

FOOD RESEARCH INSTITUTE  
(Council for Scientific and Industrial Research)

C O R N   B R E A D   M A N U F A C T U R E  
(THE PROSPECT OF USING COMPOSITE FLOUR FOR CORN BREAD)

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## PREFACE

The use of composite flours for baking kinds of bread other than the familiar all-wheat flour bread, engaged the attention of the Food Research Institute soon after its establishment in 1965. At this time it was more inspired by experimental reasons in the laboratory than the commercial motivation that underlies the present interest. The corn bread featured very prominently in these experiments and was one of the few choices out of the range.

Then, as it is now, the price of corn, not to mention the resultant meal or flour, was relatively higher than wheat flour. But unlike now, the wheat flour was in abundant supply and was not subject to a galloping inflation in price.

The world is shorter of wheat than before, and Ghana is naturally short of wheat flour all the more. But with good planning and inducements in the right direction and places, there is a much better prospect for increasing the production of corn than importing more wheat.

Corn bread, as a variety of bread, is fairly well known in the big towns, of Ghana, consequently it is unlikely to be subject to the consumer indifference and skepticism that new food products suffer from when introduced to the market. Some bakers have already made the attempt but have had their interest throttled by the high price of corn. The price of corn therefore under present conditions, is the most significant determinant of the level of interest in the production of corn bread.

This study was requested for towards the close of 1973 when the flow of wheat flour became very sticky with periodic shortages and disturbing influences on wheat flour prices. In these circumstances expedition in the submission of an appraisal was imperative with particular reference to the chances of relief from corn bread. Consequently, the investigations which led to this report could not be carried out as exhaustively as would be required normally.

These limitations, however, could not be blamed for any errors that occur since they remain the sole responsibility of the authors,

The kind co-operation and assistance of the proprietors of Ghana Electric Bakery and Tuyee Manufacturing Company Limited are hereby acknowledged. It would have been impossible to mention the medium scale bakery operations without the free offer of their experience in both all wheat and corn bread manufacture.

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## SUMMARY

This report discusses the commercial prospects of admixing wheat flour with the right proportion of corn meal/Flour to produce an acceptable corn bread.

The technique of bread making relies on the principle of gas production within the dough and the ability of the dough to hold this gas to produce an acceptable texture in the bread. The dilution of the wheat flour, which possesses this desired quality, with corn meal/flour causes a loss in this property and therefore produces a heavy and dense texture. From experiments and pilot studies the level of corn meal/flour should be about 20%.

There are three types of corn material that can be used for producing corn bread. The whole corn meal, the polished corn meal and the corn flour in that order of sophistication in processing. The whole corn meal which is recommended for the small scale producer has the disadvantage of inducing rancidity in the bread and therefore does not permit storage of the bread. The polished corn meal which is degermed and dehusked improves the storage quality. There are very limited equipment available in this country for this process, and the service is not well organised to facilitate the work of the baker.

Consequently, the use of manufactured corn flour appears to be the most appropriate form if the practice should gain any popularity among the bakers. At present there is only one factory at Tema that has the facilities for producing corn flour, and even then its capacity is already being fully utilized for the production of textile starch for the textile manufacturers whose demand this factory is hard pressed to meet.

It therefore needs to be seriously considered that the necessary provision be made to produce corn flour on a reasonable scale to take advantage of better prices at points of concentration for corn, and at the same time provide the bakers with ready-to-use corn flour. The baker is the most important agent in this proposition and his support will depend on modifications in his organisation that are few, very simple and commercially attractive.

The consumer does not present any serious challenge. Since corn bread compares very closely with all-wheat bread and can serve as a direct substitute for it; and since corn bread is not an entirely new product, acceptance by the consumer is assumed. Besides, the existing system of distributing all-wheat bread can easily accommodate this line of product.

The proposal to encourage the production and sale of corn bread is worthy of serious consideration. It carries with it, at the national level, the advantages of providing variety to the diet, encouraging the use of local material, expanding the market for corn, stimulating the primary production of corn, and saving the country some foreign exchange.

## 1. INTRODUCTION

### Technical Background

1.1 Wheat flour protein forms with water a visco-elastic substance called gluten which by suitable development gives to bread its unique texture. Wheat and rye are the only cereals that contain this protein with visco-elastic characteristics of benefit in breadmaking. The suitability of wheat flour for conventional breadmaking depends to a large extent on the gluten strength which determines the ability of the dough to retain the gas generated by yeast, and give volume to the loaf. Different varieties of wheat contain different gluten strength.

1.2 The production of bread from blends of wheat flour and non-wheat materials - "composite flour" - has been necessary in various parts of the world, for the purpose of variety and when wheat is scarce. In Ghana, 'corn bread' was introduced during the last world war.

1.3 Various technical reports have mentioned the substitution of part of wheat flour with flours of starchy crops and other cereals of tropical origin in breadmaking. Since these materials contain no gluten, they are not capable, in the absence of additives and improvers, of producing as light a product as wheat flour when used in breadmaking.

1.4 It must be mentioned that in the absence of gluten, various workers have produced bread-like products using binding agents with swelling capacity like carboxymethylcellulose, alginates, gums and surfactants like glyceryl monostearate. Apart from the fact that the method of preparation of such products is different from conventional breadmaking methods (facilities for which the average Ghanaian baker has), there is also the question of consumer acceptability of such products.

1.5 As mentioned in the Interim Report on Corn Bread<sup>1</sup> some research work was carried out in 1967 at the Food Research Institute to study the possibility of using blends of flours from local starchy crops and wheat flour in breadmaking.

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1. Andah, A. & Bartels, J.E.M. Interim report on corn bread. Food Research Institute Report, (633.1, 664.66 AND) Oct. 4, 1973



Non-wheat flours used to blend wheat flour in this work were yam flour, plantain flour, kokonte flour, garri and whole corn meal. Yam bread, garri bread and corn bread were most acceptable with regard to qualities such as flavour, texture, colour, taste and volume (Appendix I Table I).

1.6 Corn bread was chosen out of the three because of the following superior qualities:-

- (i) it is already known in Ghana, at least, to consumers;
- (ii) it is best, nutritionally, considering the use to which it is put, and for the fact that, as a cereal, corn has higher levels of various nutrients compared with yam or cassava (Appendix I Table 2).
- (iii) corn is in a convenient form for flour making.

1.7 The nutritional level of corn bread falls below, by about 1% in crude protein, that of all wheat bread. The shortage as shown in Appendix I Table 2 is too small to warrant enrichment at this stage. But cassava and yam sources are considerably poorer nutritionally, and composite bread derived from them will have to be enriched to raise the nutritional level, especially with respect to protein.

#### Economic Justification

1.8 In Ghana's external trade, wheat ranks high in the total food imported. Between 1966 and 1972, wheat imports amounted on the average to 11.8% in value of the total food imports. This average included two years, 1966 and 1971, of severe official restriction on importation. Under conditions of liberal external trade, this proportion rose as high as 16.0%, in 1968. In monetary terms, the Government spent on the average about \$6.3 million in foreign exchange on this item. This value rose to more than \$8½ million in 1972 (Appendix I Table 3).

1.9 Per capita consumption of bread is reported to have risen more than 100% between 1950 and 1960.<sup>2</sup> Between 1960-1970 consumption closely followed the pattern of importation with the evidence of a latent demand which continued to influence the price of bread upward. "... the substantial hard currency component in the price of bread mean that wheat and flour are imports which governments who are following a policy of self-sufficiency in food supply may not be willing to see increased."<sup>3</sup>

1.10 Quite apart from the pressure that domestic consumption is putting on available supplies locally, the world market outlook for wheat does not present a prospect for easier conditions in the immediate future. The FAO Commodity Review for 1972-73 reported a depletion in 1972/73 of carry over stocks due to a sharp rise in wheat shipments. This report also forecast that, "at the opening of the 1973/74 season, aggregate carry over stocks of wheat in the main exporting countries will be at their lowest level for over 20 years".<sup>4</sup> It will require sometime in the future to build up these stocks again to a comfortable level.

1.11 The world supply position has forced up the price of wheat, making it all the more difficult even to maintain the previous volume of imports. The significance of this situation in terms of employment is not certain considering the scale at which the majority of our bakers operate, not taking into account those in the chain of flour distribution. According to the 1960 Population Census, 19,456 out of 991,418 women employed were engaged in the manufacture of bakery products, with only 1.5% of that number employed as bakery hands or labourers.

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<sup>2</sup>A.J. Youngs. Wheat flour and bread consumption in West Africa: A review with special reference to Ghana. Trop. Sc. (J. of TPI) Vol.XIV No.3, 1972 p.237.

<sup>3</sup>Ibid. p.242.

<sup>4</sup>United Nations. FAO Commodity Review and Outlook, 1972-73. Food and Agricultural Organisation of the United Nations, 1973; p.63 para. 174.



Even though this number is only about 2% of the total number of women employed, this industry is of special significance to the urban towns and cities where bread baking is concentrated.

1.12 These considerations show that there is a pressing need to supplement the available wheat flour in the bread industry and the consumption of bread should not suffer drastically. Supplementation with corn will both save the country at least about  $\$1\frac{1}{2}$  million a year in foreign exchange and provide a wider scope for the limited supply of wheat flour.

## 2. COMMERCIAL PRODUCTION OF CORN BREAD

### The Problem

- 2.1 As already mentioned, corn bread is not a completely new product to the Ghanaian consumer. Even after the last World War, when wheat flour resumed normal supplies, corn bread was produced and is still being spasmodically produced in limited quantities for special consumers. In terms of use, corn bread can be considered as a complete substitute for all-wheat bread, with the advantage of providing variety as well.
- 2.2 The process of manufacture of all-wheat bread, however, is not totally substitutable for that of corn bread. In the existing bakery organisation the production of corn bread creates new activities in the acquisition of corn and its conversion into meal or flour. The manufacture of the corn bread also requires a slightly different technique, which at this stage, is not a common knowledge among bakers. Consequently there is little or no reason to expect the bakers to voluntarily pioneer the production of corn bread when there are new factors to be contended with, unless the appropriate stimulus is provided.
- 2.3 The problem at issue therefore is how to stimulate our local bakers to produce corn bread that will be acceptable to consumers at prices, at least, competitive with those of current all-wheat bread.

### Objectives

- 2.4 In order to resolve the problem posed above, the following objectives were set for this study:-
- (i) to confirm the recipe on a commercial scale;
  - (ii) to assess consumer reaction to the corn bread using this formula ;
  - (iii) to determine the cost of producing the corn bread at two levels of operation using corn meal on one hand and corn flour on the other; and to
  - (iv) identify any factors that would limit commercial production.

### Method of Study

2.5 In the Interim Report on Corn Bread, the laboratory experiments showed that the highest level of corn meal that could give acceptable bread was  $33\frac{1}{3}\%$  of wheat flour weight. Owing to the development of rancidity when whole corn meal was used, this study was conducted with corn meal that had been degermed and dehusked.

2.6 Since the Institute lacked the suitable facilities for this pilot scale baking, the trials had to be conducted in a private small scale bakery. This imposed severe limitations on the frequency of the trials since they had to be combined with the normal business in the bakery allowing the latter the first place.

2.7 At this commercial scale with only minimum controls on proofing and baking temperatures, the  $33\frac{1}{2}\%$  level of corn meal was disappointing. The loaf volume was completely unacceptable and the bread tended to flatten out mainly due to the wide bottom of the baking pans, which allowed the less sticky corn/wheat dough to spread out after moulding.

2.8 The resulting bread was also flat and could scarcely produce the conventional slice when cut. It was very heavy with a dense crust. This was disqualified by all tasters.

2.9 From further trials it was found that, on a scale for commercial production with existing facilities and standards, 20% corn flour was the highest level that gave acceptable loaf. On that basis the following recipe was adopted:-

| <u>Constituent</u> | <u>Measure</u>         |
|--------------------|------------------------|
| Wheat flour        | 80 lbs                 |
| Corn Meal          | 20 lbs                 |
| Yeast (dried)      | $2\frac{1}{2}$ ozs     |
| Salt               | 1lb 14ozs              |
| Sugar              | 4lbs 6ozs              |
| Margarine          | 1lb                    |
| Water              | $5\frac{1}{4}$ gallons |

The details of processing are attached in Appendix II.

2.10 Consumer acceptability tests were carried out on the 20% level corn bread. Owing to limitations in production already mentioned, the distribution was confined to those belonging to the middle and up to the top of the public service with the former in the majority. This was to ensure a high rate of response and return of the questionnaires.

2.11 The consumer acceptability test was supplemented with the interview of selected bakers including the Saltpond Bakers Association, who had earlier expressed interest and had been lectured on the technique of baking corn bread.

### 3. CONSUMER ACCEPTANCE

3.1 Consumer acceptance is an all inclusive measure which takes into account a wide range of criteria on which the consumer is likely to depend for a decision to accept the item offered on a permanent basis or at least, for a fairly long time. In a wider context than acceptance, is the measure of preference which would have been more pertinent to the eventual aspiration of this study, with particular reference to substitution of all-wheat bread with the corn bread. But conditions did not permit the extension of the study to the question of preference. Even under acceptance, it was not possible to carry out the tests to the point of actual purchase in the market to test consumer response in its most concrete form.

3.2 The selected criteria for consumer acceptance of external appearance, internal colour, flavour, taste and the price that would be offered, were not exhaustive, but illustrated what could be expected. Out of 94 questionnaires accompanying the samples of corn bread, 55 completed forms were returned giving about 58.5% response, which is reasonable.

3.3 The results are available below.



CONSUMER ACCEPTABILITY ASSESSMENT IN TERMS OF QUALITY

|              | Internal Colour | External Appearance | Flavour | Taste |
|--------------|-----------------|---------------------|---------|-------|
| Acceptable   | 53              | 52                  | 52      | 53    |
| Unacceptable | 2               | 3                   | 3       | 2     |
| Total        | 55              | 55                  | 55      | 55    |

For the properties of quality, there was an overwhelming acceptance of the corn bread offered; not less than 94% of the tasters responded favourably towards corn bread. All the tasters normally ate bread, and the corn bread was in general used as a substitute for all wheat bread at breakfast with all that goes with the latter, except 2 out of the 55 who used it in the evening with beans, fried fish and soup.

3.4 Corn bread tastes differently from all-wheat bread owing to the unique flavour imparted by the corn. The use of supplementary corn meal, in this case, or whole corn meal on the traditional scale, introduces into corn bread a gritty texture which is distinct from the smooth all-wheat bread. There is also a slight difference in external appearance and the internal colour.

3.5 Even though, in use, corn bread is wholly substitutable for all-wheat bread there are enough differences in properties that distinguish the two types of bread. So that this high level of acceptance by consumers, traditionally used to all-wheat bread indicates the existence of a consumer market that can be cultivated.

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3.6 There was one other property of corn bread which redounded to its favour. This referred to its density on which tasters' remark was that it was more filling. This was confirmed by a bread baker who was producing about £150.00 worth of corn bread (10p sizes) a day as well as a much larger volume of all wheat bread. His production literally sold like hot cakes but total output of the corn bread was restricted by a few limitations in the acquisition of the corn to be discussed later.

3.7 To confirm the tasters' opinion about the density of corn bread samples of corn bread and all wheat bread were checked for this property using 0.10p loaves, -

- (i) Corn Bread : weight = 165g; volume = 670cc
- (ii) All-wheat Bread : weight = 154g; volume = 875cc

3.8 This property of corn bread is both an advantage as testified by the tasters', and a disadvantage in a consumer market, like ours, where the sale of produce is not generally based on weight. In the sale of bread, buyers generally choose on the basis of size with the weight as a secondary or relatively unimportant factor. To those uninitiated into the consumption of corn bread, therefore, the choice, between it and all-wheat bread with a bigger volume for the same denomination, will tend to favour the all-wheat bread. It would mean that the corn bread will have to be produced in sizes that will compete favourably with the all-wheat bread quite apart from the sales promotion that would be necessary to influence consumers' choice in its favour.

3.9 The comparative figures for 10p loaf of corn bread and all-wheat bread shows an inverse relationship between the two in terms of weight and volume. As the weight increased from all-wheat bread to corn bread by 7.0% (165g- 154g), the volume decreased by 12% (875cc - 670cc) with a greater decrease in volume than the increase in weight. This relationship widens, with greater decline in volume, as the corn component increases.

3.10 In the consumer acceptability test, the 55 tasters who responded to questionnaires were asked to suggest a market price for the loaf of corn bread offered. The bread weighed 411.5g with a volume of 1175cc; these measurements were very close to the 20p worth of all-wheat bread available on the market. The results of this question are tabulated below:-

Table 3.2

CONSUMER ACCEPTABILITY OF PRICE OF A LOAF OF  
CORN BREAD (WT. = 411.5g, VOL. = 1175cc)

PRICE RANGE

|                | 25p | 20p  | 18p | 15p  | 10p  | Total |
|----------------|-----|------|-----|------|------|-------|
| No. of tasters | 2   | 29   | 1   | 8    | 14   | 55    |
| % of Total     | 3.6 | 52.7 | 1.8 | 14.5 | 27.2 | 99.8  |

3.11 About 53% of the tasters would buy the loaf of bread for 20p while about a half of that number would offer only 10p. The majority of the taster's assessment of price was very close to expectation. Since this was not confirmed by an actual sale it could be concluded that the majority did not reject the normal price that would have been put on it. This showed a favourable market prospect for the corn bread in terms of price.

3.12 Bread is normally bought for immediate consumption and to store for very short periods. Under our warm and humid domestic conditions the growth of moulds and other micro-organisms are favoured, making it extremely difficult to store bread.

3.13 Comparatively, all-wheat bread stores for a much longer period than the corn bread. For the latter, this shorter period is reduced much further depending on the type of corn product incorporated in the bread. The less refined the corn product the shorter it stores. These various categories of corn product require different facilities of their production and these will be discussed in detail later.

3.14 It will be obvious from the above discussion that as far as the consumer is concerned there is little or no reason why the corn bread at a competitive price based on the right standards of quality will not be accepted. As the following will show, the decision to ~~make~~<sup>make</sup> available corn bread on the market therefore rests much more on the baker, and this decision at the moment is hedged in by a number of factors which will be discussed subsequently.



#### 4. ~~PRODUCER~~ ACCEPTANCE

##### Technical and Organisational Implications

- 4.1 The most significant difference between the formula for corn bread and all-wheat bread is the dilution of the wheat flour used for the latter, with corn meal or flour for the former. The two forms of corn products produce breads that are basically the same but differ in the refinement in quality which is a reflection of the refinement in the corn materials.
- 4.2 It has to be recognised, also, that the use of the corn admixture introduces an additional set of processing activities in the existing bread baking organisation. Under our conditions, and especially at the artisanal level where the corn meal is being produced, there is no other integration of function with the corn milling. Corn milling is provided as a service only, with the ownership of the raw material and the finished meal quite separate. This could imply that the normal baking activities would have to be integrated with that of corn handling and processing, unless special provision is made separately for advanced production of meal or flour.

##### Wet Whole Corn Meal

- 4.3 At the moment the corn processing facilities in the country are overwhelmingly in favour of the production of the wet whole corn meal. This is due to the predominance and wide dispersion of the village-type corn mill. This equipment has traditionally produced the wet whole corn meal known as the corn dough, for uses like kenkey mostly, but excluding bread of any form.
- 4.4 The wet whole corn meal is adaptable for the baking of corn bread with a number of limitations. Since it is whole, it incorporates the husk, which is really chaff, to develop a rough texture which may not be important depending on the market. The presence of water and the oil bearing germ predisposes the meal to rancidity which is transferable as off-flavour to the finished bread.



Consequently the wet meal has to be used soon after milling and the finished bread has to be disposed of quickly and consumed early after baking. This particular process can only be adopted by the small scale producer for whom storage of the raw materials and finished products is not imperative.

#### Dry Whole Meal

4.5 A slight improvement on the storage life of the meal is achieved when the corn is milled dry. Since the oil bearing germ is still present, the absence of water merely shifts back a little the onset of rancidity in the finished product.

4.6 Since the available corn mills are suitable primarily for milling the moist/wet corn, the use of it for dry corn tends to wear the milling parts making the millers unwilling to offer this particular type of service. Besides, in the dry state, it takes several rounds of milling to reduce the corn to a reasonable texture thus increasing the cost of milling. For these various reasons bakers who have to use the dry meal have to select the soft variety of maize which is known to grow particularly in the Ashanti area. This is a technical detail which is beyond this report.

4.7 For both the wet and the dry meal, the corn mill does not produce a fine enough texture for conventional bread baking. Owing to the larger particle size produced, the resulting bread dough does not swell as much as that from wheat flour. Consequently the corn bread baker using the corn meal has to cut a bigger weight of dough to achieve the same volume as all-wheat bread (refer para. 3.7 page 10).

#### Polished Corn Meal

4.8 A further refinement in the meal involves the degerming and dehusking of the corn before milling. The polished corn meal eliminates the germ and therefore the prospect of rancidity. It has therefore storage advantages in the meal and the finished product.

4.9 But like the dry whole meal, the pretreated corn is hard and has to be run through the corn mill a number of time to produce the desired fineness of texture. For this reason its influence on loaf size is only slightly better than the whole meal, accountable by the absence of the husk.

4.10 For the medium to large scale producer of bread, the use of whole corn meal would not be attractive owing to the incidence and cause of rancidity, in the materials and the finished product, which prevents storage. Besides, it would be inconvenient and cost inflationary to rely on the commercial corn mills to obtain supplies of corn meal.

4.11 The more stable polished corn meal, on the other hand presents the problem of higher costs of material to the baker due to the loss of 30% - 35% in total weight of the germ and the husk. This loss is a valuable by-product for animal feed which the corn miller retains without reflecting the return on it in the milling charges. This milling process therefore becomes unduly sensitive to the price of corn and in fact no one has yet been located using this method.

#### Corn Flour\*

4.12 In countries where corn bread production is an established enterprise, the corn component of the composite flour is in the form of corn flour. By process, this flour is not different from the polished corn meal, but with the use of the right equipment, a very fine flour similar in texture to wheat flour is obtained.

4.13 Since this process requires some sophistication in equipment it can only operate at a level where a fair amount of integration of the raw material acquisition and final production of finished flour must be maintained. In this organisation the reduction in weight will not be seen as a loss but a full part of the cost benefit structure with a favourable reflection on the price of corn flour.

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\* Corn flour refers to flour from corn as distinct from corn starch

4.14 In terms of baking properties the flour has the distinct advantage of matching the volume production of all-wheat flour, provided the right level of corn flour is used.

4.15 Even though the majority of bread bakers in the country are small scale producers, the bread enterprise has a long history and established practice that has been conditioned by the use of already prepared wheat flour available on the shelves. Consequently the introduction of any modification for corn bread which requires alterations in process organisation will have to undergo a course of adjustment and adaptation in order to gain support. This course can only be shortened if the desired modifications are few, very simple and commercially attractive.

4.16 Without counting the cost at this stage, the choice between the three forms of corn products for incorporation, favours the corn flour. Given the special production facilities, it is the form that can be produced in large quantities and sold in convenient ready to use form; besides, it can store as long as the wheat flour with which it will be combined in the bread. The corn flour will therefore not involve the baker in any new activity except the division of effort between the acquisition of wheat flour and corn flour.

4.17 Since the corn flour was the most attractive form for the production of corn bread, enquiries were made on the chances of stimulating local production from existing facilities.

4.18 The Tema Food Complex had in its original plan of operation a corn flour mill unit. This unit arrived in the country but was never assembled for operation. It had since been cannibalised for use as parts to keep the wheat flour mill in running condition. There was not the slightest chance that this unit will be resuscitated.



4.19 The only mill encountered that could produce the corn flour but was producing corn starch for which there was an assured market from the textile mills, was the Tuyee Manufacturing Company, Tema. At the time of enquiry, operation was at full capacity for textile starch and further expansion was required if corn flour was to be produced. But this would require the necessary capital and the assurance that the corn flour market was sizeable and would accept the flour on the basis of the high price of corn and processing operations.

## 5. CONDITIONS FOR PRODUCING CORN FLOUR

### Availability of Corn

- 5.1 In the final analysis the decision to produce corn bread will critically depend on the supply position of corn, assuming that the supply of wheat flour will maintain its characteristic stability. Availability of corn in the country and its dispersion is a subject on which information is not available. The best indicators are the wholesale prices of corn at selected markets.
- 5.2 The method used in the identification of these markets depended on the analysis of price data for the main marketing centres especially those which occur in the areas of observed concentrated maize production. On the assumption that low mean monthly prices with correspondingly low variance (from the mean) are sufficient indices of relative availability of the produce on the market, a time series on average monthly prices for the five-year period (1967-71) was calculated.
- 5.3 The following selection was made to represent the wholesale markets with reliable supplies.

Table 5.1

MEAN MONTHLY MAIZE PRICES IN ¢ PER BAG (220LBS)  
AT THE MAJOR MAIZE MARKETS IN GHANA (CEDIS) (1967-71)

|          | Jan   | Febb  | Mar   | Apr   | May   | June  | July  | Aug  | Sept | Oct  | Nov   | Dec   |
|----------|-------|-------|-------|-------|-------|-------|-------|------|------|------|-------|-------|
| Ejura    | 6.08  | 8.22  | 8.15  | 9.53  | 12.57 | 11.37 | 7.63  | 6.88 | 5.53 | 6.31 | 9.85  | 8.75  |
| Attebubu | 7.31  | 7.70  | 8.00  | 9.07  | 10.91 | 10.81 | 9.06  | 6.27 | 5.94 | 8.05 | 8.32  | 8.37  |
| Asesewa  | 9.96  | 9.87  | 11.56 | 13.15 | 14.64 | 13.79 | 10.12 | 7.83 | 7.52 | 9.29 | 10.75 | 10.65 |
| Bawjiase | 10.67 | 9.99  | 11.43 | 13.08 | 14.65 | 12.85 | 9.93  | 8.35 | 8.07 | 9.85 | 11.17 | 10.90 |
| Mankesim | 11.16 | 10.33 | 11.34 | 13.76 | 14.77 | 15.11 | 12.09 | 8.25 | 6.84 | 9.05 | 10.98 | 11.33 |
| Kpandu   | 9.55  | 8.58  | 10.72 | 11.76 | 14.25 | 14.35 | 14.44 | 9.75 | 7.57 | 9.07 | 11.08 | 9.91  |

Source: Ministry of Agriculture - Division of Economics and Statistics, Weekly Market Information.



5.4 These maize prices on even the most favoured markets in terms of volume, if prices are reliable indicators, show a marked seasonality. The lowest prices occur from July to September. There is afterwards an upward movement from October with a slight levelling off in December to February. The highest prices are recorded in May to June.

5.5 For a manufacturing business the occurrence of wide swings, within short periods, of raw material prices can be a disturbing factor. Within these fluctuations it would appear that the prices between July and September will be the most favourable for the production of corn bread unless some arrangement is made to stabilise the price at an acceptable level.

#### Cost Relationship Between Wheat Flour and Corn

5.6 In the absence of figures on the availability and prices of corn which are directly related to corn flour production, the price of wheat flour is used as a reference to determine the price of corn that may favour the production of corn bread. In this approach, it is assumed that corn flour will be in direct competition with wheat flour with preference dependent on the price.

5.7 It is admitted that this approach is very slippery with several sources of error. For instance the processing cost of corn, which is not known for certain, will be different from that of wheat, as well as the marketing costs. Under the present conditions, however, this appears to be the best alternative to elucidate the problem without claiming any finality.

5.8 (i) The control price for wheat flour per 100 lbs = \$27.30  
(ii) Since the unit weight of a bag of corn = 220 lbs  
∴ The control price of 220 lbs of wheat flour = \$60.00  
$$\frac{(27.30 \times 220)}{100}$$

(iii) Given an extraction rate for corn flour of about 70%  
∴ The corn equivalent, by volume, to 220 lbs of wheat flour = 286lbs  
$$\frac{(220 \times 130)}{100}$$

(iv) The estimated processing cost of 1 ton of corn = ₦102.70<sup>5</sup>

∴ The estimated processing cost of 286lbs of corn = ₦13.11

$$\frac{(286 \times 102.70)}{2240}$$

(v) ∴ The maximum comparative cost of 286lbs of corn = ₦46.89

$$(\text{₦}60 - \text{₦}13.11)$$

(vi) Since a bag of corn weighs 220lbs

∴ The cost of a bag of corn should be = ₦36.06

$$\frac{(46.89 \times 220)}{286}$$

That is, if the price of wheat flour is ₦27.30 per 100lbs the competitive price of corn, considering processing costs only, should be ₦36.00 for a bag of 220lbs (i.e. about ₦16.00 for 100lbs of corn).

5.9 It has been mentioned already that the use of corn flour in the admixture tends to depress the volume of the loaf; consequently, for the same volume of all-wheat bread and corn bread, the corn bread will have to be of a greater weight. This was the experience throughout the trials and this explains the greater density of the corn bread. The depressing effect of the corn flour, in the absence of improvers has to be reflected in the price of the original corn.

5.10 According to paragraph 3.7 the following relative values were obtained for corn bread and all-wheat bread:

(i) Corn Bread : weight = 165g; volume = 670cc

(ii) All-Wheat Bread : weight = 154g; volume = 875cc

∴ 875cc of corn bread will be equivalent to 215g in weight

$$\frac{(875 \times 165)}{134} \text{ g}$$

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<sup>5</sup> Estimate obtained from interview of corn starch manufacturer.

The deduction is that the weight of all-wheat bread must be increased by a ratio of 61:154 ( $215-154 / 154$ ) to obtain the same volume in corn bread. Applying this ratio to the price of corn in paragraph (iv) reduces the price by  $\text{P}14.00 \left( \frac{61}{154} \times 36 \right)$  to about  $\text{P}12.00$  per bag of 220lbs.

5.11 For further verification of the estimated price of corn which will be competitive with corn flour, the variable cost structure of the varieties of bread were compared as follows: (refer Appendix III). The price of corn was  $\text{P}16.50$  per bag (weight: 217lbs).

Table 5.1<sup>6</sup>

|                     | <u>All-wheat</u> | <u>Corn Bread<br/>(Whole Meal)</u> | <u>Corn Bread<br/>(Corn Flour)</u> |
|---------------------|------------------|------------------------------------|------------------------------------|
| No. of loaves       | 178              | 156                                | 156                                |
| Total variable cost | 34.73            | 31.65                              | 32.97                              |
| Sales @ 0.20        | 35.60            | 31.20                              | 31.20                              |
| Gross Profit (Loss) | 0.87             | (-0.45)                            | (-1.77)                            |

5.12 It is clear from this comparative data that at a price of  $\text{P}16.50$  per bag for corn, the production of corn bread using either the whole meal or the corn flour is likely to lead to a loss by the enterprise. Therefore the price of  $\text{P}12.00$  per bag as calculated from the theoretical point of view may not carry too high a margin of error.

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<sup>6</sup> Data refined from - Interim Report on corn bread.



## 6. DISCUSSION

- 6.1 It would appear from the foregoing presentation that the proposal to encourage the production and sale of corn bread to supplement all-wheat bread is worthy of serious consideration. It carries with it the advantages of providing variety to the diet, encouraging the use of local material, expanding the market for corn, stimulating the primary production of corn and saving the country some foreign exchange.
- 6.2 Since it compares very closely with all-wheat bread and serves as a direct substitution for it, and since it is not an entirely new product, acceptance by the consumer does not offer any serious challenge. Besides, the existing distribution system of all-wheat bread can easily accommodate this line of product on the consumer market.
- 6.3 The most important agent on whom the responsibility of supporting and promoting this proposal lies is the baker, especially the well established bakeries in the big towns that regularly deal in sizeable quantities of bread. These bakeries will initially face the problem of learning and experimenting with the technique, but this can easily be overcome if there is an interest which can only be stimulated by the assurance of good business and profit. The problem of adjustments in organisation will also be overcome for similar reasons.
- 6.4 The assurance required by the baker boils down to the availability and a price of corn which is favourable to the production of corn bread. Until 1972, this country imported considerable amounts of corn, but since then domestic sources have appeared to satisfy demand. The national average wholesale prices of corn for 1973 showed a range between \$13.85 in September to \$24.67 per bag in May. For the period of 8 months from December to July the price was \$16.50 and above. The prices were excessive by corn bread standards.



6.5 At the same time average prices that prevailed in the markets noted for high concentration of supplies as mentioned already, but distant from these bakeries were reasonable at certain times of the year for the production of corn bread. But this situation offers little help due to long distances between these sources and the final point of use.

6.6 For the immediate future, it is unlikely that the production of corn will expand dramatically to make it possible to sustain moderate prices; should that happen, however, it would only be a matter of intense campaign to generate interest in corn bread.

6.7 On the other hand, a serious thought could be given to the feasibility of producing ready-to-use corn flour at a reasonable price as an incentive. It would not only be useful for corn bread but for other food preparations as well. This would divest the baker of the additional burden that existing supplies of corn and the attendant required services would impose.

6.8 It is only when the sources of concentrated supplies of the raw material have been matched with organised manufacturing facilities that an effective impact can be derived from the proposal to encourage the production of corn bread.

## 8. CONCLUSION

8.1 This report leads to the conclusion that under the existing conditions of corn supply and the concentration of bakeries, the price of corn tends to be on the high side to discourage bakers to use it for the production of corn bread. There are however sources distant from the baker that can be tapped for easier prices, but this would require the intermediary of a manufacturer of corn flour.

7.1 APPENDIX I TABLE I

COMPARATIVE QUALITIES OF BREADS FROM  
DIFFERENT COMPOSITE FLOUR SOURCES  
(20% non-wheat flour)

| Type of Bread           | Specific Volume cc/g | Flavour                         | Texture    | Crumb Colour | Taste                     |
|-------------------------|----------------------|---------------------------------|------------|--------------|---------------------------|
| Yam Bread               | 2.6                  | Acceptable                      | Acceptable | Acceptable   | Acceptable                |
| Plantain Bread          | 2.4                  | Unpleasant                      | Heavy      | Dark (Grey)  | Acceptable                |
| Kokonte Bread (Cassava) | 2.4                  | Unpleasant                      | Heavy      | Dark         | Slight bitter after taste |
| Garri Bread             | 2.0                  | Acceptable                      | Heavy      | Acceptable   | Acceptable                |
| Corn Bread              | 3.0                  | Slight rancidity but acceptable | Acceptable | Acceptable   | Acceptable                |

7.2 APPENDIX I TABLE 2

CHEMICAL COMPOSITION OF LOCAL STARCHY CROPS  
(AS % OF ORIGINAL MATTER)

| Starchy Crop                     | Moisture Content % | Crude Protein % | Crude Fat % | Crude Fibre % | Ash % | Ca mg/100g | Pl. mg/100g | Iron mg/100g |
|----------------------------------|--------------------|-----------------|-------------|---------------|-------|------------|-------------|--------------|
| Yam (fresh)                      | 62.4               | 4.2             | 0.6         | 0.3           | 1.4   | 5          | 30          | 1.1          |
| Plantain (fresh)<br>FRI          | 56.7               | 1.3             | trace       | 0.3           | 0.9   | 4          | 29          | 0.5          |
| Kokonte<br>(Cassava) FRI         | 11.5               | 1.4             | 0.5         | 1.2           | 1.9   | 45         | 95          | 1.8          |
| Garri FRI                        | 10.6               | 1.1             | 0.4         | 1.1           | 1.4   | 44         | 76          | 6.6          |
| Corn Meal                        | 12.2               | 9.3             | 3.8         | 1.9           | 1.3   | 17         | 218         | 4.2          |
| Wheat Flour<br>75-80% extraction | 12.2               | 11.0            | 1.3         | 0.4           | 0.7   | 29         | 117         | 4.0          |

7.3 APPENDIX I TABLE 3

COMPARISON OF VALUE OF IMPORTS OF UNFINISHED WHEAT  
AND WHEAT PRODUCTS, AND TOTAL FOOD IMPORTS (1966-1972)  
IN CEDIS

| Year | Wheat Imports | Total Food Imports | Wheat/Total Food % |
|------|---------------|--------------------|--------------------|
| 1966 | 3,339,038     | 47,145,846         | 7.1                |
| 1967 | 6,412,811     | 43,209,792         | 14.8               |
| 1968 | 8,139,755     | 51,012,701         | 16.0               |
| 1969 | 7,116,690     | 55,178,092         | 12.9               |
| 1970 | 6,393,219     | 79,474,163         | 8.0                |
| 1971 | 3,582,211     | 62,589,888         | 5.7                |
| 1972 | 8,736,786     | 72,221,394         | 12.1               |

Source: Central Bureau of Statistics. External Trade Statistics of Ghana, 1966-1972.



Appendix II

7.4 PROCESSING PROCEDURE

The yeast was dissolved in about a cupful of water. The sugar and salt were dissolved in the rest of the water. All the ingredients were then mixed together in an electric mixer for 15 minutes. The time of mixing would depend on the type of mixer but it should be obvious to the experienced baker when the dough is thoroughly mixed. After this, the dough was cut, scaled, moulded and panned immediately. It was then fermented (in cupboards in this case) at 28°C - 29°C for 4 hours after which time the bread was baked in a fairly hot oven for 30-40 minutes. The traditional oven was used in this work and although it was not possible to take the temperature of the oven, it was observed that a temperature slightly higher than what is normally required for a 100% wheat bread was necessary to bake this type of bread.

After baking the loaves were left for 3 hours to cool before they were packaged in polyethylene bags.

VARIABLE PRODUCTION COSTS (ALL-WHEAT)

|                    |               |
|--------------------|---------------|
| 100lbs Wheat Flour | ø27.30        |
| 1lb Margarine      | 1.00          |
| 4½lbs Sugar        | 1.00          |
| 2lbs Salt          | 0.07          |
| 3oz Yeast          | 0.28          |
| Other Supplies     | 4.10          |
| 1.78 Plastic Bags  | <u>0.98</u>   |
|                    | <u>ø34.73</u> |

VARIABLE PRODUCTION COSTS (CORN FLOUR)

|                   |               |
|-------------------|---------------|
| 80lbs Wheat Flour | ø21.84        |
| 26lbs Maize       | ø3.00         |
| Processing        | <u>0.90</u>   |
| 20lbs Corn Flour  | 3.90          |
| 1lb Margarine     | 1.00          |
| 4½lbs Sugar       | 1.00          |
| 2lbs Salt         | 0.07          |
| 3ozs Yeast        | 0.28          |
| Other Supplies    | 4.10          |
| 156 Plastic Bags  | <u>0.78</u>   |
|                   | <u>ø32.97</u> |

VARIABLE PRODUCTION COSTS (WHOLE MEAL)

|                   |               |
|-------------------|---------------|
| 80lbs Wheat Flour | ø21.84        |
| 20lbs Maize       | ø2.30         |
| Processing        | <u>0.28</u>   |
| 20lbs Corn Meal   | 2.58          |
| 1lb Margarine     | 1.00          |
| 4½lbs Sugar       | 1.00          |
| 2lbs Salt         | 0.07          |
| 3ozs Yeast        | 0.28          |
| Other Supplies    | 4.10          |
| 156 Plastic Bags  | <u>0.78</u>   |
|                   | <u>ø31.65</u> |