DEVELOPMENT OF AN INTERMEDIATE DEHYDRATED FERMENTED CASSAVA DOUGH

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ABSTRACT

Cassava dough samples purchased from four different markets in Accra were dehydrated at a temperature of about 50-55°C to a moisture content of about 5.7%. Chemical analysis on both the fresh and dehydrated dough samples was performed. The results showed a general decrease in volatile acidity and non-volatile acidity during dehydration. Also there were defferences between the proximate composition of fresh dough samples and that of dehydrated dough samples but these did not follow a specific trend. However comparison of the mean values for fresh dough samples with those of the dehydrated dough samples showed that the differences were not significant. Preference/Acceptance tests performed on akple prepared from the fresh and dehydrated dough samples indicated a general preference for the fresh dough. But comparison of the mean scores returned for the fresh and dehydrated dough samples showed no significant difference between the two. Thus the dehydrated dough samples were found to be equally suitable for preparation of akple.

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LIST OF ABBREVIATIONS USED:

1. MDN → Cassava Dough from MADINA Market
2. MKL — Cassava Dough From MAKOLA Market
3. TS — Cassava Dough From TEMA STATION Market
4. MLT — Cassava Dough from MALLATA Market
5. -F ⇒ Fresh Cassava Dough
   -D ⇒ Dehydrated Cassava Dough

e.g. MDN - F ⇒ Fresh Cassava Dough From Madina Market
MDN - D ⇒ Dehydrated Cassava Dough Obtained From MDN - F etc.

I N T R O D U C T I O N

Cassava is very widely consumed in various forms especially in Southern Ghana. The major processed cassava products available on the market are gari, kokonte and agbelima. Gari and kokonte are dry products and can therefore be stored for a considerable length of time without much deterioration in quality. AGBELIMA (fermented cassava dough) however cannot store for a long time without deterioration. But Agbelima is an important intermediate product for the preparation of some major Ghanaian dishes. For example the major dish of the Ewe, Akple, is prepared from a mixture of corn dough and agbelima (cassava dough). Also Yakayake another favourite dish of the Ewes and many other Ghanaians is prepared from Agvelima by steaming. The Gas also have a favourite dish called 'Fufu' which unlike the Fufu of Akan fame (ie. pounded boiled cassava) is prepared from Agbelima by cooking the dough to obtain a thick porridge.

Prolonged storage of cassava dough results in:

(i) an increase in acidity of the dough and
(ii) the growth of mould on the surface of the dough.

These effects are not very desirable and considering the importance of Agbelima in the diet of many Ghanaians, it is necessary that a suitable method of preserving the dough be found to increase its shelf life. It is considered that if fermentation can be arrested by dehydrating the fermented cassava dough, it would be possible to obtain an intermediate dehydrated fermented cassava dough with suitable acidity which can be reconstituted when needed for the production of yakayake, fufu and akple.

The successful dehydration of maize dough (Andah & Osei-Yaw 1979) provides much encouragement for the trials on cassava dough to be carried out.

The project therefore aims at:-

(i) examining the feasibility of developing the intermediate dehydrated fermented cassava dough;
(ii) developing the product and solving any other problems that may be identified during the course of developing it;
(iii) investigating the suitability of the reconstituted product for the preparation of yakayake, fufu and akple;
(iv) determining the acceptability of the dehydrated product;
(v) conducting shelf life studies on the product.

In this preliminary report an account is given of:-

(i) the procedure adopted in developing the product

(ii) notable changes occuring in the composition of the product during dehydration

(iii) the suitability of the product for the preparation of akple

(iv) the acceptability of the dehydrated product based on taste panel assessment of akple product from the product.

LITERATURE REVIEW

1. PREPARATION OF CASSAVA DOUGH (AGBELIMA)

a) Traditional Processing Technology

In the traditional method of preparing Agbelima, the cassava tubers are first peeled by removing or slicing off the skin with a knife. The peeled tubers are then washed thoroughly several times with water and grated. The grating which is basically a size-reduction process is done on perforated tin sheets by rubbing the peeled tubers over the rough side of the perforated tin sheets in a bowl. Following the initial grating the grated mash is packed into fibre bags or baskets and covered with a piece of sack. The liquid is squeezed out by placing heavy stones on the bags. This partial dewatering process takes about 2-3 days and during this period fermentation takes place. The fermented dough is packed into polythene bags in baskets and is ready for use. (Dovlo, 1972)

b) Improved Processing Technology

The sequence of processing is the same as for the traditional method ie. peeling, washing, grating, pressing and fermentation. The peeling and washing processes are the same as for the traditional method. The grating however is done on an F.R.I. (Food Research Institute) fabricated grater which consists of a trapezoidal hopper mounted on an angle iron stand. The grating rotor is made of wood 25 cm in diameter and covered with a thick perforated galvanised metal sheet (Lartey et al 1980). The peeled tubers are fed into the hopper and a lever is used to press the roots against the rotating roter. An adjustable saw blade is incorporated which gives a clearance for controlling the particle size of the grated material. The grated mash is loaded into woven mesh sacks of polypropylene for subsequent pressing and fermentation.

Pressing is done in a hand-operated screw-type mash press which consists of an angle-iron frame work supporting galvanised metal sheets at the sides. Moving whithin this housing is a screw ram arrangement and a leverage system for pressing and unloading respectively. A perforated false bottom is provided which allows for a free passage of the cassava liquor on pressing through a chute into a container below. The loaded sack is placed in the press and pressure is applied from the top by means of the screw ram till about 30% of the weight of the cassava mash is pressed out as exudate. The partially dewatered mash is left in the press for about 60-72 hours for fermentation to take place (Laryea-brown and Anderson 1980). The product (agbelima) is then ready for use.

2. BIOLOGICAL AND CHEMICAL CHANGES THAT OCCUR DURING FERMENTATION OF CASSAVA TUBER PULP

The fermentation of cassava tuber pulp has been found by Collard and Levi (1959) to result in detoxification of cassava which occurs in two stages. The micro-organisms responsible for the fermentation are the bacteria, *Corynebacterium manihot* and the fungus *Geotrichum candida*.

The process of grating the cassava causes an extensive rupturing of the cell structure of the tuber thereby resulting in the release of starch and the endogenous enzyme linamarase into the mash.

The fermentation process is initiated by the bacterium *Corynebacterium manihot* acting on the starch to produce lactic and Formic acids which lower the pH of the pulp. This increase in acidity of the pulp produces two effects. First it produces favourable conditions for the action of the endogenous enzyme linamarase which then hydrolyses the cyanogenetic glucosides, linamarin and lotaustreelin into gaseous hydrogen cyanide. This constitutes the main detoxification process. Then secondly the increase in acidity favours the growth of the fungus *Geotriohum candida* which then proliferates and produces a variety of aldehydes and esters (Christian 1966) and these contribute to the flavour and aroma of the dough.

Caurie (1970) however reported that the fermentation process involves three phases which correspond to approximately 24 hour cycles. According to him there is an initial growth phase during which most of the soluble carbohydrates are used up. This is followed by a period of no growth but of intense metabolic activity resulting in the accumulation of metabolic products such as acids, alcohols etc. Some of these products are Lethal and cause the autolysis of some of the micro-organisms. The dead yeasts and bacteria supply endoenzymes which catalyse the synthesis of metabolic products which accumulate in the fermenting pulp. During the third phase of the fermentation the metabolic products produced in the second phase take part in chemical reations catalysed again by the liberated endoenzymes which results in the development of the desired aroma characteristic of properly fermented cassava tuber pulp.

Although all three phases are aerobic, they have different oxygen requirements. The end of the fermentation is indicated by a second declining growth phase of bacteria and the domination of the pulp by yeasts.

3. PHENOMENA OBSERVED IN DRYING

Factors which determine the rate of evaporation from the surface of a body of water or a completely wet porous object like a wick, according to Corpley and Van Arsdel (1964) include, the temperature of the water, the temperature, humidity, pressure, velocity of the air and less importantly the size and shape of the wet surface and the direction of the air movement with respect to it. The earliest stages of the drying of a wet food material are essentially identical with this evaporation from pure water.

Many porous structural materials and some food commodities behave for a considerable time after the beginning of drying as though their surfaces were remaining completely wet. The rate of evaporation from unit surface of the body is then substantially the same as from pure water, and hence can be estimated with a fair degree of accuracy from the air temperature, humidity and velocity, regardless of the kind of commodity being dried. After a short initial warm up period this phase of behaviour as a completely wet body is characterised by an unchanging rate of evaporation per unit of exposed surface and hence is known as the "constant rate" phase. Sometimes two different brief "constant rate" periods are observed.

Sooner or later, the rate of evaporation per unit of surface area begins to decrease. This is the beginning of the "falling-rate" phase. The mean moisture content of the body at this time is sometimes called the critical moisture content.

The progress of drying is usually observed by frequent weighing of a sample of the material. True drying rate takes into account the shrinkage of exposed surface which usually accompanies drying but a "gross drying rate" which is simply the rate of loss of weight per unit time is often the only directly observed quantity. The area shrinkage in food materials is usually great enough to cause the gross drying rate to begin to decrease immediately after drying begins and many materials exhibit no constant rate phase at all, even when shrinkage is allowed for.

4. PRESERVATION BY DEHYDRATION - WATER ACTIVITY AND FOOD QUALITY

It has been found that food stability depends not only on the quantity of water present but also on the state in which the water exists in the food, water in foodstuffs exists in two forms: free water and bound water or in other words physically bound water and chemically bound water respectively (Mackay 1967). According to Rockland (1969) as reported by Plahar (1983) the state of water in a food system is defined on the basis of the extent and degree of Hydrogen bonding of water with itself, with dissolved melecular species and with isoluble or partially soluble species of the food. This state of water according to Rockland determines its availability for deteriorative reactions and the term water activity is used to define the degree to which the water present in the food is bound and unavailable for certain reactions.

As reported by Plahar (1983) water activity ranges for the growth of different organisms have been established by Scott (1957) Mossel and Ingram (1955) and other workers.

For example:

For most bacteria	minimum	water	activity	for	growth	= .90
" " Yeast	"	"	"	"	"	= .88
" " Moulds	"	"	"	"	"	= .80

where water Activity (Aw) is defined as the equilibrium vapour pressure that the water in food exerts (P) divided by the vapour pressure of pure water at the temperature of the food ie $Aw = \frac{P}{Po}$ (Labuza, 1974, as reported by Plahar(83).

These limits are however dependent on other environmental factors like nutrients, pH and temperature.

Desired water activity for microbial stability can be achieved by either dehydration to remove free water or by use of humectants to bind available water.

Rockland (1969) again identified three physical states of water present in foods each with distinct physical and chemical properties. These are the monolayer, the multilayer and capillary water. The monolayer is regarded as chemically innert water bound to ionic groups such as carbonyl and amino groups. The multilayer is less tightly bound and is assumed to be hydrogen bonded to hydroxyl and amide groups. The bulk or capillary water is found in the interstitial pores in which capillary forces and dissolved solutes depress vapour pressure.

In dehydration the objective is usually to obtain the monolayer value for maximum stability if the physicochemical characteristics of the product would permit.

5. STANDARDS AND QUALITY SPECIFICATIONS FOR SOME EDIBLE PROCESSED CASSAVA PRODUCTS

There are variations between standards for the different cassava products and different countries have differing parameters on which they base their standards. But the consistently emphasised quality parameters are moisture fibre, ash, and starch contents, plus general cleanliness of the products.

The range of specifications for the principal commercial products taken from official standards in Brazil, Thailand, India and Paraguay is shown below.

TABLE 1A

RANGE OF SPECIFICATIONS FOR EDIBLE COMMERCIAL CASSAVA PRODUCTS FOLLOWING OFFICIAL STANDARDS

	CHIPS	FLOUR	STARCH	GARI
Moisture % max	10-14	10-14	12.5-14	8-10
Fibre % max	2.1-5.0	1-6	0.2-0.3	-
Ash %	1.8-3.0	1.8-3.0	0.3-1.0	-
Starch % min	70-82	70-82	80-98	-

(Ingram J.S. 1975)

6. METHODS FOR SENSORY TESTING

There are three fundamental types of sensory tests: preference/acceptance tests, discriminatory tests and descriptive tests. Preference/acceptance tests are effective tests based on a measure of perference or a measure from which relative preference can be determined. The personal feeling of a panelist toward the product directs his response. Discriminatory tests are used to determine whether a difference exists between samples. The panelist does not allow his personal likes or dislikes to influence his response.

Laboratory difference panels can be used to determine if there is a difference among samples. Descriptive tests are used to determine the nature and intensity of the differences.

The tests to determine a difference between samples include the triangle test, the simple-paired comparisons test, the Scheffe paired comparisons test, the duo-trio test, the multiple paired comparisons test, ranking, scoring and ratio scaling.

The most commonly used scale for preference testing is the nine-point hedonic scale. The term 'hedonic' is defined as having to do with pleasure. This test is only used in connection with scales in which the panelist expresses his degree of liking or disliking such as in the sample questionnaire in Appendix 1 (Larmond Elizabeth, 1982).

MATERIALS AND METHODS

MATERIALS:

The cassava dough worked on was purchased from the local markets. Four batches of cassava dough were purchased from different markets in Accra, namely Makola, Tema Station, Mallata and Madina markets. For each batch of dough bought a sample was taken for chemical analysis after which the remainder was divided into three (3) portions. One portion was kept in a deep freezer for sensory evaluation at a later date and the other two portions were dehydrated.

A sample of the dehydrated dough was taken for chemical and microbiological analysis; the remainder was divided into three (3) protions; one stored under air conditon, the other at room temperature and the third portion was used for sensory evaluation.

METHODS

1. DEHYDRATION AND DRYING RATE DETERMINATION

For dehydration an F.R.I. fabricated cabinet dryer was used. The dryer makes use of five (5) filament bulbs as its heating sources, and air circulation within the dryer is facillitated by a fan installed within it. The dryer is not thermostatically controlled.

In this work five (5) 100 watt filament bulbs were used in the dryer and that gave a maximum temperature of 55°C.

To dry the dough, the dryer was switched on for one (1) hour to enable it attain the maximum temperature. The cassava dough sample spread evenly on wire gauze trays were then put into the dryer and dried at a fan speed of "2". On introducing the dough into the dryer the temperature normally falls to about 42-45°C and then rises steadily during the period of drying to the maximum. The samples were dried to a moisture level of between 5-7% after which they were cooled, milled and bagged in polythene.

The weight of the dough before and after dehydration was taken, and the ratio reported as yield of product.

DRYING RATE DETERMINATION

Before each batch of dough was put in the dryer the moisture content was taken. During the period of drying, samples were taken at one (1) hour intervals for moisture determination until the product attained the desired moisture level of between 5-7%. A plot of moisture level against time was made to obtain a drying curve.

CHEMICAL A NALYSIS

MOISTURE

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

DETERMINATION OF ASH CONTENT

About 2 g samples were ashed in an electric muffle furnace at a temperature of about 600°C. The ashing was done in silica dishes previously ignited, cooled in a dessicator and weighed. The residue remaining after 2 hours incineration was reported as ash (A.O.A.C. 1970).

DETERMINATION OF CRUDE FAT

The crude fat was determined from accurately weighed samples of about 2g in a soxhlet extraction unit with petroleum ether (B.Pt. 40-60°C). (A.O.A.C 1970 7.048).

CRUDE PROTEIN DETERMINATION

The crude protein content was estimated as total nitrogen on the assumption that all the nitrogen in the sample is present in the form of protein. Much as this assumption is not necessarily true because of the sensitivity of non-protein nitrogen containing materials to the method used for nitrogen determination- , it is considered that since the non-protein portion constitutes only a small fraction of the total nigrogen, the error introduced therefore is insignificant.

For the total Nitrogen determination the macro-kjeldahl method was used. An accurately weighed sample of about 2g. was digested in H_2SO_4 in presense of selenium catalyst. The digested sample was reacted with NaOH to convert the nitrogen into ammonia, which was then absorbed in an excess of boric acid. The excess boric acid was titrated with standard base, and the ammonia was calculated by difference. From this the nitrogen content was determined; and the percentage protein was calculated as (N X6.25) (A.O.A.C. 1970).

DETERMINATION OF STARCH

The Lintners method of starch determination as described by Pearson (1979) was used. Acid hydrolysis was carried out on about 5g sample using concentrated hydrochloric acid. Phosphotungstic acid (5%) was then added to precipitate the proteins present, after making up the volume of hydrolysed sample to 200 ml. with 12% $^{W}/_{w}$ HCl. The mixture was shaken, filtered and the optical rotation of filtrate in a 400 mm tube, measured. Percentage starch was reported as

$$\% \text{ Starch} = \frac{4000a}{lD}$$

where:

a = observed optical rotation

l = length of the polarimeter tube in decimeters.

D = specific rotation of starch ($+200^{\circ}$).

N.B. Ideally the optical rotation should have been measured in a 200 mm. tube and the % starch reported as (observed optical Rotation x 1.912). But the 200 mm tube wasn't available so the 400 mm. tube was used.

TOTAL ACIDS DETERMINATION

Total acidity of the samples was determined using a modification of AACC (1976) method, as described by Plahar (1983). A 10% ($^{W}/w$) slurry of the dough sample or dehydrated sample was prepared in a 250 ml. flask. The particles were kept in suspension by agitating the flask by hand at ten minute intervals for thirty minutes. 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.

VOLATILE AND NON-VOLATILE ACIDS

Volatile acids were determined by distillation and alkali tiltration of water extracts. Non-volatile acids were determined by the difference between total acidity and volatile acid content.

SCREEN (SIEVE) ANALYSIS - PARTICLE SIZE DISTRIBUTION

The Simon Laboratory Sifter was used for the analysis of the Dehydrated cassava dough flour. For each determination 250g sample oven-dried to a constant weight at 115°C were shaken for 5 minutes and the amount of sample retained on each screen weighed to obtain the particle size composition of the sample. The results are used to calculate the fineness moudulus (F.M.) from which the average size of grain(D) in inches can be calculated by means of the equation:

$$D = 0.0041\,(2)^{F.M.}$$

The fineness modulus indicates the uniformity of the flour and is defined as the sum of the weight fractions retained above each sieve divided by 100 (Henderson and Perry 1976).

SENSORY EVALUATION

The hedonic scale was used for a simultaneous assessment of

(i) any significant detectable differences between fresh dough and dehydrated dough and

(ii) any preferendes for the fresh or dehydrated dough.

Both the fresh dough and its corresponding dehydrated product were used to prepare akple according to two standard recipes.. The two samples were presented to ten (10) panelists to express their liking or disliking for a particular sample. The rating for each sample were given numerical values ranging from like extremely (9) to dislike extremely (1). The mean scores received by each sample were compared using the t-test as described in Appendix 2.

The standard recipe used for preparing the akple were as follows:

RECIPE A

In this recipe the ratio of corn dough to cassava dough is 2:1 and it is the recipe that is normally used.

(i) Akple from Fresh Cassava dough:

wt. of corn dough used	- 200g
wt. of cassava dough used	- 100g
wt. of water used for cooking	- 350g
Total Weight	650g

The mixture was cooked until the correct consistency was obtained.

(ii) Akple from dehydrated cassava dough samples

wt. of corn dough used	- 200g
wt. of dehydrated cassava dough	- 54g
wt. of water added for reconstitution	- 46g
wt. of water used for cooking	- 350g
Total Weight	- 650g

The mixture was also cooked until the correct consistency was obtained.

RECIPE B

In this recipe the ratio of corn dough to cassava dough was 1:1 This recipe was adopted to make more pronounced the cassava dough effect in the akple in order to see whether there really exist any detectable difference between the fresh and dehydrated dough samples should the 2:1 ratio not produce any detectable difference.

(i) Akple from fresh cassava dough samples:

wt. of corn dough used	- 100g
wt. of cassava dough used	- 100g
wt. of water used for cooking	218g
Total Weight	- 418g

(ii) Akple from Dehydrated Cassava dough samples:

wt. of corn dough used	-	100g
wt. of dehydrated cassava dough	-	54g
wt. of water added for reconstitution	-	46g
wt. of water used for cooking	-	218g
Total Weight	-	418g

Both (i) and (ii) were cooked to obtain the correct consistency. Receipe A was used for the samples from Madina and Tema Station Markets whilst Recipe B was used for Makola and Mallata market samples.

Even though the hedonic scale is a typical preference test it was used to test for difference also because it is considered that if a panelist could like one product more than the other then there must certainly be difference between them.

RECONSTITUTION OF PRODUCT

Reconstitution of the product was done by calculating the amount of moisture lost during dehydration and adding this amount back to the dehydrated product.

RESULTS AND DISCUSSION

DEHYDRATION & DRYING RATE

Table 2 shows the moisture content of the cassava dough at various times during the drying process. The moisture content of the dough samples ranged between 47.38 - 51.79% and it took about 4 hours to dry them to a moisture content of between 5-6%.

The graphs in fig. 1, 2, 3, 4, show the drying curves based on the data in Table 2. All four graphs conform only slightly to the expected curves based on the phenomena observed in drying food substances. Instead of a constant-rate and a falling rate phase, what is portrayed in the curves show an initial constant-rate phase of drying during the third hour before the falling rate phase sets in during the fourth hour.

This apparent deviation from the expected can be explained on the basis that since the temperature of the drier rises with time to its maximum limit during drying - because of the lack of a thermostatic control - the increase in drying rate during the third hour is due to the higher temperature at which the dryer is operating during that hour when the dryer has reached its maximum temperature.

Also since the drying cabinet used was not calibrated against a standard moisture oven it is possible that this short-coming would effect the performance of the dryer, and it would therefore not give a drying curve that conforms to a standard drying curve. Furthermore it would be noted from the curves that the four (4) dough samples showed different behaviours. And this could be due to the fact that they were prepared differently by different people.

TABLE 2 - MOISTURE CONTENT OF CASSAVA DOUGH DURING DEHYDRATION

TIME (HRS)	MDN	MKL	TS	MLT
0	51.79	49.72	50.21	47.38
1	37.54	39.90	40.78	36.23
2	25.68	29.54	28.17	27.15
3	8.50	12.46	17.22	11.69
4	5.74	5.88	5.65	5.67

YIELD

The values shown in Table 3 show that it is possible to obtaine a yield of between 48-51% of dehydrated cassava dough from fresh dough; and this is quite encouraging. The principal cause of loss of material was the falling off of particles through the holes in the mosquito netting of which the drying trays were made. Such losses even though very minimal can be prevented by the use of trays with a solid base and a convenient dryer to accomodate such trays.

TABLE 3 - PERCENTAGE YIELD OF DEHYDRATED CASSAVA DOUGH FROM FRESH CASSAVA DOUGH

SAMPLE	YIELD
MDN	48.21
MKL	48.75
TS	51.51
MLT	48.04

CHEMICAL ANALYSIS

To facilitate comparison of values for the fresh and dehydrated cassava dough all the results of chemical analysis have been reported on a dry weight basis.

ACIDITY

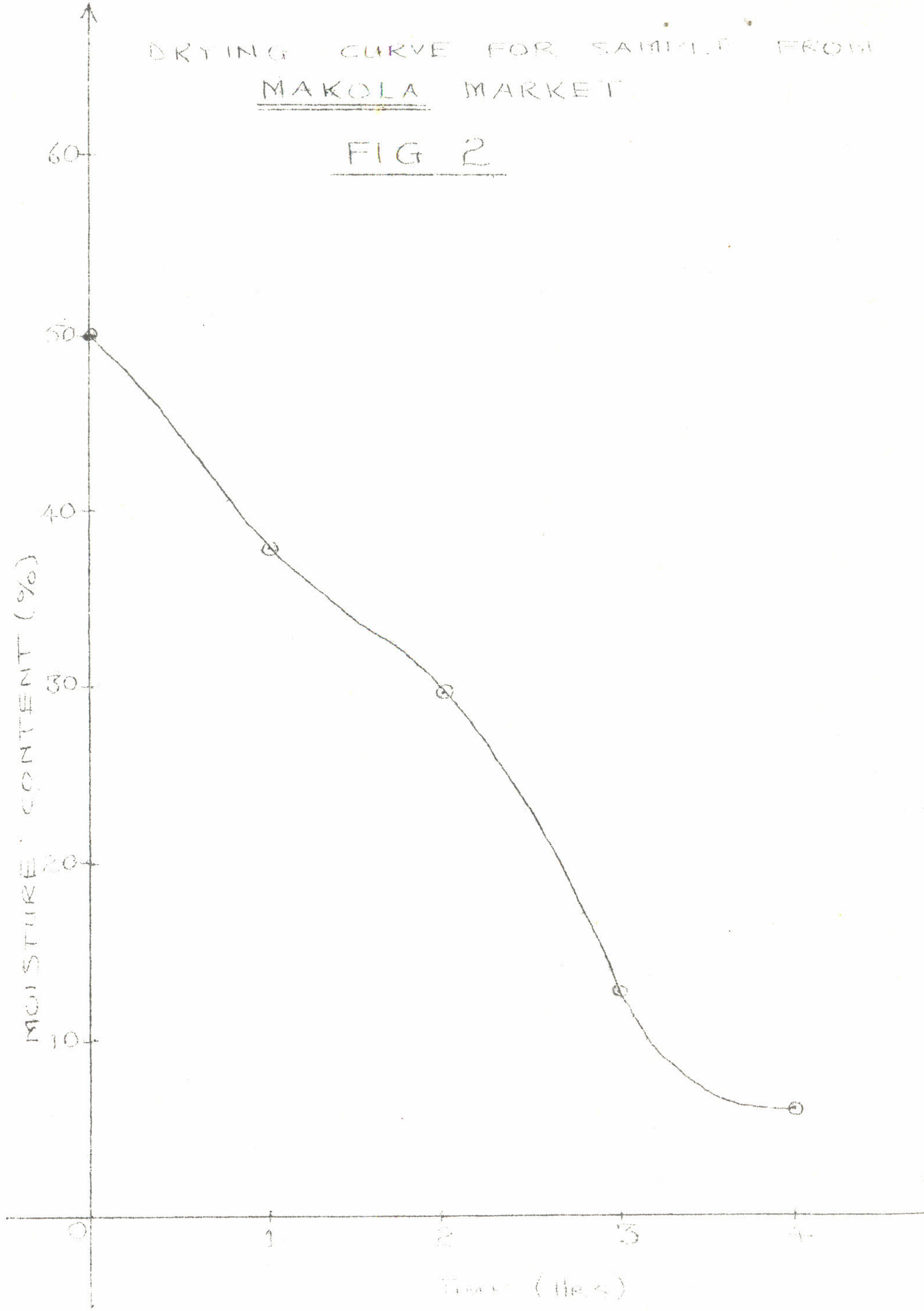
Total acidity, Volatile acidity and Non-volatile acidity values for the four (4) fresh cassava dough samples and their corresponding dehydrated samples are given in Table 4. From the values it can be seen

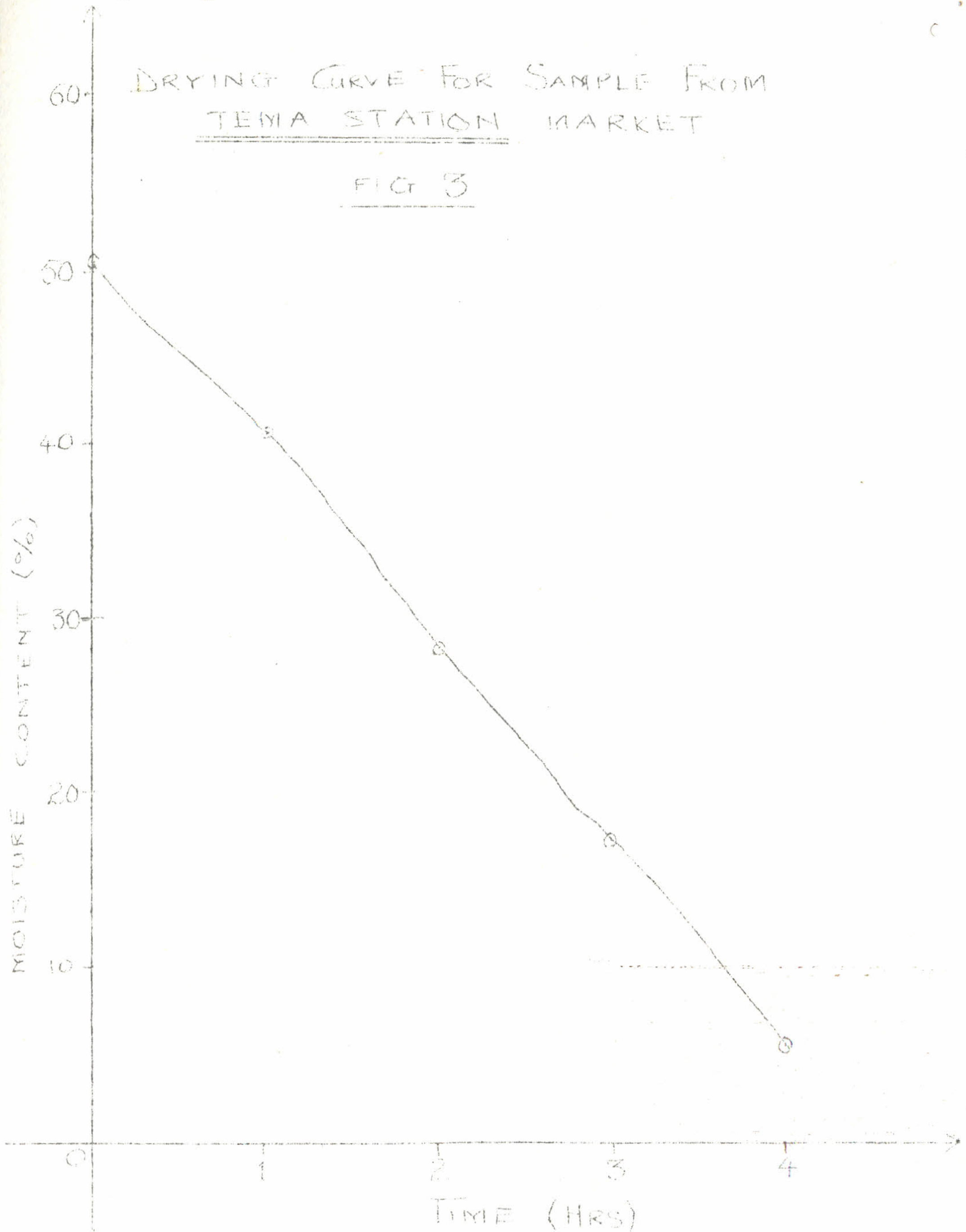
DRYING CURVE FOR SAMPLE FROM MADINA MARKET

FIG 1

DRYING CURVE FOR SAMPLE FROM MAKOLA MARKET

FIG 2





DRYING CURVE FOR SAMPLE FROM TEMA STATION MARKET

FIG 3

DRYING CURVE FOR SAMPLE FROM MALLATA MARKET

FIG 4

that the total acidity of fresh samples on dry weight basis ranged between 1.92-2.68% (as lactic acid) whilst for the dehydrated samples the range is 1.28-2.04%. This indicates a full in total acidity by a value of between 0.41-0.68 during dehydration.

Volatile acidity of fresh samples - ranged between 0.43-0.58%. The dehydrated samples have values ranging between 0.06-010% for volatile acids, showing a fall in volatile acidity of between 0.37-0.49%.

With the non-volatile acids the fresh samples had values ranging between 1.37-2.18 whilst the values for the dehydrated samples ranged between 1.18 - 1.97. This shows a fall in non-volatile acidity of between 0.12 - 0.19.

The results show that during dehydration between 23-35% of the total acids is lost. Of this amount 15-25% are lost as volatile acids whilst ∠ about 8-10% reduction in the non-volatile acid component. This means that 66-72% of the total losses is accounted for by volatile acids and 28-34% by non-volatile acids. The percentage losses of the total, volatile and non-volatile acids are shown in Table 5. ∠ there is also

TABLE 4A: ACIDITY OF FRESH CASSAVA DOUGH SAMPLE

SAMPLE	TOTAL ACIDS (%)	VOLATILE ACIDITY (%)	NON-VOLATILE ACIDITY (%)
MDN - F	1.95	0.58	1.37
MKL - F	2.08	0.43	1.65
TS - F	2.68	0.50	2.18
MLT - F	1.92	0.48	1.44

TABLE 4B: ACIDITY OF DEHYDRATED CASSAVA DOUGH SAMPLES

SAMPLE	TOTAL ACIDS (%)	VOLATILE ACIDITY (%)	NON-VOLATILE ACIDITY (%)
MDN - D	1.28	0.10	1.18
MKL - D	1.55	0.06	1.49
TS - D	2.04	0.08	1.96
MLT - D	1.39	0.09	1.30

TABLE 5: PERCENTAGE LOSSES IN TOTAL VOLATILE AND NON-VOLATILE ACIDS DURING DEHYDRATION

SAMPLE	% LOSS OF TOTAL ACIDS	% LOSS OF VOLATILE ACIDS	% LOSS OF NON-VOLATILE ACIDS
MDN	34.63	24.87	9.74
MKL	25.57	17.77	7.78
TS	23.21	15.69	9.92
MLT	27.45	20.66	8.49

PROXIMATE COMPOSITION

Results of the proximate composition of both the fresh and dehydrated dough samples are shown in Table 6A and 6B

A. ASH CONTENT: The results show that with exception of the sample from Tema Station Market, there is a slight decrease in the ash content of all the dehydrated samples.

B. PROTEIN: Two samples showed on increase in protein content for the dehydrated dough, whilst two showed slight decreases.

C. FAT: With exception of the sample from Tema station market which showed a lower fat content for the dehydrated dough all the other samples showed a higher fat content for the dehydrated dough than for the fresh dough.

D. STARCH: The dehydrated dough shows a lower starch content than the fresh dough in three samples.

Even though the results indicate variations in the proximate composition of the fresh and dehydrated dough, the calculated mean values for all four samples - as indicated in the tables, and analysis of the results using the t-test show that the differences are not significant and can therefore be attributed much more to experimental errors than to actual differences in composition.

However taking the differences into consideration the results show that with exception of the fat content, there is a linear correlation between the proximate composition of fresh dough and that of the dehydrated dough, as shown by the scatter diagrams in Figs 5, 6, 7, and 8, and by the correlation coefficients in Table 6 C. An example of the method by which the coefficient of correlation was calculated is shown in Appendix 3.

TABLE 6A: PROXIMATE COMPOSITION OF FRESH CASSAVA DOUGH SAMPLES ON DRY WEIGHT BASIS

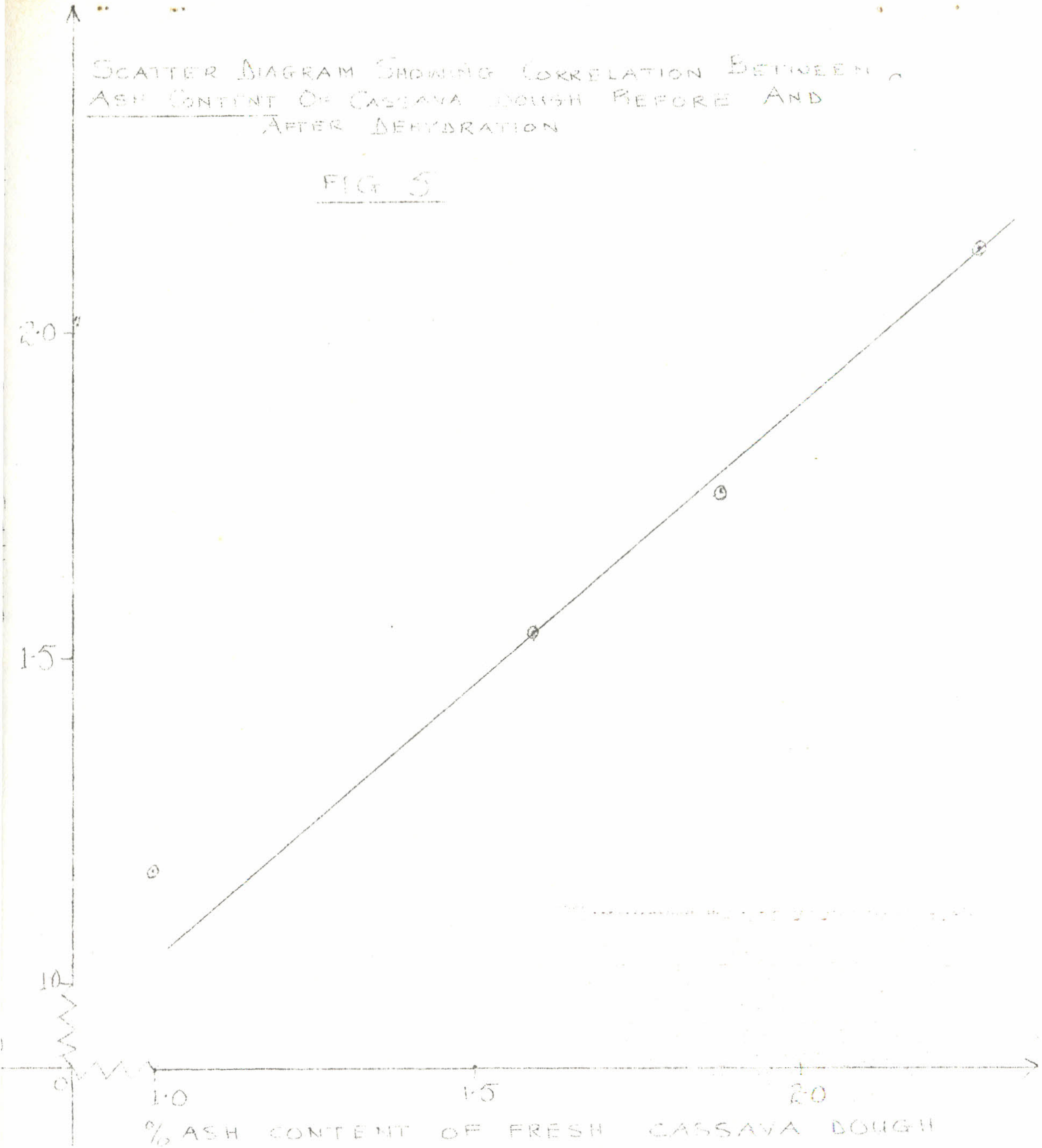
SAMPLE	ASH (%)	CRUDE PROTEIN (%)	CRUDE FAT (%)	STARCH (%)
MDN - F	1.87	1.65	0.83	84.93
MKL - F	1.59	1.21	0.80	82.33
TS - F	1.00	1.18	0.80	79.26
MLT - F	2.28	1.20	0.95	75.44
MEAN	1.68	1.31	0.85	80.49

TABLE 6B: PROXIMATE COMPOSITION OF DEHYDRATED CASSAVA DOUGH SAMPLES ON DRY WEIGHT BASIS

SAMPLE	ASH (%)	CRUDE PROTEIN (%)	CRUDE FAT (%)	STARCH (%)
MDN - D	1.74	1.56	0.98	81.68
MKL - D	1.53	1.42	0.98	80.74
TS - D	1.17	1.16	0.63	75.51
MLT - D	2.12	1.40	1.04	78.52
MEAN	1.64	1.38	0.91	79.11

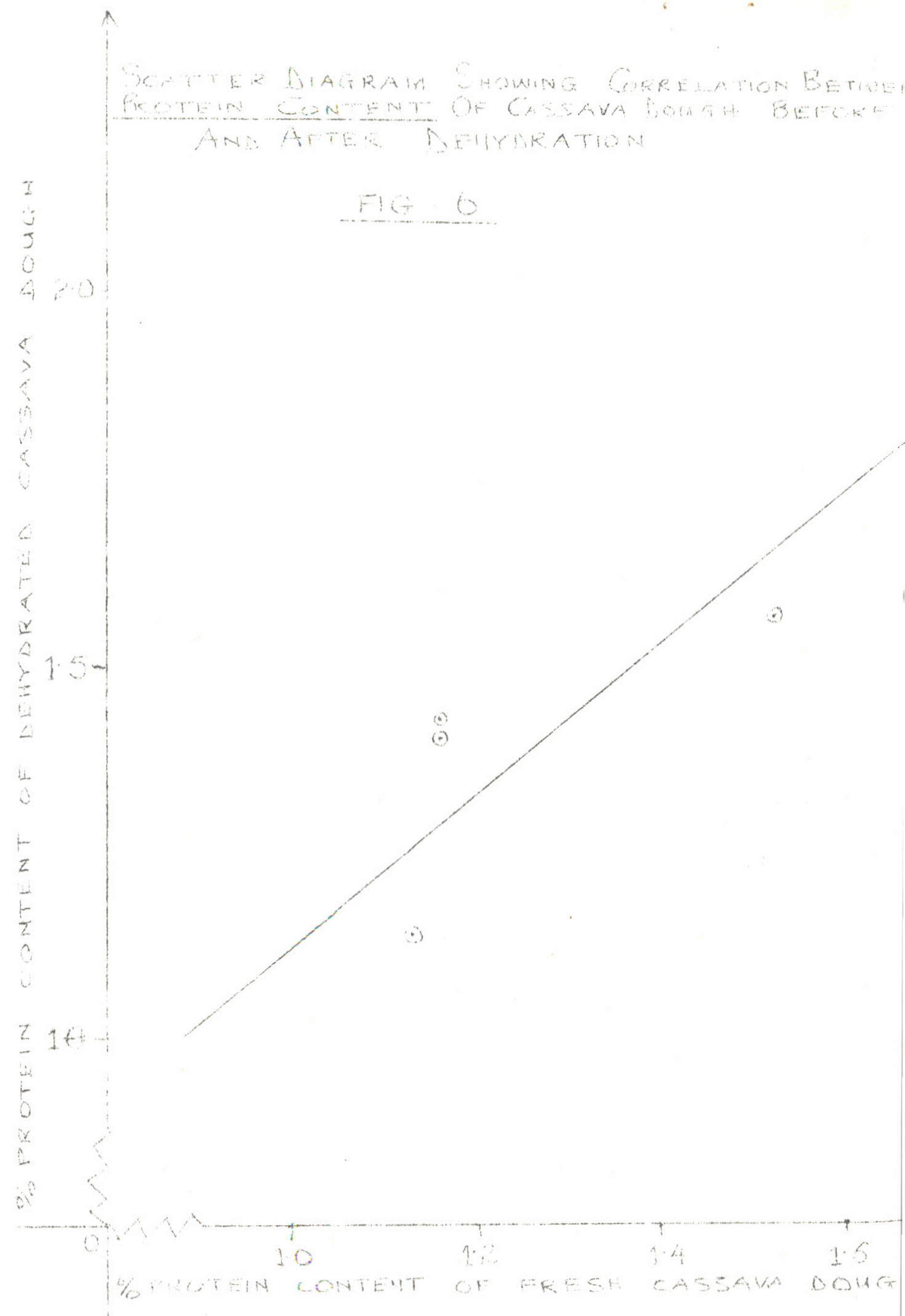
TABLE 6 C: CORRELATION COEFFICIENTS FOR PROXIMATE COMPOSITION BEFORE AND AFTER DEHYDRATION

	ASH	CRUDE PROTEIN	CRUDE FAT	STARCH
CORRELATION COEFFICIENT	0.99	0.92	0.48	0.95



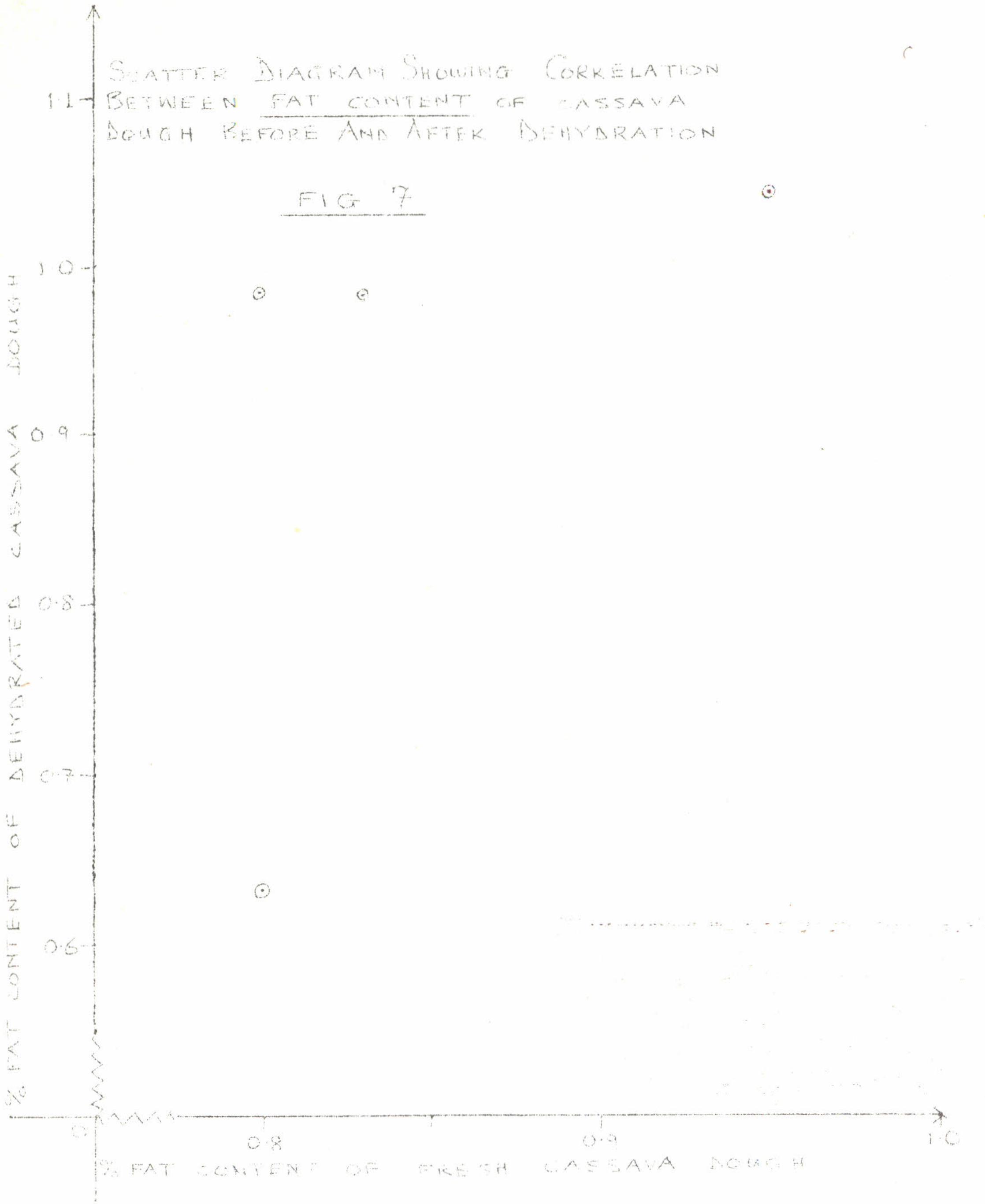
SCATTER DIAGRAM SHOWING CORRELATION BETWEEN ASH CONTENT OF CASSAVA DOUGH BEFORE AND AFTER DEHYDRATION

FIG 5



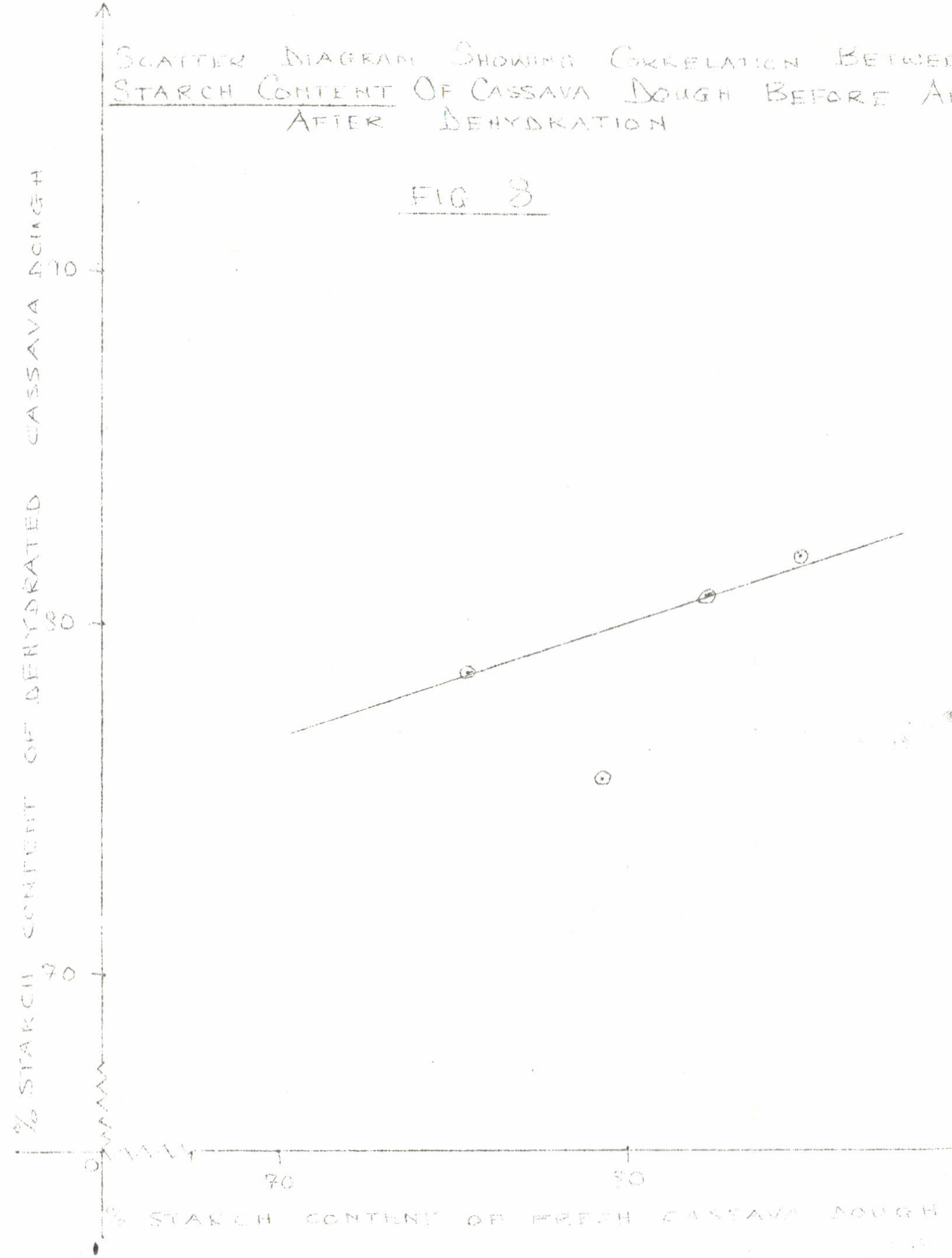
SCATTER DIAGRAM SHOWING CORRELATION BETWEEN PROTEIN CONTENT OF CASSAVA DOUGH BEFORE AND AFTER DEHYDRATION

FIG 6



SCATTER DIAGRAM SHOWING CORRELATION BETWEEN FAT CONTENT OF CASSAVA DOUGH BEFORE AND AFTER DEHYDRATION

FIG 7



SCATTER DIAGRAM SHOWING CORRELATION BETWEEN STARCH CONTENT OF CASSAVA DOUGH BEFORE AN[D] AFTER DEHYDRATION

FIG 8

SIEVE ANALYSIS

The sieve analysis for the dehydrated cassava dough flour from all four markets are given in Table 7. On the average about 97% of particles in each sample are less than 475 microns in size whilst less than 7% are less than 129 microns. Thus majority of the particles ie. about 90%, have a particle size of about 129 microns. The mean finess modulus for all the samples is 2.97 which by calculation using the formula on page 8 gives an average grain size of 0.0328 inches for the dehydrated cassava dough flour.

TABLE 7: SIEVE ANALYSIS OF DEHYDRATED CASSAVA DOUGH SAMPLES

SAMPLE	PERCENTA OF MATERIAL RETAINED					FINENESS MOULUS
	475 mic	129 mic	117 mic	112 mic	PAN	
MDN - D	3.13	92.15	4.70	0.19	0	2.89
MKL - D	3.11	90.70	5.78	0.20	0	2.96
TS - D	3.07	89.80	6.92	0.19	0	2.96
MLT - D	3.10	92.02	4.70	0.18	0	2.98

SENSORY EVALUATION

Table 8 shows the mean scores for the taste panel assessment. With exception of the sample from Mallata Market where the mean scores indicate no relative preference for either the fresh or dehydrated product, the mean scores for samples from the other three markets show a general preference for the fresh dough. However comparison of the mean scores received by each sample using the t-test shows that even though there is some detectable difference between the akple prepared from fresh cassava dough and that prepared from the dehydrated dough the difference is not significant. Thus the dehydrated dough flour can be considered as not being significantly different from the fresh dough.

However comments like "Sample A (ie akple from fresh dough) is acidic", "Sample A is slightly more fermented" and "Sample A is slightly sour" which some of the panelists noted down confirms the reduction in acidity during dehydration as indicated by chemical analysis.

TABLE 8: MEAN SCORES FOR TESTE PANEL ASSESSMENT OF FRESH AND DEHYDRATED CASSAVA DOUGH SAMPLES

	MEAN SCORES			
	MDN	MKL	T	MLT
Sample A	7.1	6.6	7.5	6.4
Sample B	6.8	5.8	7.3	6.4

SAMPLE A: Akple prepared from fresh cassava dough
SAMPLE B: Akple prepared from dehydrated cassava dough

RECONSTITUTED PROJECT

The product was reconstituted by adding 88g. of water to 100g of dehydrated cassava dough flour. This brings the dehydrated dough flour from its 5.7% average moisture level to 50% moisture level, which is the average moisture level of fresh cassava dough.

The reconstituted product had a slightly burnt off flavour, even though it had a little of the characteristic cassava dough flavour. Also it had a darker appearance compared to the fresh cassava dough.

The reduction in the characteristic cassava dough flavour can be attributed to the loss of the volatile components of the dough - mainly volatile acids, al-dehydes and esters which are the main flavour components - during dehydration. The extent of loss of volatile acids has been discussed. Some further work may have to be done on the amount of aldehydes and esters lost during dehydration.

The dark appearance of the reconstituted product is likely to be due to some browning reactions that might have occured during dehydration. Browning has been found to be one of the most obvious and in some respects the most troublesome of all the changes that accompany the drying of/food/a substance. It is caused by the formation of unsaturated colored polymers of varying composition from both enzymatic and non-enzymatic reactions. The browning observed in the reconstituted product could be more of non-enzymatic origin than enzymatic since the temperature at which the dough was dehydrated may not permit any oxygenases present to act. And it could be due to carbonyl-amino reactions, which may occur during dehydration of the dough ie. on application of heat. Copley and Van Arsdel (1964) outlines the various types of browning reactions.

These changes in flavour and appearance were not however very much noticeable in the akple prepared from the dehydrated product.

CONCLUSION

The results obtained clearly show that:

9i) It is possible to develop an intermediate fermented Dedydrated Cassava Dough which compare favourably with the Fresh dough as far as it's use in the preparation of Akple is concerned.

(ii) the product obtained is acceptable

(iii) the nutritional value of the cassava dough is not seriously affected by the dehydration process

(iv) even though the acidity of the cassava dough reduces during dehydration, this did not seriously affect the acceptability of the product.

These findings are very significant because they show that Agbelima (fermented cassava dough) can now be preserved by dehydration without loss of any essential nutrients or fear of rejection by consumers.

To make this project complete and to establish a certainty on the universal acceptability of the product the following investigations would be carried out as a second phase of the projedt.

(i) The suitability of the intermediate fermented dehydrated cassava dough for the preparation of 'Yakayake and "fufu" and acceptance tests on these product.

(ii) Shelf-life studies on the dehydrated product.

ACKNOWLEDGEMENT

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APPENDIX 1

QUESTIONNAIRE FOR TASTE PANEL ASSESSMENT

NAME .... DATE ....

PRODUCT ....

Taste these samples and check how much you like or dislike each one.

SAMPLE A

Like extremely ....
Like very much ....
Like moderately..................
Like slightly....................
Neither like nor dislike.........
Dislike slightly,................
Dislike moderately ....
Dislike very much................
Dislike extremely ....

SAMPLE B

Like extremely ....
Like very much ....
Like moderately..............
Like slightly................
Neither like nor dislike ......
Dislike slightly.............
Dislike moderately...........
Dislike very much............
Dislike extremely............

COMMENTS:

APPENDIX 2

AN EXAMPLE OF THE COMPARISON OF MEAN SCORES FROM TASTE PANEL ASSESSMENT USING THE T-TEST

SCORES FOR THE TASTE PANEL ASSESSMENT OF AKPLE PREPARED FROM FRESH AND DEHYDRATED CASSAVA DOUGH (SAMPLE A & B RESPECTIVELY)
SOURCE OF DOUGH - MADINA

JUDGES	SAMPLE A	SAMPLE B	Diff (d)	d^2
1	6	8	-2	4
2	6	7	-1	1
3	3	6	-3	9
4	6	8	-2	4
5	7	4	3	9
6	8	7	1	1
7	9	6	3	9
8	9	7	2	4
9	8	7	1	1
10	9	8	1	1
TOTAL	71	68	3	43
MEAN	7.1	6.8	0.3	4.3

Calculate d (average difference)

d = mean for A - mean for B

= 7.1 - 6.8

= 0.3

Calculate s (standard deviation)

$$s = \sqrt{\frac{\sum d^2 - (\sum d)^2/n}{n-1}}$$

$\sum d^2$ = sum of the square of each difference

= 43

$(\sum d)$ = sum of the difference squared

= $3^2 = 9$

n = number of pairs

= 10

$$s = \sqrt{\frac{43 - \frac{9}{10}}{9}}$$

$$= \sqrt{\frac{42.1}{}}$$

$$s = \sqrt{\frac{43 - \frac{9}{10}}{9}}$$

$$= \sqrt{\frac{42.1}{9}}$$

$$= \sqrt{4.678}$$

$$= 2.163$$

Find the t-value of statistical chart in Appendix 4 under the column headed 0.050 (for 5% level of significance). The df (degrees of freedom) is the number of pairs minus one.

df = 10 - 1 = 9

t value = 2.262

The samples are significantly different if

$$\frac{\bar{d}}{s/\sqrt{n}} > t$$

$$\frac{\bar{d}}{s/\sqrt{n}} = \frac{0.3}{2.163/\sqrt{10}}$$

$$= \frac{0.3 \times 3.16}{2.163}$$

$$= 0.438$$

0.438 is not greater than t value (2.262). The conclusion is that there is no significant difference in the akple prepared from fresh cassava dough and that from dehydrated dough.

CALCULATION OF COEFICIENT OF CORRELATION BETWEEN ASH CONTENT OF CASSAVA DOUGH BEFORE AFTER DEHYDRATION

X = Independent **Variable**

= Ash content before dehydration

Y = Dependent Variable

= Ash content after dehydration.

DATA I

	X	Y	X^2	XY
	1.87	1.74	3.50	3.25
	1.59	1.53	2.53	2.43
	1.00	1.17	1.00	1.17
	2.28	2.12	5.20	4.83
TOTAL	6.74	6.56	12.23	11.68
MEAN	1.68	1.64		
$(\text{TOTAL})^2$	45.42			

Lease square regression line of Y on X is :

$$Y = ao + a_1 X$$

where:

$$a_o = \frac{(\Sigma Y)\ (\Sigma X^2) - (\Sigma X)\ (\Sigma XY)}{N\Sigma X^2 - (\Sigma X)^2}$$

$$a_1 = \frac{N\Sigma XY - (\Sigma X)\ (\Sigma Y)}{N\Sigma X^2 - (\Sigma X)^2}$$

From data: $ao = \frac{(6.56)(12.23) - (6.74)(11.68)}{4(12.23) - 45.42}$

$$= \frac{80.19 - 78.79}{3.46}$$

$$= \underline{\underline{0.4039}}$$

$$a_1 = \frac{4(11.68) - (6.74)\ (6.56)}{4(12.23) - 45.42}$$

$$= \frac{46.76 - 44.21}{3.46}$$

$$= \underline{\underline{0.7346}}$$

DATA II

	Yest	Yest - $\bar{Y}$	$(Yest - \bar{Y})^2$	Y - $\bar{Y}$	$(Y - \bar{Y})^2$
	1.7776	0.1378	0.0189	0.1000	0.0100
	1.5719	- 0.0681	0.0046	-0.1100	0.0121
	1.1385	- 0.5015	0.2515	-0.4700	0.2209
	2.0788	0.4388	0.1924	0.4800	0.2304
TOTAL			0.4675		0.4734

Yest = Value of Y for given values of X on estimated from the equation

$\bar{Y}$ = ao + a, X.

$\bar{Y}$ = Mean of Y values

Cofficient of correlation (r) is given by

$$r = \sqrt{\frac{(\Sigma Yest - \bar{Y})^2}{\Sigma(Y - \bar{Y})2}}$$

$$= \sqrt{\frac{0.4675}{0.4734}}$$

$$= \sqrt{0.9875}$$

$$= 0.99$$

Since r, the coefficient of correlation is near to 1 it implies that there is a linear correlation between the ash content of the cassava dough before and after dehydration.

APPENDIX 4

The distribution of t

Degrees of Freedom	0.500	0.400	0.200	0.100	0.050	0.025	0.010	0.005	0.001
	Probability of a larger values, sign ignored								
1	1.000	1.376	3.078	6.314	12.706	25.452	63.657		
2	0.816	1.061	1.886	2.920	4.303	6.205	9.925	14.089	31.598
3.	0.765	0.978	1.638	2.353	3.182	4.176	5,841	7.453	12.941
4	0.741	0.941	1.533	2.132	2.776	3.495	4.604	5.598	8.610
5	0.727	0.920	1.476	2.015	2.571	3.163	4.032	4.773	6.859
6	0.718	0.906	1.440	1.943	2.447	2.969	3.707	4.317	5.959
7.	0.711	0.896	1.415	1.895	2,365	2.841	3.499	4.029	5.405
8	0.706	0.889	1.397	1.860	2,306	2.752	3.355	3.832	5.041
9	0.703	0.883	1.383	1.833	2.262	2.685	3.250	3.690	4.781
10	0.700	0.879	1.372	1.812	2.228	2.634	3.169	3.581	4.587
11	0.697	0.876	1.363	1.796	2.201	2.593	3.106	3.497	4.437
12	0.695	0.873	1.356	1.782	2.179	2.560	3.055	3.428	4.318
13	0.694	0.870	1.350	1.771	2.160	2.533	3.012	3.372	4.221
14	0.692	0.868	1.345	1.761	2.145	2.510	2.977	3.326	4.140
15	0.691	0.866	1.341	1.753	2.131	2.490	2.947	3.286	4.073
16	0.690	0.865	1.337	1.746	2.120	2.473	2.921	3.252	4.015
17	0.689	0.863	1.333	1.740	2.110	2.458	2.898	3.222	3.965
18	0.688	0.862	1.330	1.734	2.101	2.445	2.878	3.197	3.922
19	0.688	0.861	1.328	1.729	2.093	2.433	2.861	3.174	3.883
20	0.687	0.860	1.325	1.725	2.086	2.423	2.845	3.153	3.850
21	0.686	0.859	1.323	1.721	2.080	2.414	2.831	3.135	3.819
22	0.686	0.858	1.321	1.717	2.074	2.406	2.819	3.119	3.792
23	0.685	0.858	1.319	1.714	2.069	2.398	2.807	3.104	3.767
24	0.685	0.857	1.318	1.711	2.064	2.391	2.797	3.090	3.745
25	0.684	0.856	1.316	1.708	2.060	2.385	2.787	3.078	3.725
26	0.684	0.856	1.315	1.706	2.056	2.379	2.779	3.067	3.707
27	0.684	0.855	1.314	1.703	2.052	2.373	2.771	3.058	3.690
28	0.683	0.855	1.313	1.701	2.048	2.368	2.763	3.047	3.674
29	0.683	0.854	1.311	1.699	2.045	2.364	2.756	3.038	3.659
30	0.683	0.854	1.310	1.697	2.042	2.360	2.750	3.030	3.646
35	0.682	0.852	1.306	1.690	2.030	2.342	2.724	2.996	3.591
40	0.681	0.851	1.303	1.684	2.021	2.329	2.704	2.971	3.551
45	0.680	0.850	1.301	1.680	2.014	2.319	2.690	2.952	3.520
50	0.680	0.849	1.299	1.676	2.008	2.310	2,678	2.937	3.496
55	0.679	0.849	1.297	1.673	2.004	2.304	2.669	2.925	3.476
60	0.679	0.848	1.296	1.671	2.000	2.299	2.660	2.915	3.460
70	0.678	0.847	1.294	1.667	1.994	2.290	2.648	2.899	3.435
80	0.678	0.847	1.293	1.665	1.989	2.284	2.638	2.887	3.416
90	0.678	0.846	1.291	1.662	1.986	2.279	2.631	2.878	3.402
100	0.677	0.846	1.290	1.661	1.982	2.276	2.625	2.871	3.390
120	0.677	0.845	1.289	1.658	1.980	2.270	2.617	2.860	3.373
oo	0.6745	0.8416	1.2816	1.6448	1.9600	2.2414	2.5758	2.8070	3.2905

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