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The Rheological and Baking Properties of Wheat/Cocoyam Composite Flour

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Rheological and baking tests were carried out on wheat-cocoyam composite flour mixed in different proportions. The results of the farinograms and extensograms showed that replacemtnt of wheat flour up to 20% level gave bread of acceptable quality. The proportion of extensibility and resistance to force decreased with the increase of cocoyam flour in the composite mix. Mixing tolerance index also indicated the poor quality of the composite flour beyond 20% replacement. Breadmaking properties, as indicated by internal and external scores, also showed that beyond 20% replacement level the bread was unattractive and lacking in the required quality attributes.

Key words: Cocoyam-wheat flour blends, Rheological properties, Baking properties, Wheat-cocoyam flour blends.

Introduction

Flour is used as a recipe ingredient in many baked products (Lingard and Sizer 1980). Composite baked goods are known to have their origin from composite flours. Nout (1977) described composite flours as mixtures of non-wheat flours with or without the addition of wheat flour. Non-wheat flours include, for instance, flours or starch prepared from roots and tubers such as yam, cassava, sweet potato and cereal flours such as rice, maize, sorghum, millet etc.

Baked goods enjoy increasing popularity in Nigeria, the commonest being bread. Wheat flour, the main ingredient for baked goods is prepared in Nigeria from unmilled wheat imported from overseas countries (Onyekwere 1977; Aguiyi 1982). This import of wheat amounted to approximately 1x5x109 kg in 1957 and increased three times in 1989 (Adeyemi *et al* 1992), placing considerable burden on the foreign exchanges reserves of the Nigerian nation (FAO 1974; Okaka and Norman 1977).

Efforts to drastically reduce wheat import by third world countries date back to 1957 when the Food and Agricultural Organisation pioneered a study on the technological feasibility of the use of composite flour for the production of bread, biscuits and pasta products (Nout 1977; Titilola and Igben 1986). The aim of the present work is to determine the feasibility or otherwise of using wheat/cocoyam composite flour for making bakery products by way of rheological tests and baking trials, since cocoyam is available locally and is cheap; it is presently not used in many food products (Ihekoronye and Ngoddy 1992).

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Experimental

Materials. Wheat flour of the trade mark "Golden Penny" of 70% extraction rate was used. The cocoyam corms used were obtained from the farm settlements around the Polytechnic Community.

Material processing. Cocoyam corms were sorted, peeled and placed in distilled water to prevent enzymatic browning. The peeled corms were sliced with stainless steel knife, blanched in distilled water containing 1 mg litre^{-1} sodium metabisulphite at a temperature between 70-80° for 5 min. It was then dried at 70°C in an air oven. The dried slices were milled and sieved through 0.025 VIPO sieve mesh to obtain particle size same as that of wheat flour (100 µm).

Chemical and rheological test. The moisture content of the cocoyam flour and the "Golden Penny" flour was determined using the air oven method (AACC 1976). The ash content was determined using the muffle furnace (AACC 1976). Maltose figures were also determined by the Blisch and Sandsted method (Pearson 1976). The flours were blended in various proportions (Table 1) and rheological tests were undertaken using the Bradender Farinograph and Extensograph.

Operation of the farinograph. Flour 300g was placed in the mixer and the temperature brought to 30°C. The mixer was then switched on and water from the burette was carefully run in. The pen was set on the chart at zero. With the mixer in operation, a curve was recorded (farinogram) which showed the shape and general configuration that reflected the physical properties of the dough.

Operation of the extensograph. The dough was scaled in duplicates of 150 g, transferred to the moulding compartment of the extensograph, homogenised and formed into a dough ball and passed through a modifier from which it came out as dough roll.

With the spring of the extensograph set, the dough was allowed to rupture by the force of the spring and curve of the resistance to extension was recorded on the extensograph sheet. The dough was reshaped and rested for 45 min and resistance to extension measured second and third times. Extensibility (E), resistance to extension (R) and the ratio (R/E) were determined from the third curve.

Results and Discussion

The result of chemical analyses of the flours (Table 2) shows that the wheat flour is higher in moisture content than the cocoyam flour but cocoyam flour is relatively richer in minerals. There is a negative correlation between moisture content and mineral status of the flours. The higher the moisture content, the lower the mineral status and vice versa. Maltose content is higher in cocoyam flour and this seems to reflect the higher starch content of cocoyam when compared to wheat (Aguiyi 1982).

Table 1
Composition of flour blends (g)

	Control	Blend I	Blend II	Blend III	Blend IV	Blend V
GPF -	1000	900	800	700	600	500
CYF -	0	100	200	300	400	500

GPF = Golden Penny flour; CYF = Cocoyam flour.

Table 2
Chemical composition of flours

Nutrients	GPF	CYF
Moisture (g 100 g^{-1})	14.06	7.65
Crude protein (g 100 g^{-1})	10.80	1.60
Carbohydrate (g 100 g^{-1})	36.35	87.57
Crude fat (g 100 g^{-1})	1.29	0.43
Ash (g 100 g^{-1})	0.42	3.91
Maltose (mg 100 g^{-1})	218	465->

GPF = Golden Penny flour; CYF = Cocoyam flour.

The rheological properties of the composite flour blends are given in Table 3. Water absorption increased progressively with increase in the proportion of cocoyam flour in the blends. This may be attributed to the higher absorption power of cocoyam starch (Osuji 1985). Arrival time and peak time both increased little with increasintg proportion of cocoyam flour. This observation supports the suggestion that cocoyam flour takes up more water though at a slow rate; and beyond 20% of cocoyam flour in the blends, more time is needed for the dough to reach the correct consistency (Bamidele *et al* 1990).

The stability time decreased from 6.50 min for whole wheat flour to 1.0 min for composite four at 40% cocoyam flour replacement level; this is probably due to the fact that dough made from composite flour is not stable. It should not be allowed for enough ripening (Adisa 1979). Its consistency will be negatively affected, the structure will collapse and the resulting loaf volume will be unacceptable. There was decrease in resistance to extension and extensibility with increase in the level of supplementation. This may be attributed to the diluted glutin in the composite flours there by lacking in the required extensibility and spring properties as a result of improper dough development (Adeyemi and Muller 1979). The ratio of resistance to extensibility (R/E) also decreased with increase in cocoyam flour in the composite mix. Bread from such composite flour would give poor volume.

The baking performance of the composite flour blends at

Table 3
Rheological properties of the flour blends

Blends Parameters	Control	Blend I	Blend II	Blend III	Blend IV	Blend V
Absorption (%)	59.00	62.30	65.00	67.00	69.00	71.10
Arrival Time (Min)	1.00	1.00	1.00	1.50	1.50	1.15
Peak Time (Min)	1.50	1.25	1.50	1.75	2.00	1.25
Stability (Min)	6.50	6.00	3.00	1.00	1.00	1.35
Departure Time (Min)	7.50	7.00	4.00	2.50	2.50	2.50
Mixing Tolerance (BU)	30	32	60	60	85	135
Resistance (R) to Extension (BU)	570	368	230	300	290	280
Extensibility (E) (mm)	150	125	110	115	105	70
R/E Rati	3.5	2.9	2.09	2.89	2.76	4

GPF, Golden Penny flour; CYF, Cocoyam flour; Min, Minutes; Bu, Brabender Unit; mm, millimeters.

Table 4
Quality attributes of composite bread

Blends Parameters	Control	Blend I	Blend II	Blend III	Blend IV	Blend V
External Score						
Replacement level (gk g^{-1})	0	100	200	300	400	500
Actual Volume (Cm)^3	525	500	445	420	405	380
Crust Colour (5)	4	4	4	4	3	3
Break Fill (5)	2	1	1	0	0	0
Break Size (5)	2	1	1	0	0	0
Break Character (5)	6	5	3	2	1	1
Pan Crust (10)	7	7	7	6	6	5
External Score (35)	21	18	16	12	10	9
Internal Score						
Texture (10)	9	8	6	5	5	3
Crumb Colour (10)	8	7	5	4	3	1
Grain (10)	8	7	7	5	5	4
Cell Structure (10)	8	8	7	6	6	6
Internal Score (40)	33	30	25	20	19	10

various levels of supplementation are compared with that of wheat flour in Table 4. Bread properties and the volumes of the loaf are considerably affected at replacement levels beyond 200 g kg^{-1} which is in agreement with the inference drawn from the results of the reheological tests. The crust colour and pan crust was however minimally affected by the levels of supplementation. However increasing supplementation impaired the texture and crumb colour of the bread produced. This agrees with the work of Nout (1977) and Bamidele *et al* (1990).

In summary, breads of acceptable quality can be produced from composite flour blends up to 200 g kg^{-1} cocoyam flour with 800 g kg^{-1} baker's grade wheat flour. Thus the maximum acceptable replacement level of wheat flour with cocoyam flour for breadmaking is 20%. Beyond this limit the composite dough obtained becomes unmanageable for breadmaking.

References

Adeyemi I A, Muller M G 1979 *Wheat Protein Fibrils, their Role in Flocculation Dough and Baking Tests, Food Texture and Rheology, ed* P Sherman. Academy Press, London, pp 325-314.

Adeyemi I A, Adabiri B O, Afolabi O A, Oke O L 1992 Evaluation of some quality characteristics and baking potential of amaranth flour. *Nig Food Journal* **10** 8-15.

Adisa A S 1979 Rheological properties of unripe plantain flour, Master's Degree Dissertation (Unpublished).

Aguiyi P C 1982 *Manufacture and Evaluation of Bread from Composite Flours.* Project Report (Unpublished).

AACC 1976 *Approved methods of the American Association of Cereal Chemists.* AACC, St. Paul, Minn.

Bamidele E A, Cardoso A O, Olaofe O 1990 Rheology and baking potential of wheat/plantain composite flour. *J Sc Food Agric* **15** (3) 421-424.

F A O 1974 *Food and Agricultural Organisation Production Year Book.* 28, 1 FAO, Rome, Italy.

Ihekoronye A I, Ngoddy P O 1992 *Integrated Food Science and Technology in the Tropics.* Macmillan Publishers, pp 280-281.

Lingard E H, Sizer J 1980 *Commodities for Caterers.* Cassell Publishers, New York.

Nout M J R 1977 Taste Panel Evaluation of Bread Preparation from difference composite flours. *NIFST Ann Conference,* 1, 34-38.

Okaka J, Norman P 1977 Cowpea powder in breadmaking. *J Food Sci* **42** 13.

Onyekwere O 1977 Status of Breadmaking in Nigeria. *NIFST Ann Conference,* 34-38.

Osuji G 1985 *Advances in Yam Research,* 1st ed. Frontline Publishers, Nigeria.

Pearson D 1976 *The Chemical Analysis of Food,* 7th ed. J and A Churchill, London.

Titilola S T, Igben M S 1986 An assessment of the present and future status of cereal production and consumption in Nigeria. *Nig Food J* **41** 12-25.