Effect of cassava starch on the strength of wheat flours milled in Ghana and their use in biscuits

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SUMMARY

A study was made, on a laboratory scale, of the extent to which locally milled strong flours can be softened with cassava starch for use in biscuit and cake manufacture. The effect of starch at levels of 10, 25 and 50% (flour weight) on dough characteristics was determined with a Chopin Alveograph. The strength of two commercial brands of wheat flour tested was reduced as the level of starch increased. Baking tests and taste panel results showed that a flour mixture containing 10% starch produced biscuits and cakes with the best external and internal characteristics.

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RÉSUMÉ

ANDAH, ABIGAIL: *Effets de l'adjonction de fécule de manioc aux farines de blés durs produites au Ghana et son usage en biscuiterie et pâtisserie.*

Une étude a été faite, à l'échelle du laboratoire, pour savoir dans quelle mesure des farines de blés durs moulues au Ghana peuvent être rendues plus tendres par l'adjonction de fécule de manioc, afin d'être utilisées pour la fabrication de biscuits et de gâteaux. Les effets de l'adjonction de fécule dans la proportion de 10, 25 et 50% (poids de farine) sur les qualités de la pâte ont été déterminés au moyen de l'extensimètre de Chopin. L'élasticité de la pâte produite par deux marques commerciales de farine de blé essayées a été réduite d'autant plus que la quantité de fécule mélangée avec elles a été plus grande. Les essais de cuisson et les moyennes des appréciations organoleptiques ont montré qu'une farine mélangée à 10% de fécule donnait des biscuits et gâteaux offrant les meilleures caractéristiques externes et internes.

Introduction

There are different types of biscuits, and the biscuit manufacturer needs different types of flour for the various kinds. It is reasonable to make the broad generalization that a soft or weak flour (softer than flour for bread manufacture) is required for most biscuit products (Kent-Jones & Amos, 1967; Matz, 1968). For instance, a weak flour is required for shortbread, biscuits, cakes and sponge goods (Daniel, 1963; Fance, 1966).

However, where soft flour is unavailable, starches are sometimes used in the biscuit industry to modify the characteristics of strong wheat flour. Sweet goods including biscuits and cakes, require flour with a protein content of about 7% to give the proper texture and eating qualities; therefore, 5–15% of flour weight may be made up of added starch (Hahn, 1969).

The three flour mills now operating in Ghana produce only strong flour for breadmaking. The aim of this project was to find the extent to which the locally milled 'strong' flours can be 'softened' with cassava starch.

Materials and methods

Two samples of each of two brands of flour were purchased in the market. Analytical data of these flours can be found in Tables 1 and 2 (A.A.C.C., 1962). Mixtures of each brand of flour and cassava starch were prepared at the levels of 0, 10, 25 and 50% starch. Cassava starch at *p*H 6·4 was prepared in the laboratory from fresh cassava. The starch content was 82·0% and the moisture content 10·3% (Pearson, 1970).

An imported 'soft' flour with 7·8% protein content (N × 5·7) and 11·3% moisture was used as a control flour.

Particle size tests

The particle size distribution of the two brands of flour was determined by sieving 30 g flour for 5 min on a nest of sieves using a Simon Laboratory sifter (S.C.C., 1963).

Physical dough tests

Alveograms of the mixtures of flour and starch were determined with a Chopin Alveograph at a temperature of 25°C.

These curves give an indication of the effect of various levels of starch on the rehological properties of dough. By means of a planimeter, the area of the curvature in square centimetres was obtained. It is generally held that this area gives a good indication of the baking strength of the flour. 'Strong' flours give curvatures of large area, while 'soft' flours give curvatures of small area. The peak height 'P' is measured in millimetres and it is found that this height corresponds approximately to what the baker terms 'stability' of dough. The length of the baseline 'L' is measured in millimetres and this gives a measure of the extensibility of the dough.

Baking performance test for cookies

The 'strength' of a flour affects the cookie-spread ratio: diameter/thickness and appearance. 'Strong' flours tend to produce smooth cookies with very little spread whilst 'soft' flours produce cookies with more spread.

The suitability of the flour and starch mixtures for the preparation of cookies or biscuits was determined using laboratory method 10–15 of A.A.C.C. (1962). Each baking test was carried out twice. Six cookies were laid edge to edge and the diameter (width) was measured to the nearest millimeter. Each cookie was rotated 90° and the diameter was measured again. The average was the 'Diameter' (D). Six cookies were stacked and the height was measured to the nearest millimetre. The 'Thickness' (T) was the stack height. The cookie-spread ratio (D/T) was determined for each flour and starch mixture. The texture, colour and flavour of each group of cookies was assessed by a panel of 6 tasters.

Baking performance test for cakes

Kissell (1959) has given a lean-formula for cake as follows:

Ingredient	*Quantity*
Cake flour	150 g
Sugar solution	212 cm³
Shortening (Emulsified)	41·8 g
Baking powder	7·1 g
Distilled water	55–95 cm³

*3 000 g granulated sugar dissolved in 450 cm³ hot distilled water. Solution has specific gravity of 1·340.

Kissel's lean formula cake method was used to determine the suitability of the mixtures for cake production. This method presents a basic formula from which all structure-producing ingredients except flour are excluded. Omission of egg albumin and milk solids emphasizes the structure-producing ability of the test flour.

In this work, volume was measured by seed displacement approximately 4 h after baking. A cake with a rounded top was considered best and this occurred only at an optimum liquid level for any given flour. The amounts of water added to the dry mix ranged from 55 cm³ to 95 cm³.

A scoring table was used to assess the volumes, internal and external characteristics of cakes.

Results and discussion

Tables 1 and 2 show that the composition of the two flours are similar. The Falling Number of flour II is lower than that of flour I. This indicates higher amylase activity in flour II possibly due to addition of higher level of malted flour.

Table 3 shows that in both brands of flour, about 60% of particles passed through the sieve

TABLE 1

Chemical Composition of Flour Samples I and II

Component	*Flour sample I*	*Flour sample II*
Moisture (%)	10·1	11·2
Protein (N × 5·7) (%)	13·9	13·5
Fibre (%)	1·8	1·4
Ash (%)	0·62	0·55
Calcium (mg/100 g)	124	126
Phosphorus (mg/100 g)	49·9	63·5
Iron (mg/100 g)	1·74	1·99

TABLE 2

Amylase Activity, Acidity and Gluten Content

	Flour sample I	Flour sample II
pH	6·25	6·17
Total acidity		
mg NaOH/100 g	55·0	46·6
Gluten g/100 g	15·1	14·8
Falling number	276	223

TABLE 3

Particle Size Tests

Mesh No. of sieve	Percentage through	
	Flour I	Flour II
40 GG (439)	100	100
10 XX (129)	79·5	79·8
11 XX (117)	72·1	73·7
12 XX (112)	59·9	60·6

with mesh 12XX (BS). The greater part of the flour was too fine for the set of sieves used in this work. Therefore, a complete picture of particle size distribution could not be obtained.

Table 4 shows that the baking strength (Area), the stability ('P') and the extensibility ('L') of flour I were reduced by the addition of cassava starch. Biscuit flours must have certain dough characteristics, which in the Alveogram are indicated by low 'P' and high 'L' values (Kent-Jones & Amos, 1967; Guilbot, 1970). The mixture with 10% starch gave alveograms which had these characteristics for biscuit making.

TABLE 4

Effect of Cassava Starch on Alveogram of Flour I

Percentage starch	Area of alveogram (cm^2)	'P'— Stability of dough (mm)	'L'— extensibility of dough (mm)
0	70·0	119·0	88·0
10	45·0	77·0	96·0
25	34·5	68·0	81·0
50	14·3	33·0	55·0
Control	45·4	78·0	95·0

Cookies made with 100% of flours I and II were small in size and had smooth surfaces. This is because strong flours give less cookie-spread (Matz, 1968). When 50% cassava starch was used, the cookies were too soft and thick. The highest values of cookie-spread were obtained with mixtures containing 10% starch (Table 5).

Taste panel results also showed that mixtures with 10% starch gave the most desirable cookies with respect to flavour, texture and colour. Cookies made with 100% strong flour were hard and browned unevenly, whilst mixtures with 50% starch gave biscuits that were too crumbly and pale (Fig. 1).

Fig. 2 shows the values of cake volume obtained with flour I, and containing different levels of starch. For each particular mixture, various moisture levels were used to determine the optimum quantity of water that had to be added to the cake batter. The mixture with 10% cassava starch gave the highest cake volume and the highest panel score for external and internal appearance (Table 6).

TABLE 5

Effect of Starch on Cookie-Spread of Flours I and II

Percentage of starch in flour mixture	Flour I			Flour II		
	Diameter of 6 cookies (mm)	Thickness of 6 cookies (mm)	Ratio of diameter to thickness	Diameter of 6 cookies (mm)	Thickness of 6 cookies (mm)	Ratio of diameter to thickness
0	323·0	47·0	6·87	326·0	48·0	6·79
10	333·0	40·0	8·33	335·0	41·0	8·17
25	334·0	45·5	7·34	329·0	45·0	7·09
50	328·0	50·0	6·56	329·9	50·0	6·58
Control flour	340·0	39·8	8·55	340·0	39·8	8·55

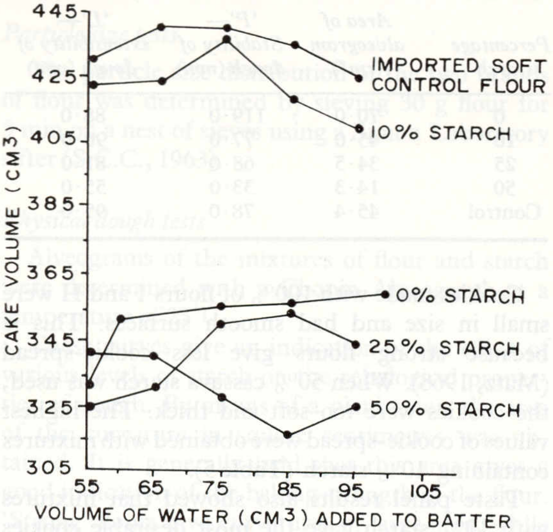

Fig. 2. Effect of starch on cake volume using Flour I and different liquid levels.

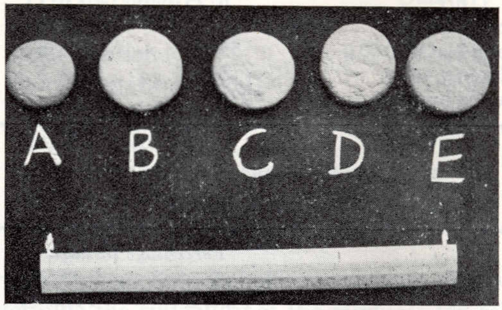

Fig. 1. Effect of cassava starch on cookie-spread (A) 100% strong flour; (B) 90% strong flour + 10% cassava starch; (C) 75% strong flour + 25% cassava starch; (D) 50% strong flour + 50% cassava starch; (E) 100% biscuit flour (Control).

TABLE 6

Scoring for External and Internal Appearance of Cakes Using Mixtures of Flour I and Starch

Scoring characteristics (b)		*Percentage of starch in mixture* (a)			
		0	10	25	50
Crust	15	12	13	8	5
Symmetry	5	3	3	3	2
Silkiness	5	3	4	3	2
Tenderness	10	6	8	5	3
Grain	35	20	30	12	12
Colour	30	30	30	18	10
Total score	100	74	90	49	34

(a) It was not possible to use Flour II in a similar experimental series because of a shortage of materials.

(b) The scoring terms are defined as follows:

Crust. The colour of the crust should be uniform and not spotty or blistered. It should be golden brown. The crust should not be thick or tough.

Symmetry of form. The cake should not have a high cracked centre or depressed in the centre. It should not shrink from the sides on cooling. A rounded top contour is considered optimum.

Texture. This is determined by the sense of touch for *silkiness* and *tenderness*. (a) *Silkiness* is an expression of the pliability and smoothness of the crumb. (b) *Tenderness*. The crumb should be soft.

Grain. This refers to the cell structure of the crumb. Thin walled-cells, small in size and evenly distributed in crumb is considered best.

Colour of crumb. Colour is affected by crumb structure. A fine crumb will give the appearance of a lighter colour.

Conclusions

From the above-results, it appears that locally milled wheat flours, can give biscuits and cakes of acceptable quality if cassava starch is added. The amount of cassava starch used depends on flour characteristics. It is emphasized that since there are various types of biscuits and cakes, the level of starch in the flour should be determined by the type of product that is aimed at. If in doubt about a new brand of flour, the baker is advised to test a small batch of the flour with the exact procedure that is to be used, before the flour is used in large quantities.

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