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PROXIMATE, PHYSICAL AND SENSORY PROPERTIES OF SOY-SWEET POTATO FLOUR COOKIE

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ABSTRACT

Flour mixtures consisting of full-fat soy flour and sweet potato flour at 25-75% levels were used in cookie production. Proximate, physical and sensory properties of the cookies were determined. Physical and sensory properties investigated included thickness, diameter, spread factor, spread ratio, fragility, appearance, flavour, texture, aroma, internal crumb appearance and general acceptability which were compared with those of cookies made from whole wheat. Results showed that there was no significant ($p > 0.05$) difference in cookie physical characteristics, as compared with the control sample, except in spread factor and fragility. Cookie spread was found to be influenced by the presence of sugar, oil and water absorption of flour. Panelists' acceptance of cookies was at between 60 and 70%.

Key words: Properties, soy-sweet potato, flour, cookies.

INTRODUCTION

Cookies represent the largest category of snack foods in Nigeria (Ogazi, 1985, Addo et al., 1987, Okaka and Isieh, 1990) and most other parts of the World (Lorenz, 1983). Cookies would supply significant proportion of the nutrient requirement of most people. Conventional cookies are made from wheat flour of protein content of 12-15%. The use of wheat flour in baked goods is mainly due to the characteristic viscoelastic properties of the gluten. Wheat is imported by Nigeria and the low exchange rate of the local currency has made wheat flour and consequently baked goods such as bread and biscuits very expensive.

Fortification of sweet potato with soy flour increased the protein level of the blends (Lorenz, 1983, Walter, et al., 1978, Bouwkamp, 1985, Iwe and Onuh, 1992), and provides some level of complimentarity which makes the blends relevant in solving malnutrition problems. Soybean flour has been used to improve the nutrient density and functional properties of sweet potato flour (Iwe and Onuh, 1992, Iwe and Ngoddy, 1998). Both sweet potato and soybean are relatively available and cheaper than wheat and have high cultivable potentials in Nigeria.

The objective of this study, therefore, was to evaluate the proximate, physical and sensory properties of cookies made from soy-sweet potato flour mixtures with the purpose of producing low cost baked goods.

MATERIALS AND METHOD

Fresh sweet potato (*Ipomoea batatas* (Lam)L.), soybean seeds (Samsoy 2 variety) and wheat flour (Golden Penny, Nigeria Flour Mills PLC) were purchased from a local market. Margarine (Blue band, Lever Brothers, Nigeria PLC), fresh eggs, sugar and sodium bicarbonate were purchased from a local supermarket.

Preparation of Flours

Full-fat soy flour was prepared as described by Iwe and Onuh (1992) and Weingartner (1987) while sweet potato flour was prepared according to the method of Hamed et al. (1973). Flours of average particle size of 200-212μm were mixed according to Nyotu et al. (1981) at full-fat soy and sweet potato flour ratio of 100:0, 25:75, 50:50, 75:25, and 0:100. Mixtures were packaged in dark polyethylene/cellophane bags and stored in a cool-dry place until used for baking.

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Preparation of Cookies

A standard recipe (Uyoo, 1994) consisting of 49.5% flour, and 20% margarine, 10% whipped whole egg, 20% sugar and 0.5% sodium bicarbonate respectively was used in making the cookies. Cookies were prepared from each flour mixture or wheat flour by the creaming method (Addo et al., 1987). The margarine and whipped whole eggs were creamed by gentle mixing for 60 seconds, after which the flour, sugar and sodium bicarbonate were added. This was followed by further mixing for another 60 seconds. The resultant batter was rolled on a wooden pastry board to sheets of uniform thickness which were subsequently cut into circular shapes with tin biscuit shapers of 5.2cm diameter. The shaped batters were baked in a fan driven GENLAB (model B65) oven at 160°C for 10-12 minutes. Control samples were prepared from 100% wheat flour using the same procedure. Emerging cookies were allowed to cool for 30 minutes under ambient conditions (RH: 60-70%; 29 ± 1°C) before packaging in aluminum foil and evaluation. Wheat flour cookies were made which served as controls.

Chemical and Physical Analysis

Proximate composition and energy were evaluated by the AOAC (1984) method on triplicate samples in which energy was calculated by the Atwater method (protein x 4; fat x 9; carbohydrate x 4) (Osborne and Voogt, 1978).

The width, thickness, diameter, spread factor and spread ratio were determined as described by Claughton and Pearce (1989) and Lorenz (1983). Essentially, the width of cookies from each flour type was measured by stacking eight cookies and measuring the height. Thickness and diameter were determined on each of the ten representation cookies from each flour type by use of micrometer screw gauge and vernier calipers respectively. The mean values for each parameter were used for calculating spread factor (width/thickness) and spread ratios (diameter/thickness) respectively.

Fragility was determined by placing known weights on top of representative samples of cookies for each flour type until it fractured (Okaka and Isieh, 1990).

Sensory Evaluation

The appearance, taste, texture, internal crumb appearance and general acceptability of the cookies made from each of the flour types were evaluated by a panel of 14 judges composed of mainly lecturers and students in the University community. Preference analysis using an nine-point Hedonic scale (Ihekoronye and Ngoddy, 1985), were carried out on coded samples on a scale ranging 1 (Dislike extremely) to 9 (Like extremely).

Statistical Analysis

The test of significance ($p < 0.05$) of results for the various treatment was made by the multiple range F-test while the means were separated where appropriate by Tukey's LSD test (Ihekoronye and Ngoddy, 1985).

RESULTS AND DISCUSSION

Proximate composition of flour mixtures

As expected, the blending of full-fat soy flour and sweet potato flours resulted in significant ($p < 0.05$) changes in the proximate composition of the flour mixtures (Table 1). Crude protein, ether extract, fibre and ash significantly increased, while carbohydrate decreased significantly with increased level of full-fat soy flour in the blends. Such decrease in carbohydrate with increase in soy flour in mixtures have been reported in "Ugali"-a Kenyan soy-supplemented maize meal (Nyotu et al., 1986), soy-supplemented rice (Chauhan and Bains, 1985), and soy-sweet potato flour mixtures (Iwe and Onuh, 1992).

The increase in energy values of the mixtures is attributed to increase in oil content since the Atwater factor of oil is twice more than the factor for both protein and carbohydrate (Osborne and Voogt, 1978).

The flour mixtures containing more than 25% soy flour had significantly ($p < 0.05$) higher protein and fat values than the wheat flour. This could be an advantage in improving the nutrient densities of the cookies from such flour blends over those of conventional wheat flour, as already reported (Lorenz, 1983).

Physical properties of cookies

The physical properties of cookies made

Table 1. Proximate composition of Soy-sweet potato flour mixtures and wheat flour (Control).

% Sweet potato	Proximate Composition* Protein	Fat	Fibre	Ash	Carb	Energy	WAI
100	3.2	0.8	0.4	2.2	93.7	1660.1	4.0
75	11.8	8.0	1.05	2.5	78.2	1795.7	4.3
50	23.3	14.8	2.0	2.7	59.2	1944.7	4.4
25	34.4	17.8	2.9	3.5	40.4	2078.8	4.8
0	45.5	20.2	3.8	4.0	22.3	2204.4	5.0
5 Wheat	14.9	1.6	0.23	0.83	82.4	1689.33	nd
LSD	5.08	4.17	1.02	0.89	4.9	5.17	

*= proximate composition is expressed in percentages except for energy (KJ) and WAI (Water absorption index) in g/g.
Each result is a mean of triplicate determinations, expressed on dry weight basis.
**= Data from Iwe and Onuh (1992).

Table 2. Physical properties of Soy-sweet potato cookies a cookies obtained from wheat flour (Control).

% Sweet potato	Physical properties Width	Thickness	Diameter	Sp. fac.	Sp. ratio	Frag
0	321.0	25.3	52.1	126.7	2.1	2033.3
25	324.0	25.0	52.3	129.6	2.1	2516.7
50	322.5	24.4	52.3	132.2	2.2	4700.0
75	320.0	22.4	52.5	143.1	2.4	5233.3
100	321.0	23.1	52.2	139.3	2.3	4466.7
Wheat	295.5	23.7	47.3	124.5	2.0	6233.3
LSD	30.35	2.4	5.5	13.59	0.28	536

Width (mm), Thickness (mm), Diameter (mm), Sp. fac. (spread factor), Sp. ratio (spread ratio), and Frag (Fragility, (gm). Each value was a mean of five determinations.

from the flour blends are shown in Table 2. There were no significant difference ($p < 0.05$) in the width and diameter of the cookies, although the values for the wheat flour cookies were relatively lower.

The spread ratios and spread factors of the cookies increased with increase in the level of sweet potato flour in the mixtures up to about 75% substitution. Cookies from wheat flour had significantly ($p < 0.05$) lower values. Increase in spread ratios and factor of cookies or biscuits have been correlated with increase in sugar and oil contents and low water absorption (Lorenz, 1983). Addo et al. (1987) and Okaka and Isieh (1990) implicated high sugar content to be responsible for increase in spread of biscuits made from flour composites. In molten state the sugars flow and spread and set on cooling. From this study however, optimum spread values were obtained at full-fat soy flour/sweet potato flour ratio of 25:75 showing possible interactions between the various components

especially the carbohydrate and lipids in affecting the spread ratios and spread factors.

Cookies made from blends containing higher levels of full-fat soy flour were more fragile (less rigid) than those containing higher levels of sweet potato flour. There were significant ($p < 0.05$) increase in the rigidity of cookies as the sweet potato level rose to 75% in the flour blend (Table 2). There was a slight decline in rigidity in the 100% sweet potato flour sample. Increase in rigidity should have been influenced by the presence of starch, because it is obvious from Table 2 that the control sample had very high rigidity value, owing to the viscoelastic nature of wheat flour (Jongh, 1961). Iwe and Onuh (1992) showed that blending sweet potato flour will tolerate up to 20-30% full-fat soy flour without loosing its viscosity characteristics. Okaka and Isieh (1990) proved that biscuit spread directly related to rigidity. From this study, cookies made from blends containing 25 to 50% soy flour had higher spread values and of course rigidity.

Sensory properties of cookies

Results of the sensory evaluation of cookies are shown in Table 3. Panelists scored the appearance of cookies containing higher levels of soybean higher than those containing higher levels of sweet potato and even wheat, even though there was no significant difference ($p < 0.05$) in the scores. This situation was as a result of the brownness of the cookie samples. It was physically observed that panelists preferred dark brown to light brown cookies. Browning is a physico-chemical reaction which readily occurs as a result of an intimate reaction between amino acids and reducing sugars in baked goods (Chauhan and Bains, 1985). Optimum browning was achieved at the 50:50 sample blend (Table 3).

Texture of cookies was influenced by the level of sweet potato in the mixture. Hardness of cookies slightly increased (not significantly), as level of sweet potato increased. There was however a lower value at 100% sweet potato level. This situation confirms that rigidity of cookies increases with the increase of sweet potato in the mixture, and soy flour influences the rigidity of the sweet potato flour (Table 2). Lorenz (1983) showed that cookie grittiness is related to the ash content. Ash content of the samples (Table 1) increased as the value of texture increased (Table 2).

The flavour of cookies was acceptable to the panelists. There was no significant difference ($p \leq 0.05$) in the flavour of samples owing possibly to the fact that samples contained similar levels of additives during batter preparation. There was also no significant difference in aroma (Table 3). Aroma of baked goods results from the interaction between reducing sugars and amino compounds

Table 3. Sensory Properties[a] of cookies obtained from Soy-sweet potato flour and wheat flour (Control).

Properties	% Sweet potato in the mixture 0	25	50	75	100	Wheat
Appearance	7.5	7.4	7.7	6.8	6.9	6.2
Texture	6.8	6.3	7.0	7.4	6.9	6.3
Flavour	7.7	6.8	7.0	7.5	7.8	7.3
Aroma	6.3	6.3	6.9	7.4	7.2	6.5
ISCC[b]	6.5	6.7	7.9	7.9	6.9	6.8
General acceptability	7.6	7.6	7.7	7.8	7.3	7.0

a = Data is based on means of fourteen panelists responses on a scale ranging from 9 (like extremely) to 1 (dislike extremely).
b = ISCC = internal surface crumb colour.

accompanied by formation of aldehydes (Kent, 1975). It is also affected by the products of alcoholic and lactic fermentation- organic acids, alcohols, esters, and flavour residues chiefly in the crust. The lack of significant differences in flavour and aroma may be explained from the point of view of batter preparation also, where little or no fermentation took place.

The internal surface crumb colour (ISCC) of the samples did not differ significantly (Table 3). There was however a slight increase in ISCC at increasing sweet potato flour content in the blends.

Cookies made from the flour blends compared favorably with the control samples in most of the quality characteristics examined. Besides panelists observation that cookies from the 100% soy flour had a peanut smell and that natural sweet potato taste was noticed in cookies prepared from the 100% sweet potato sample, cookie could be made from the flour blends especially with the 50 to 75% sweet potato samples which have higher proximate, physical and sensory ratings.

CONCLUSION

Results of this study show that acceptable cookies could be made from soy-sweet potato flour blends. Flour blends containing 25 to 50% full-fat soy flour would be most useful in such venture.

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