

FOOD RESEARCH INSTITUTE



BREADMAKING IN GHANA WITH SPECIAL

REFERENCE TO COMPOSITE FLOURS

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1. ABSTRACT

Although wheat is not a cereal that is cultivated commercially in Ghana, the consumption of wheaten bread and the art of breadmaking have been known to Ghanaians since contact was established with a series of European nations in the then Gold Coast around the 15th Century (1). Today, the breadmaking industry occupies a significant place in the food manufacture sector and the consumption of bread is on a sharp increase.

Through a survey conducted on the local bakeries, this paper provides information on wheat consumption, equipment, techniques, major ingredients used by the bakeries and the type of bread manufactured. Chemical, rheological and baking properties of market samples of wheat flour are also given.

The final part of this work deals with studies on the prospect for the manufacture of composite flour bread (Corn bread) by the Ghanaian baker.

2. INTRODUCTION

2.1. Bread/Wheat Consumption

Bread consumption in Ghana has risen sharply over the years and is reported to have risen more than 100 percent between 1950 and 1960⁽¹⁾

It has always followed the pattern of wheat imports since bread is the major product manufactured from wheat in Ghana. Wheat imports in recent years have been fluctuating, although demand has steadily risen. Until a few months ago, there was no government controlled price per unit weight of bread. On occasions when the local wheat stocks were low, the retail price of bread shot up as much as three times the usual price, even though wheat flour was sold at the usual controlled prices.

Table 1 ⁽²⁾ shows a sharp drop in wheat imports after 1975 until 1978 when import figures rose due to food aid in the form of wheat grains, which were received from some friendly countries. For the past five years or so, wheat imports have not been based on demand alone, but also on resources available at any one particular time, taking into account other needs of the nation. Import figures, therefore do not portray a true picture of demand for bread and other wheat-based foods.

TABLE I
WHEAT IMPORTS, 1974 - 1978 (2)

YEAR	QUANTITY	VALUE ₵
1974 (cwt.)	2695998	25005358
1975 (cwt.)	1637068	22452073
1976 (Hun.kg.)	889817	23081422
1977 (Hun.kg.)	976013	23335781
1978 (Hun.kg.)	1696302	30350144

With the increase in bread consumption, breadmaking as an industry has proliferated in all parts of the country. Levels of operation vary widely in capacity and types of equipment used.

2.2 Survey

Information contained in this paper was collected by the author during various assignments with the bakery industry from 1975 to 1981. Data was collected in Tamale in the Northern Region, Saltpond in the Central Region and Accra the capital. In all, 50 bakeries were visited in the three regions.

3. THE BAKERY INDUSTRY

Unpublished data on bakeries in Accra and Tema metropolitan area indicates that there are a total of 6668 registered bakeries, excluding other flour users such as biscuit manufacturers, caterers dough-nut and macaroni makers.⁽³⁾ These bakeries fall into three sizes of operation, namely the large scale, the medium scale and the small-scale with optimum individual capacities of 100, 50 and 10 bags of flour (45.4kg each) per week respectively.

The small scale bakeries make up 78 percent of total number of bakeries in these two towns and are reported to have handled during 1980-81 56 percent of total flour supplied to the industry. The medium and large scale operations make up 21 percent and 1 percent of total number of bakeries respectively. A significant quantity of flour output was also handled by the medium scale operations (34 percent) while the large scale bakeries handled only 10 percent of flour output.

Capacity utilization ranged from 50 - 67 percent for the large-scale, 25 - 67 percent for the medium scale and 33 - 100 percent for the small bakeries during 1980-81.

4. BREADMAKING IN GHANA

4.1 Wheat Flour

With the exception of what comes as food aid, there is a government ban on wheat flour importation. Medium/Strong flour for breadmaking is the only type that is milled locally by the three flour mills. The quality of wheat flour available on the market has been found to vary considerably from time to time. Table 2 (4) shows quality characteristics of ten samples of flour purchased from markets in Accra. Optimum specific volume of bread baked from these flours ranged from 3.5 - 5.0 cc/g.

TABLE 2
SOME QUALITY CHARACTERISTICS OF MARKET
SAMPLES OF WHEAT FLOUR

QUALITY FACTOR	MEAN VALUE	RANGE OF VARIATION	COEFFICIENT OF VARIATION * (Percent)
Moisture Content + (Percent)	11.8	10.5-13.1	5.9
Protein Content + (No. 5, 7; percent)	12.4	11.2-13.2	5.4
Ash Content + (percent)	0.65	0.54-0.85	21.6
PH +	5.8	5.5 - 6.1	12.6
Wet gluten (Percent) +	36.3	29-43	14.0
Hegberg falling.No. (s)	287.4	254-319	7.8
Waterabsorption : (percent)	56.3	50.6-62.5	6.1
Arrival Time (min)	1.3	0.9 -1.9	23.6
Dough Development . time (min)	2.7	2.1 - 3.5	17.9
Dough Stability . (min)	9.8	7.5 - 12.5	19.6
Mixing tolerance . index (BU)	111.9	70.0-150.0	24.6

* Standard deviation X 100
Mean

+ A.A.C.C. (1962)

. Brabender Farinograph

4.2 Breadmaking ingredients

The basic breadmaking ingredients are wheat flour, activated dry yeast, crude salt, sugar and water.

Optional ingredients are bakery fat, baking powder, nutmeg, yellow food colour, butter flavour, eggs and evaporated milk.

4.3 Types of bread

Table 3 shows the different types of bread that are known to the Ghanaian consumer and levels of ingredients used in each type. More than ten types of bread including bread made from composite flours are known in Ghana. These include :- Tea bread, sugar bread butter bread, Milk bread, and brown bread.

4.4 Breadmaking Processes

4.4.1 Straight Dough Method

The most common breadmaking method that is used is the straight-dough method in which all ingredients are measured and mixed together into a dough. The dough is then rested for 20-40 minutes after which time it is scaled and moulded for final proofing.

4.4.2 Mechanical Dough development method

Dough sheeting rolls are used to develop the dough after mixing and bulk fermentation. This technique was very popular with the large-scale bakeries about two decades back but is now used by only a few. After the dough is mechanically developed, it is rested moulded and left for the final proofing.

4.4.3 Final Proofing

Final proofing time ranges from 4 - 18 hours among the bakeries. One important feature which was observed is the exceptionally long final proofing which is generally practiced by the majority of the bakeries. Final proofing is generally done overnight at room temperature.

* The flow diagrams for the two methods of breadmaking are shown in Figs. 1 & 2."

COMPONENTS OF SOME TYPES OF BREAD THAT ARE KNOWN IN GHANA

Type of Bread	Loaf Specific Volume (ml/g)	Flour (% weight)	Major Ingredients (% of flour wt.)			
			Granulated Sugar	Activated Dried Yeast	Bakers Fat	Crude Salt
Tea Bread	4.5 - 5.8	Wheat flour 100%	0.0 - 3.0	0.001-0.070	Nil	2.0 - 2.7
Butter Bread		Wheat flour 100%	2.0 - 7.0	0.001-0.070	1.0 - 2.0	1.5 - 2.0
Sugar Bread		Wheat flour 100%	8.0 - 17.0	0.004-0.200	0.0 - 3.0	0.8 - 1.0
Milk Bread	3.8-4.2	Wheat flour 100%	2.0 - 7.0	0.001-0.070	1.0 - 2.0	1.5 - 2.0
Brown Bread		Bran meal 10-25% Wheat flour 75-90%	2.0 - 3.0	0.200-0.300	1.0 - 2.0	1.5 - 2.0
'Corn Bread'	3.5-4.0	Wheat flour 80-95% Maize Meal 5-20%	2.0 - 3.0	0.200-0.300	1.0 - 2.0	1.5 - 2.0
'Cassava Bread'	3.5-4.0	Wheat flour 90-95% Cassava flour 5-10%	2.0 - 3.0	0.200-0.300	1.0 - 2.0	1.5 - 2.0
* 'Cocoa Bread'	4.0-4.5	Wheat flour 100% Cocoa Powder 5%	8.0 - 17.0	0.004-0.200	1.0	0.8-1.0
'Russian Bread'	3.5-4.0	Rye flour → Wheat flour →	-	-	-	-

* Cocoa Bread is sugar bread flavoured with cocoa powder

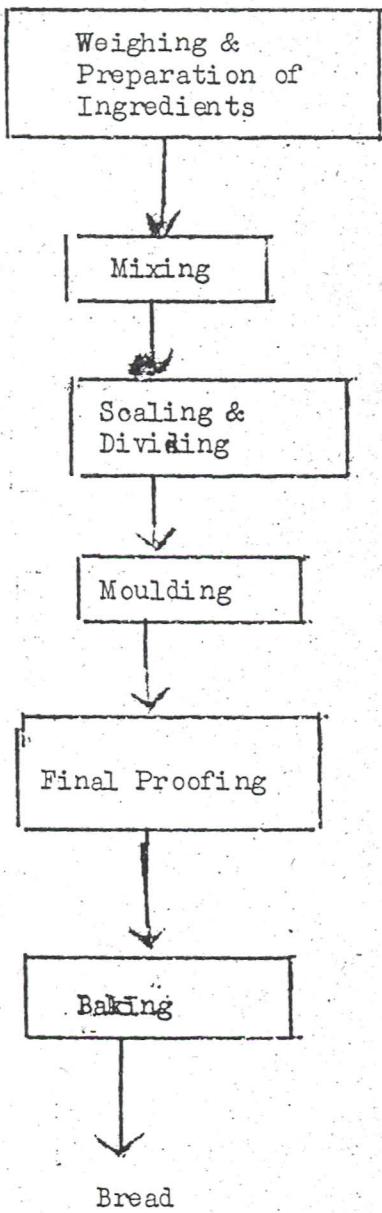


Fig.1 Breadmaking by the Straight-dough method

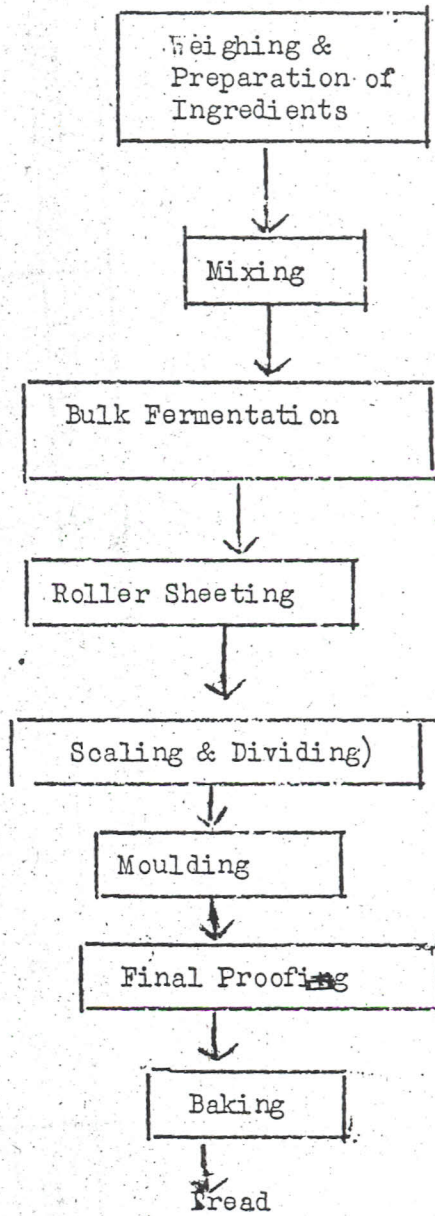


Fig.2 Breadmaking by the Mechanical Dough-Development Method.

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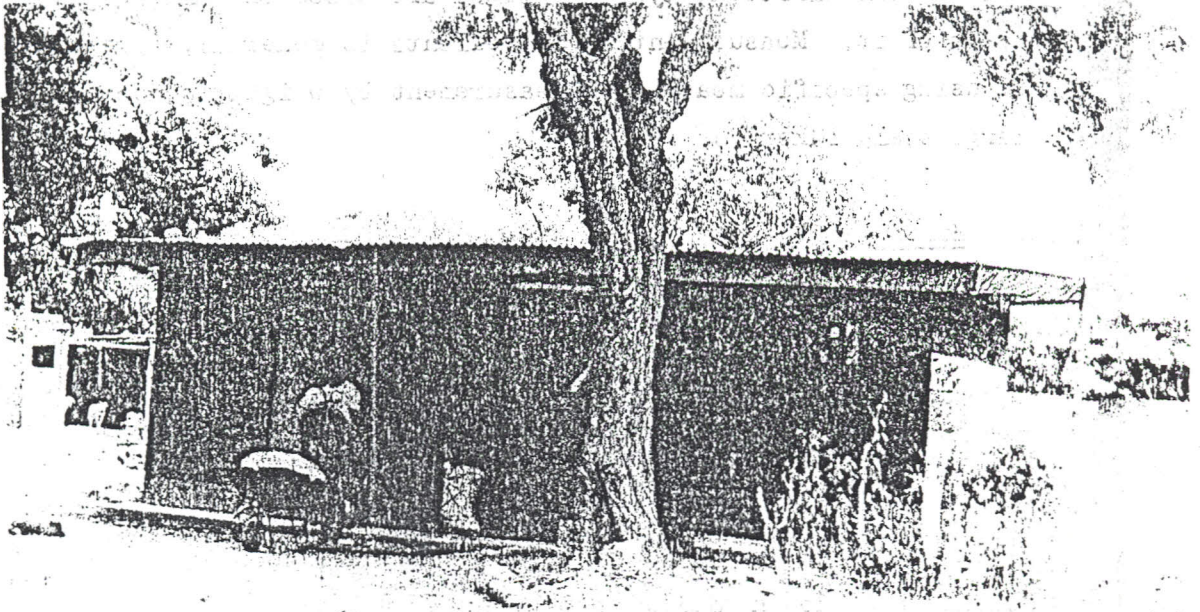


FIG. 1: DOUGH MIXING HOUSE

These centres provide dough mixing services to bakers for a fee. They also provide an-lam- storage facilities for customers' flour.

4.5 Choice of Technology

4.5.1 Measurement of Ingredients

Wheat flour, the major ingredients, is bagged at 45.4kg weight. Recipes for the different types of bread are based on this weight or multiples of it. Measurement of ingredients is generally done by the volume using specific measures. Measurement by weight is done only by the large scale bakeries.

4.5.2 Mixers

Dough mixing and kneading is largely mechanised using mainly the vertically rotating open pan mixers. These mixers are mostly locally made with capacities ranging from 10 - 90kg per batch. Repairs and maintenance are efficiently done with locally fabricated spare parts. They are operated by either electric or diesel powered motors.

One unique development during the last two decades, is the establishment of dough mixing centres both in the rural and urban towns. These centres provide service for a fee to the small scale baker who does not own a dough mixer (This is mostly the case with the small scale baker, as shown by Table 5). Storage space for the flour of customers (in bags) is provided by the mixing centres which may or may not be physically attached to a bakery. Table 4 gives more information on some dough mixing centres in Tamale, a principal town in the Northern Region of Ghana.

8a.

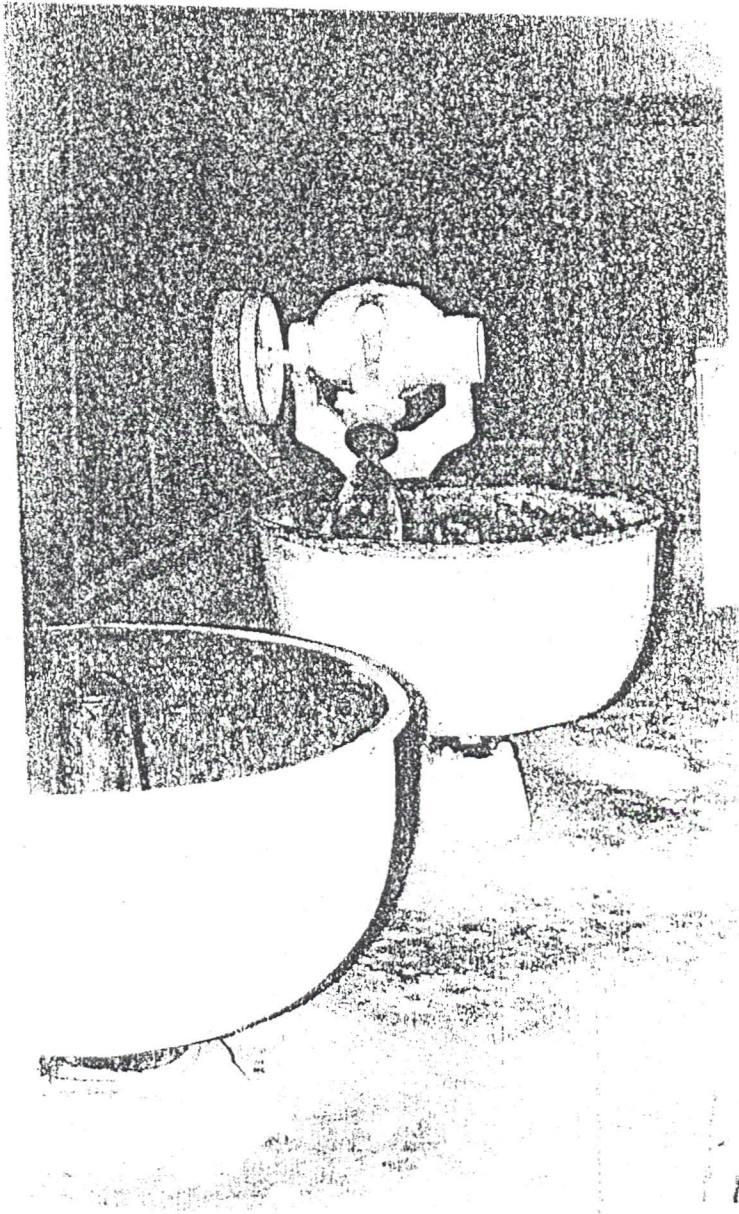


FIG. 11 ROBEY & CO. PATENT

This is the most common type of toilet in the most parts of the country. This type of toilet is locally manufactured (water is imported).

TABLE 4
INFORMATION ON DOUGH MIXING
CENTRES IN TAMALE

Mixing Centre	No. of Mixers	Capacity of Mixers (Bags of flour)	Source of power	No. of Operators	No. of Bakers Served	Country of Manufactures
A	2	1 each	Electric	4	10	Local
B	1	1.5	Electric	1	6	Local
C	3	1 each	Diesel	6	15	Local
D attached to Bakery	2	1.5 and 1	Electric	2	6	1 Local 1 Yugoslavia
E	1	1.5	Diesel	1	10	Local
F	2	1.5	Diesel	2	25	Local
G	1	1.5	Diesel	1	8	Local

10

TABLE 5
CHOICE OF TECHNOLOGY AMONG THE THREE SIZES
OF BAKERIES) (A total of 50 bakeries were visited)

	Large Scale	Medium Scale	Small Scale
No. of Bakeries	10	15	25
Dough Mixers	10	15	Nil
Roller Sheeters	2	Nil	Nil
Mechanical Moulders	2	2	Nil
Evens	Multiple deck	4	Nil
	Improved Traditional	6	9
	Traditional	Nil	6
			25

9.a

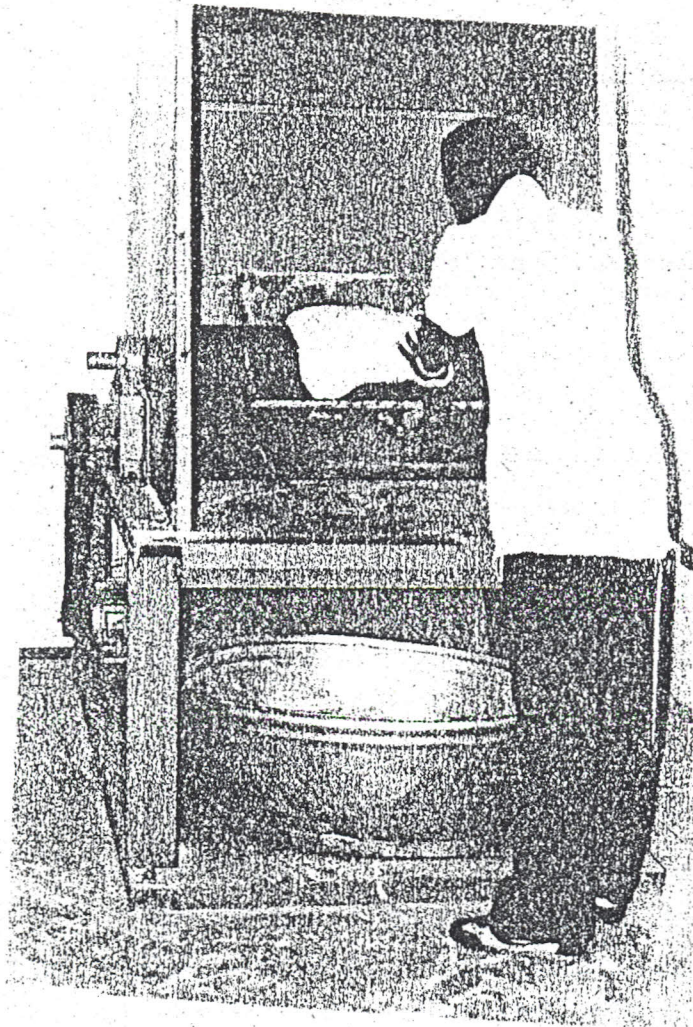


FIG. 111: ROLLER SHEETING MACHINE

This equipment, used for dough development, is found mainly in the large scale units.

4.5.3 Dough Sheetting Rolls

These are used to stretch the dough several times in order to develop it. They are operated by electric powered motors and have a capacity of about 35kg of dough per batch. They ^{are} mainly locally manufactured these days from steel pipes.

4.5.4 Scales and Dividers

Scaling and dividing of dough is generally done by visual assessment and cutting by hand with knives. This practice was observed at all levels of operation in all the regions covered by the survey. Only a handful of the large scale bakeries use scales and manually operated dividers. (see Table 5)

4.5.5. Dough Moulders

Hand moulding is the most predominant method used even among the large scale operations. It was observed that human labour is very much pronounced in this step of breadmaking. (Table 5)

Some small scale bakeries in Accra use the services of roving professional bakers who move from bakery to bakery to do hand moulding for a fee.

Mechanical moulders, electrically powered in all cases, are used by very few bakeries, mainly in Accra.

4.5.6 Proofing Cabinets

Wooden cupboards with shelves are used as proofing cabinets. The big bakeries have fermentation rooms with wooden shelves on which final proofing is done. Since room temperatures are generally high, no heating systems are used for dough proofing.

4.5.7 Baking Ovens

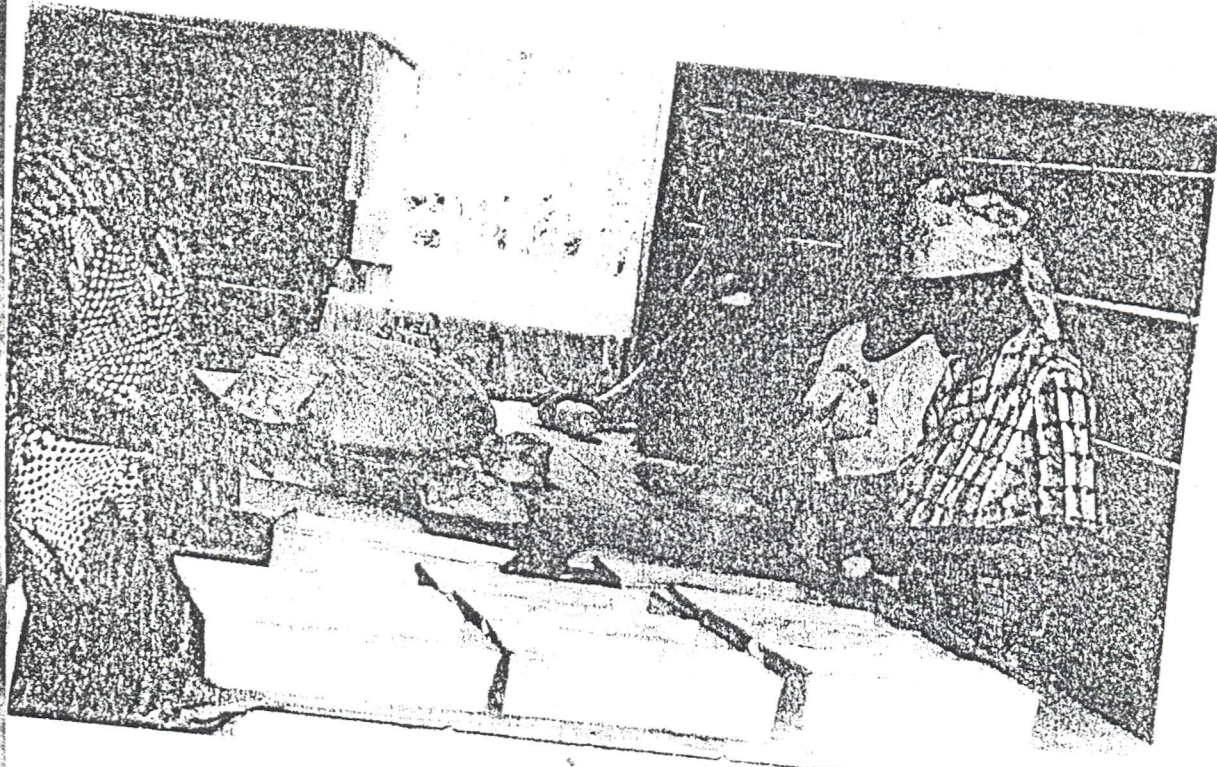
The dome-shaped traditional peel ovens are the most predominant type used in all parts of the country. It is estimated that about 90 percent of total bread output is baked in this type of oven.

Various other types of oven are also in use and all of these can be divided into 2 main groups:

4.5.7.1 Traditional Baking Oven

The traditional peel type ovens are built with burnt bricks or mud into a dome-shaped chamber with one opening. Sizes of such ovens range from capacities of 20-70kg of loaves per batch (loaf sizes of about 400g each). Sometimes up to 4 such ovens are found in one bakery. Firewood is the only fuel used in these ovens;

10a.



ART. IV: AND HOLDERS OF DUGH

Dough moulding is generally done by hand
in the line of operation.

106.

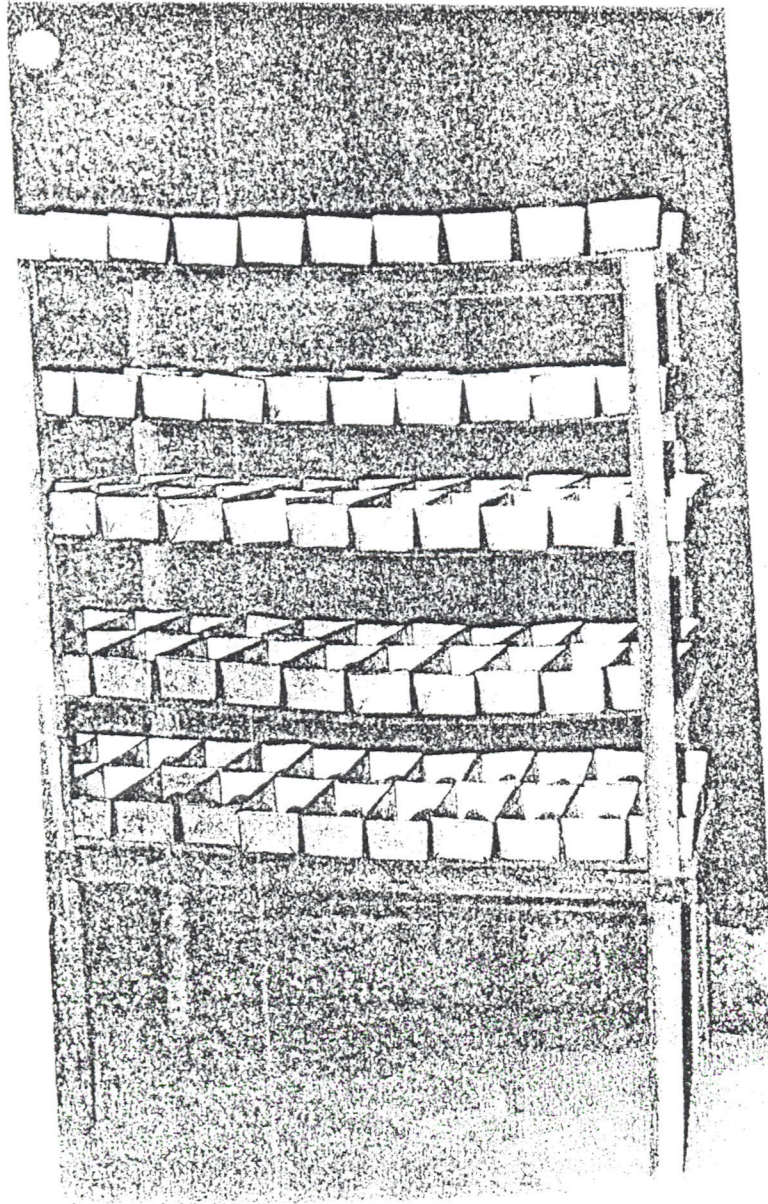


FIG. V : PANNED DOUGH ON RACKS, READY TO BE
COVERED FOR FINAL PROOFING.

It is fed through this opening, ignited and allowed to burn till the right temperature is attained. The embers are then raked out and the oven is allowed some time to have even distribution of heat before baking is started. The loaves are then fed individually by means of a long-handled wooden shovel or a 'peel' through the opening into the hearth. Since the loaves that enter the oven first come out last, the usual practice is to load the oven first with bigger loaves which need higher temperatures and then follow these with smaller-sized loaves until the oven is full. This ensures that the smaller loaves have shorter baking time and makes up for the "first in, last out" short-coming of this type of oven. During baking, the opening is covered with a piece of wood which in turn is covered with wet jute bags.

A number of improved versions of the traditional oven have been developed over the years. One such improvement has a shelf in the oven and so increases capacity utilization⁽⁵⁾.

4.5.7.2 Multiple Deck Oven

This type of oven is found only in the large scale operations and all such ovens found have total capacities of taking 420kg of loaves (400g per loaf). They are multiple decked, with three separate chambers each with independent temperature control. These ovens are built to use either electricity or firewood for heating but all the 4 encountered in the survey were using firewood as fuel.

The heating chamber in these ovens are at the back of the oven which is also at the back of the bakery. Heat is conducted from the heating chamber to the three baking chambers.

Other versions of the multiple deck ovens are fired by diesel^{oil} or gas.

4.5.8 Cooling and Packaging

Cooling of baked loaves is usually done on wooden racks or trays after which bread is packaged in polythene bags.

4.5.9 Sources and Utilization of Energy

4.5.9.1 Sources

Energy sources for the baking industry in Ghana, vary, depending on the situation in each environment. The major sources are electricity, ^{Liquefied Petroleum Gas} diesel oil and firewood. The different types of energy source used for the various equipment

11a.

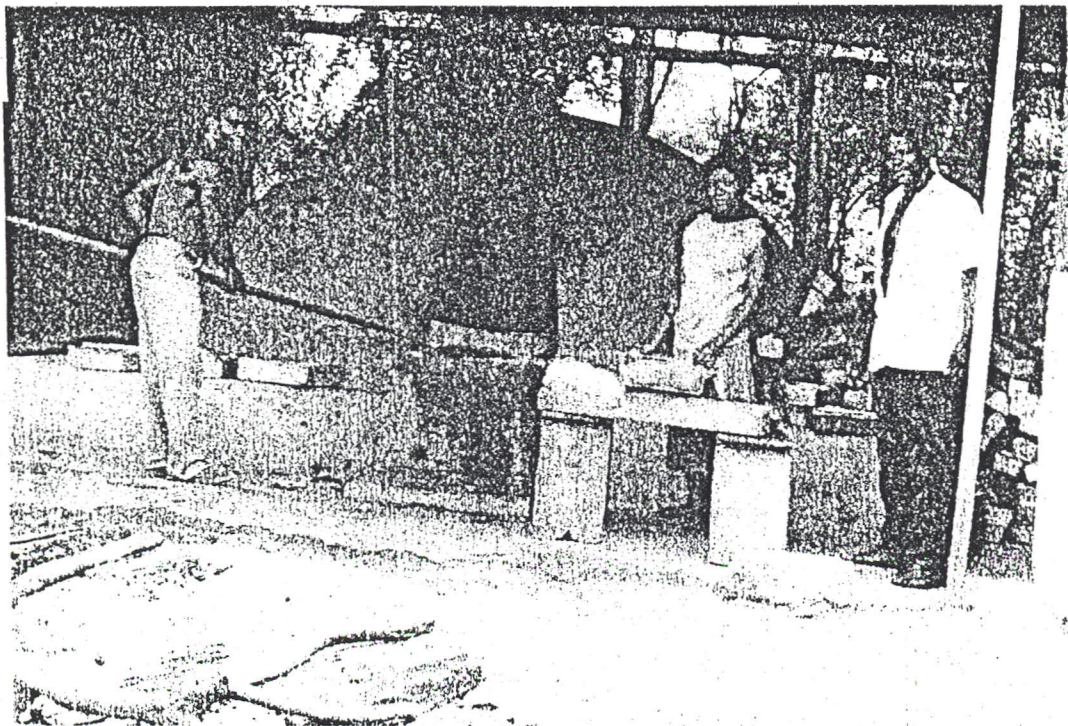


FIG. VI : UNLOADING OF BAKED LOAVES OF BREAD
FROM A TRADITIONAL OVEN.

11.6.

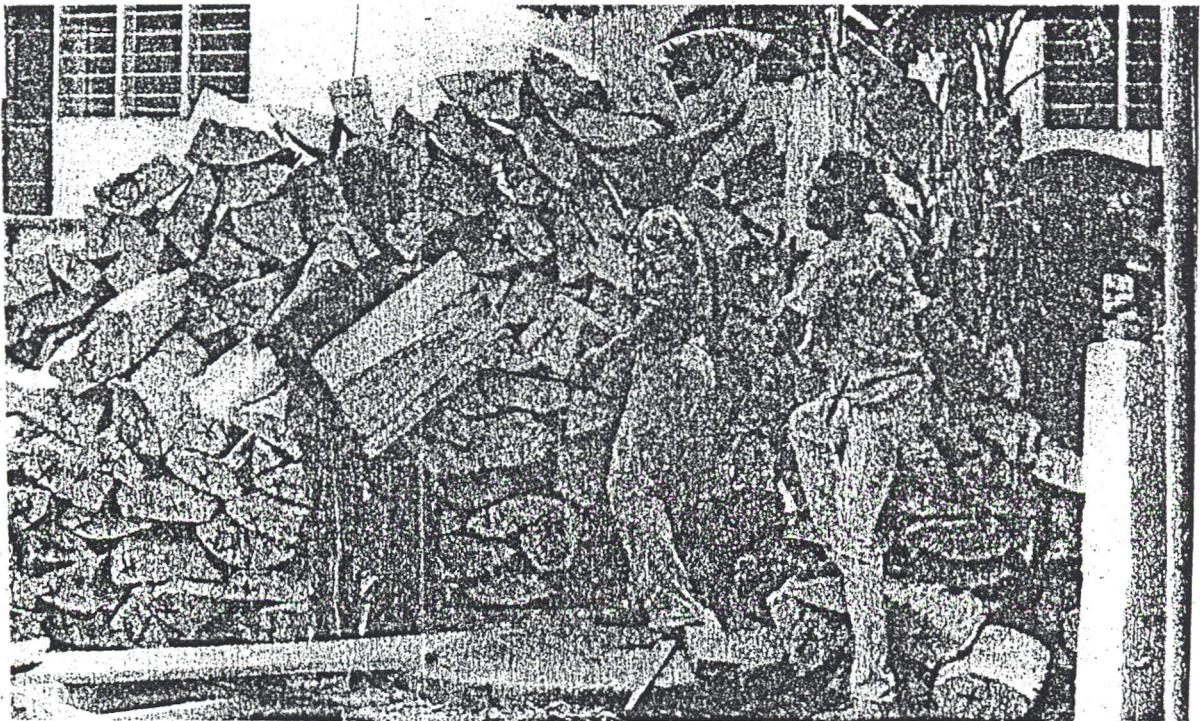


FIG. VII : A STACK OF FIRE-WOOD

Firewood is stock-piled to ensure regular supply of fuel.

have been discussed already.

Most dough mixers in the rural areas use diesel motors. And in those urban areas where electric power cuts and power fluctuations are common, diesel operated mixers are preferred.

Gas~~oline~~^{oil}, gas and electric fired ovens can be found in Accra and some urban towns. However, for all sizes of operations in all localities (both urban and rural), firewood is preferred as a source of fuel for oven firing. This is because it is thought to be more reliable since its availability can be managed even though it is sometimes very expensive and scarce, especially in the rainy season.

According to the 1979 survey by UNDP resident representatives, an energy crisis faces 2,000 million people mostly in the rural areas of developing countries where wood and charcoal together with agricultural residues remain the predominant if not the only fuel⁽⁶⁾.

National forestry policies should therefore give priority to production of fuel-wood, a renewable energy source.

4.5.9.2 Utilization

Efficiency of heat utilization in the traditional ovens is very low owing to their very poor heat retention capacity. A lot of heat is lost through the walls of the oven. In the face of mounting energy costs, every effort should be made to conserve energy, by cutting down on wastage.

The heat retention capacity of some of these traditional ovens have been increased in some improved types. The sole (i.e the foundation) of these ovens is packed with about 50cm of crude salt which has a good heat retention power and so acts as a heat reservoir. This allows 4 batches of bread to be baked without reheating the oven.

However, more improvements are needed to achieve better utilization of energy.

4.5.10 Social Aspects

The small-scale bakeries which make up a greater portion of the industry, even in the urban areas (78% in Accra) are almost entirely made up of women. The last census, held 20 years ago, recorded over 19,000 women bakers.

12a.



FIG. VIII: LOAVES OF BREAD IN DIFFERENT SHAPES

5. COMPOSITE FLOURS

5.1 Types of Composite Flour Bread

Ghanaian consumers have been exposed to bread made from composite flours as far back as the late thirties. Levels of the different flours used in the different types of bread known in Ghana are indicated in Table 3.

5.1.1 'Corn Bread' made from maize flour and wheat flour, was introduced into Ghana during the 2nd World War and is the most popular of all the other types of composite flour bread. Over the years, corn bread usually appeared on the markets during harvesting time for maize when the price of this cereal is reasonably low.

5.1.2. 'Russian Bread' made from a mixture of rye and wheat flours, was very popular in the mid sixties. The composite flour was imported from the Soviet Union and distributed to state-owned bakeries which produced the type of bread.

5.1.3. 'Cassava Bread' During 1973-74 the concept of import substitution was given a wide coverage in the mass media. Wheat imports and the use of local starchy materials in breadmaking was one of the areas that drew a lot of attention. Bread made from Cassava flour or gari, and wheat flour mixture emerged on the Ghanaian market during this period.

5.1.4. 'Sorghum/Millet Bread' In the course of the survey it was found that a few bakeries in Tamale (in the Northern Region) produced millet and sorghum bread. This made up about 5% of total bread output of each bakery and was made on order. The two cereals are major staples produced in the Northern Regions.

5.1.5. 'Cocoa Bread' The government of Ghana launched a campaign in 1977 to encourage and increase local utilization and consumption of cocoa products. One of the products which was developed during this period was cocoa bread. This was sugar bread flavoured with defatted cocoa powder (Table 3).

5.2 Research Studies

Studies on the use of local starchy crops for breadmaking started in 1966 at the Food Research Institute (7), materials used in these studies were plantain, gari, cassava, yam, cocoyam and maize flours. The general aim of the work was to determine to what extent the blending of wheat flours with other non-wheat flours affects the baking quality of wheat flours. Levels of up to 33% of each diluent were used to replace wheat flour.

Our results indicate that dough and loaf characteristics are affected in the following ways:

5.2.1 Brabender Farinogram studies indicate that percent water absorption is increased in all cases except when plantain flour is added to wheat flour.

5.2.2. Dough development time is generally reduced except in cases when mixtures contained yam flour or unsoaked gari.

5.2.3 With the exception of yam flour, all other starchy non-wheat flours have a weakening effect on the strength of wheat dough.

5.2.4 Studies on gas production show that addition of starchy non-wheat flours to wheat flour reduces both total gas produced and gas retained in the dough.

5.2.5. Optimal total fermentation time for wheat dough is reduced by the addition of starchy non-wheat flour. Fermentation tolerance is thus reduced.

5.2.6 Baking Tests indicate that with the exception of yam flour, loaf volume is reduced by addition of starchy non-wheat flours. This confirms finding in 5.2.4.

5.2.7 Results of work on protein enrichment indicate that with the exception of raw full-fat soya flour, other forms of preheated defatted soya had deleterious effect on breadmaking potential of wheat flour.

5.3 Production and Marketing Studies were done in 1973-74

5.3.1. Pilot Studies concentrated on production of 'corn bread' at the **commercial scale (8)**. Facilities of a commercial roller mill (used for corn starch production) were used to produce flour from two varieties of locally cultivated maize i.e. yellow, and Ohawa (a local white variety).

The yield of flour was low (50%) with the yellow maize which was slightly flinty in texture. The white maize Ohawa, is dent type with very soft and floury endosperm. This gave a slightly higher yield of flour (55%).

5.3.2. Trials of 'Corn bread' production were carried out at a commercial bakery with a capacity to process 90 kg of wheat flour. Levels of up to 3% maize flour were used to replace wheat in the bread. ^{batch}

5.3.3. Consumer Acceptance of the bread indicated that 'corn bread' with 20 per cent maize flour is highly acceptable - 94 percent favourable response to quality attributes such as colour, external appearance, flavour and taste.

5.3.4. A favourable market prospect for 'corn bread' in terms of price was also indicated when it was sold at the same rate as all-wheat bread.

5.3.5. Three groups of Bakers Co-operative were instructed by demonstration to prepare 'corn bread'. Very high enthusiasm was initially shown by the bakers in all three groups. After about three trial ^{baking} follow up visits indicated that the bakers did not find the production of 'corn bread' economically attractive for the following reasons:

- There is no industrial production of Maize Flour and other non-wheat flours in Ghana. These flours are therefore not available to the bakers in ready - to-use form as is the case with wheat flour. Each baker has to prepare his/her maize flour requirement at a service mill and this is found very inconvenient.
- The prices of locally produced crops are much higher than the price of imported wheat. The use of composite flours prepared from local materials is therefore not economically attractive to the bakers.

6. CONCLUSIONS

6.1 Breadmaking

6.1.1 The level of technology employed in breadmaking in Ghana is mostly traditional in the rural areas and intermediate in the urban areas.

6.1.2 Most equipment are locally manufactured. Repair and maintenance are effectively done with local skills and materials.

6.1.3 The type of skills required in the industry (including management skills) are simple and readily available even in the rural areas.

6.1.4 Two main operations, dough moulding and baking, were identified as highly labour intensive. This observation was made with respect to all levels of operation.

6.1.5 Selection of sources of energy differs in different parts of the country (and sometimes within the same township) and is based primarily on consistent availability of the source.

6.1.6 Energy wastage in firing of traditional ovens is very high due to low heat retention capacity. A lot of work needs to be done towards improvement of these ovens.

6.1.7 Firewood is the predominant fuel used, at all levels of operation, for firing of ovens.

6.2 Bread From Composite Flours

6.2.1 'Corn bread', which is familiar to a lot of people, is highly acceptable to most consumers. It is envisaged that consumer acceptability of bread from composite flours would not pose much problem if a well planned consumer education is carried out in a national programme on composite flours.

6.2.2 The manufacture of bread from composite flours is not economically attractive to the Ghanaian baker, mainly because the prices of locally produced diluents for wheat flour are high.

7. RECOMMENDATIONS

7.1 The traditional baking oven has to be improved to increase heat utilization efficiency.

7.2 Firewood, the major fuel that is used in firing the traditional ovens (in fact, the main fuel for other uses in the rural areas) is getting scarce and very costly. National policies on forestry should, therefore, treat the production of fuel-wood as a top priority.

7.3 Government policies on pricing of wheat, locally produced crops, and bread should be such that they encourage incorporation of non-wheat flours in bread.

7.4 Along side efforts to commercialize utilization of non-wheat flours in bread as a means of reducing foreign exchange expenditure on wheat imports, studies should be carried out on the development of traditional foods to compete with or replace bread.

7.5 Increased production of locally cultivated crops is a must, in order to achieve successful implementation of a national programme on composite flours.

8. ACKNOWLEDGEMENT

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