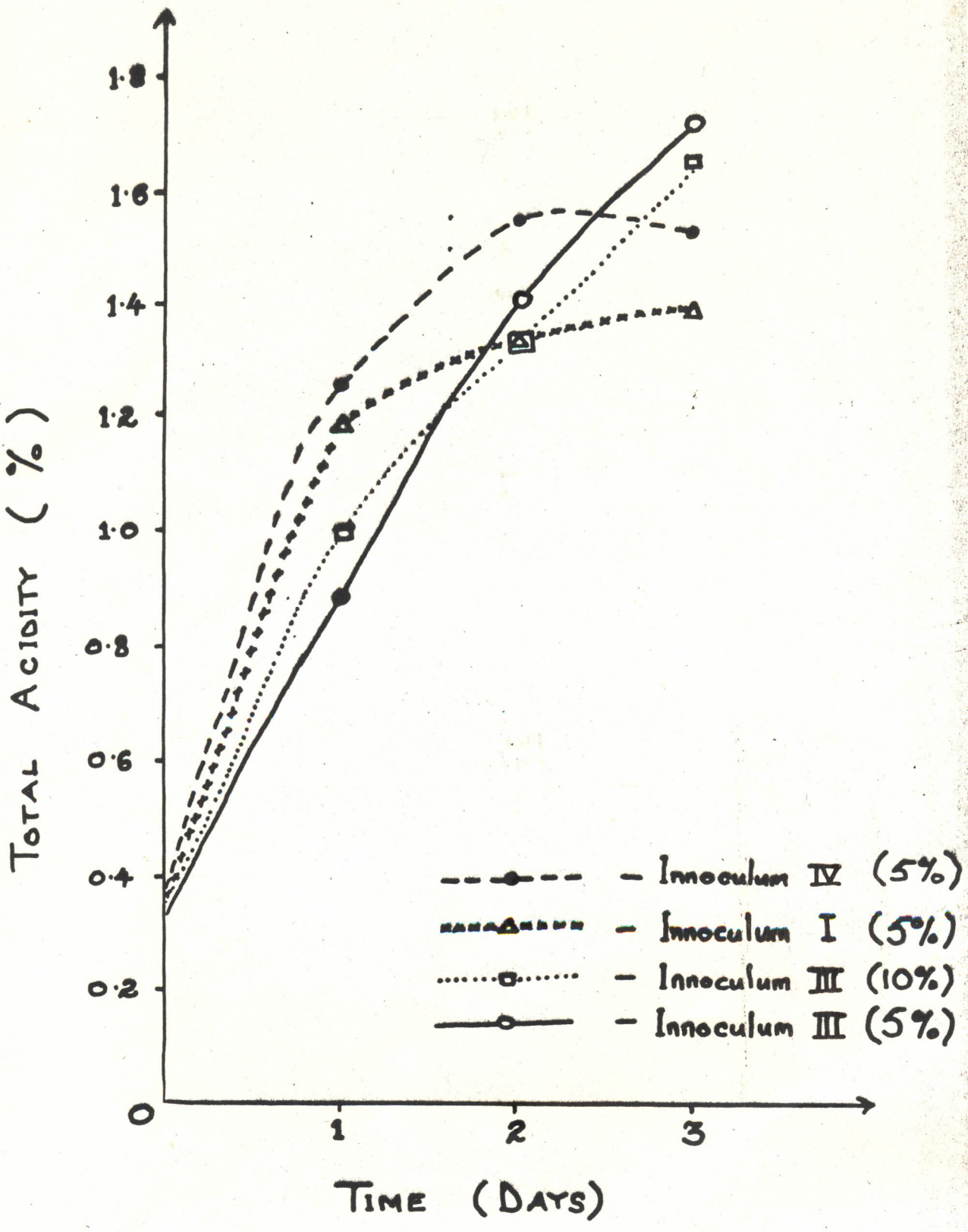

FIG. 6 – CHANGE IN TOTAL ACIDITY WITH TIME FOR SET II (UNPRESSED) SAMPLES: 5% AND 10% INNOCULATED.

SET II SAMPLES

As can be observed in Figs 5 and 6, the set II samples also indicate a general increase in acidity with time This trend is more obvious for the 5% and 10% innoculated samples than for the 2% innoculated samples which showed some degree of fluctuation.

The fall in acidity of some of the samples during the 2nd day of fermentation (see Figs 4 and 5) could be due to the fact that conditions during that period of fermentation might have been favourable for esterification reactions which used up the acids. This explanation would however need to be confirmed by estimating the ester content of the dough at various stages of the fermentation process and correlating this with the total acids content.

A similar explanation as above could be offered for the drop in acidity during the 3rd day of fermentation for the Innocullum II and Innocullum IV samples in figs. 4 and 6 respectivley.

The observed increases in total acidity after the decrease, could also be due to the growth of hitherto dormant strains of other acid producing microorganisms whose growth might have been favoured by the drop in acidity. This fact would also have to be confirmed by studying the microbial flora of the fermenting mash during different stages of the fermentation process.

4.0 CONCLUSION

From the results of the investigation it is observed that moisture content and total acidity of market samples of agbelima ranged between 46.5-52.5 and 1.01-2.73 (on dry wt. basis) respectively and even th though some ideal value have been suggested in the discussions above it must be admitted that the sample size used in this investigation is not large enough to permit these suggested ideal values to be taken as the standard. More samples would therefore have to be screened before a conclusion can be reached on what should be the standard moisture and total acid level of Agbelima.

Also as indicated in the discussion the low acid levels of the fermented laboratory samples compared with the market samples could be attribulable to improper preparation of innoculla or improper handling (freezing) of the cassava tubers prior to processing.

There would therefore be the need to carry out a thorough investigation into the mode of preparation of the various innoculla, study their microbiological and biochemical properties, and successfully produce them in the lab. before further investigations are carried out. In addition cassava tubers intended for investigations must be used fresh from the farm without [illegible]ing.

Since some of the trends observed in the moisture and total acid contents of some of the laboratory samples were irregular, it would be necessary to confirm whether these trends are really as they are before investigating the underlying causes for such trends.

A thorough study on the aldehyle and ester content of the dough could not be carried out because the method available did not yield reproducible results, and a trial attempt to use it for the market samples gave very irregular results as indicated in Table 1 and in the discussions. A more suitable method may have to be found to enable this study to be carried out effectivley since it would contribute in a large measure to understanding some of the observed trends in total acidity during fermentation, and also in establishing suitable process parameters for the dehydrated fermented cassava dough.

One general conclusion that can however be drawn from the observations made is that the Innoculant III, prepared by soaking tubers in water for 3 3 days, seems to be more effective as far as acid production in the fermenting mash is concerned.

5.0 REFERENCES

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