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Functional Properties of Wheat and Sweet Potato Flour Blends

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Abstract: In this study the functional properties of wheat and sweet potato tuber (*Ipomea batatas*) flour blends were investigated. The sweet potato tubers were brought from local farm in Offa Kwara State. The tubers were thoroughly sorted, washed, peeled, sliced, blanched, soaked, drained, sundries and milled into flour. Wheat flour used was purchased at Orisumbare market in Osogbo Osun State. The wheat and sweet potato flour were blended using the following ratios (WF:SPF:100:0, 90:10, 85:15, 80:20, 75:25, 0:100). These samples were thereafter subjected to functional properties analysis. The results revealed that as more and more sweet potato flour was added to wheat flour, there was significant effect on the functional properties.

Key words: Wheat, sweet potato, functional properties

INTRODUCTION

Flour is fine powder made from cereals or other starch based produce. It is most commonly made from wheat. Flour is the key ingredient in bread production which constitutes a staple in the diet of many countries. Therefore, the availability of adequate supply of flour has often been a major economic and political issue. Flour can also be made from legumes and nuts, root and tubers such as yam, cassava, sweet potato etc. flour produced from non wheat sources is otherwise known as composite flour.

Composite flour includes yam, cassava, cocoyam, sweet potato, instant yam flour to mention but few. Attempts to improve the chemical and sensory qualities of composite flour especially instant yam flour has been reported by various authors (Ngoddy and Onuoha, 1983; Ofi, 1983; Sanni *et al*., 2006). These flour has been incorporated with wheat flour in production of bakery goods such as cookies, brand and cake. Through this, diversified, reduced cost of production and acceptable products can be produced since wheat cannot survive in Nigeria's soil. These flours have their properties that enhance their wide utilization which include water and oil absorption capacity, foaming capacity, foam stability, bulk density, gelation capacity, emulsion capacity etc (Adeyeye *et al*., 1994; Abbey and Ibeh, 1988). Incorporation of composite flour into wheat flour for bakery goods production is expected to produce effect in the functional properties of the blended samples. Several studies have indicated the possibility of incorporating hulless barley, soya bean, sorghum, cowpea flour into wheat flour at various level and the rheological and baking properties have been reported (Oftman and Garba, 1997; Kinsella, 1979; Sathe and Salkhe, 1981).

In this paper, functional properties of wheat and sweet potato flour blends were investigated. The two flour were blended using the following blend ratios (WF:SPF 100:0, 90:10, 85:15, 80:20, 75:25, 0:100).

MATERIALS AND METHODS

The sweet potato tubers used for this work were bought from a farm in Offa Kwara State, Nigeria. Commercial wheat flour was purchased at Orisumbare market in Osogbo Osun State, Nigeria. Equipment used include milling machine, mechanical sieve, pH meter, oven, desiccators, centrifuge, balance, Rapid Visco Analyzer (RVA) and stirrer. Other materials used include knife, water, pipettes crucibles, bowls and napkin.

Production of sweet potato flour: The sweet potato tubers were thoroughly sorted to remove bad ones from the lot. The sorted tubers were washed to remove adhering soil, dirts and extraneous materials. The tubers were thereafter peeled and sliced to facilitate fast rate of drying and ease milling operations. The sliced tubers were then blanched in order to inactivate enzymes that may cause browning reaction. These were then cooled and drained followed by drying. Following drying, the tubers were milled, sieved into fine flour and packaged for further use.

Functional properties determination

Swelling power: 1 g of the sample was weighed into a conical flask. It was hydrated with 15 ml distilled water, shook for 5 min with mechanical shaker at low speed. Heating was done for 40 min at 80-85^{o}C with constant stirring in a water bath. The content was transferred into a clean, dried and pre-weighed centrifuge tube.

7.5 mil of distil water was added and centrifuged at 2200 rpm for 20 min. The supernatant was decanted into a pre-weighed can and dried at 100^{o}C to a constant weight. The sediment was weighed in the centrifuge. Swelling power and solubility were calculated viz:

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Solubility = % starch dissolved in the sediment

Viscosity measurement: Viscosity was determined using the Bradender amylograph. The procedure involved dispensing 200 g suspension of 10% (w/v) preparation of each sample into the equipment and monitoring the viscosity of the slurry as the temperature increases.

pH determination: The pH of the samples was measured with a pH meter. 10 g of each sample collected especially were homogenized in 50 ml of distilled water. The resulting suspensions were decanted and their pH determined using pH meter already standardized with buffer solutions of pH 4.0 and 7.0.

Total solids and moisture determination: 2 g of the sample was weighed into a previously weighed crucible. The crucible plus sample taken was then transferred into an oven set at 100°C to dry to a constant weight. At the end of the drying, the crucible plus sample was removed from the oven and transferred to desiccators, cooled for 10 min and weighed.

$$\text{Moisture (\%)} = \frac{W_1}{W_1} - \frac{W_3}{W_0} \times \frac{100}{1}$$

Where,
W_1 = Weight of crucible plus wet sample
W_0 = Weight of empty crucible
W_3 = Weight of crucible plus dried sample

Emulsification capacity: 2 g sample was blended with 25 ml distilled water for 30 sec in a blender at 1600 rpm. After complete dispersion, refine corn oil was added from a burette and blended until there was a separation into two layers of water and fat. Emulsifying capacity was expressed as ml of oil emulsified by 1 g of flour.

Water absorption capacity: 15 ml of distilled water was added to 1 g of the flour in a weighed 25 ml centrifuge tube. The tube was agitated on a vertex mixer for 2 min. It was centrifuged at 4000 rpm for 20 min. The clear supernatant was decanted and discarded. The adhering drops of water was removed and the reweighed. Water absorption capacity is expressed as the weight of water bound by 100 g dried flour.

Fat absorption capacity: 10 ml refined corn oil was added to 1 g of the flour in a weighed 25 or 80 ml centrifuge tube. The tube was agitated on a vertex mixer for 2 min. It was centrifuged at 4000 rpm for 20 min. The volume of free oil was recorded and decanted. Fat absorption capacity is expressed as mil of oil bound by 100 g dried flour.

Foaming capacity and foaming stability: 2 g flour sample and 50 ml distilled water was mixed in a

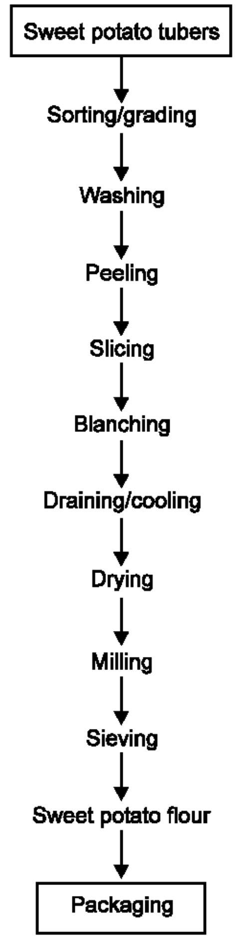

Fig. 1: Flow chart of sweet potato flour production

Sample codes designations

Sample codes	Designation
A	100% WF
B	90% WF : 10% SPF
C	85% WF : 15% SPEF
D	80% WF : 20% SPF
E	75% WF : 25% SPF
F	100% SPF

WF = Wheat Flour; SPF = Sweet Potato Flour

blended at room temperature. The suspension was stirred for 5 min at 1000 rpm. The total volume after 30 sec was recorded. It was allowed to stand at room temperature for 30 min and the volume of foam recorded. The percentage increase in volume after 30 sec is expressed as foaming capacity.

Bulk density: 50 g flour sample was put into a 100 ml measuring cylinder. The cylinder was tapped several times on a laboratory bench to a contant volume. The volume of sample is recorded.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of Sample}}{\text{Volume of sample after tapping}}$$

Table 1: Functional properties of Wheat Flour (WF) and Sweet Potato Flour (SPF) blends

Sample	MCM (%)	pH	EC (%WF)	GC (%)	WA (g^{s-1})	FA (g^{s-1})	FC (%)	BD (g/cm^3)	WP	V (B.U)	SS
A	3.07	6.01	14.68	10.75	2.45	2.15	4.12	7.47	12.75	73	8.63
B	2.75	5.70	9.68	9.70	1.83	1.75	3.68	6.75	7.40	68	6.85
C	2.60	5.70	10.57	8.75	1.55	1.57	3.30	5.80	6.85	61	6.75
D	3.24	5.63	11.40	6.45	1.24	1.43	2.35	5.73	6.50	55	6.40
E	3.60	5.40	12.70	5.40	1.18	0.70	1.17	5.25	6.10	49	6.35
F	3.68	5.50	25.40	3.60	1.27	0.65	1.28	6.83	5.73	35	6.01

Key: WF = Wheat Flour; SPF = Sweet Potato Flour; A = 100% WF; B = 90% WF : 10% SPF; C = 85% WF : 15% SPF; D = 80% WF : 20% SPF; E = 75% WF : 25% SPF; F = 100% SPF; B.U Brabender Unit.
MCM (%) = Moisture Content M (%) EC = Emulsion Capacity (%WF) GC = Gelation Capacity (%) WA = Water Absorption (g^{s-1})
FA = Fat Absorption (g^{s-1}) FC = Foaming Capacity (%) BD = Bulk Density (g/cm^3) WP = Welling Power
V = Viscosity (B.U) SS = Swelling Solubility

Gelation capacity: 2-20% suspension was prepared with 5 ml distilled water in test tube. The tubes containing the suspension was heated for 1 h in a boiling water bath. It was cooled rapidly under running cold water. The test-tube was cooled for 2 h at 4°C. The test was inverted to see if content will fall or slip off. The least gelation concentration is that concentration when the sample from the inverted test tube does not fall or slip.

RESULTS AND DISCUSSION

Functional properties of wheat and sweet potato flour blends: The functional properties determine the application and use of food material for various food products. The results of functional properties of wheat and sweet potato flour blends are as presented in Table 1. From the table the moisture content of Sweet Potato Flour (SPF) was higher than that of Wheat Flour (WF). This might be due to the drying method used for SPF. The moisture content for WF was 3.07 while 3.68 was recorded for SPF. However, the two products are below the minimum limit of moisture content for flour (Ihekeronye and Ngoddy, 1985). The moisture content of the flour was on the increase as more and more SPF was added to WF. The moisture content of food products goes a long way in suggesting the shelf life of the product. Sample E (75% WF : 25% spf) recorded the highest value for moisture content among the blended samples. All the values of the blended sample fall within the acceptable limit of dry products (15%).

The results obtained for pH of 100% WF was 6.01 while that for 100% SPF was 5.50 signifying that sample E is slightly acidic compared to sample A. The pH values for other blends ranged between 5.40 and 5.70. as more and more SPF was added to WF the pH value was tending toward slight acidity. Acidic products are more shelf stable that non acidic counterpart (Ihekeronye and Ngoddy, 1985). Emulsion capacity results revealed that SPF had 25.40% which was higher than that of WF (14.68%). Emulsion properties play a significant role in many food system where the protein have the ability to bind fat such as in meet products batter, dough and salad dressing (Sathe and Salkhe, 1981). The emulsion capacity of the blends increased as more SPF was added with sample E recording the highest emulsion capacity of 12.70% among the blended samples.

The gelation capacity of sample A (100% WF) was 10.75% while it was 3.60% for sample F (100% SPF). The low gelation value recorded for SPF suggests that it may not be a good gel forming agent. This indicates that more flour will be needed to form a gel with SPF because of its low gelation capacity (Adebowale *et al*., 2005). The gelation capacity of the blended samples was on the decrease as the percentage of SPF incorporation increase. The values for the blended samples ranged between 9.70 and 5.40 Variations in the gelling properties of different flours may be due to variations in the ratio of different constituents such as carbohydrates, lipids and proteins that make up the flours (Abbey and Ibeh, 1998).

The water absorption capacity of sample A is 2.45 gs^{-1} while that of sample E is 1.27 gs^{-1} indicating that sample A has higher water absorption capacity. Sample A therefore has higher affinity for water which is informed by its lower moisture content 3.07%. The water absorption capacity of the blended samples is on decrease as more and more SPF was added to WF. The fat absorption capacity for sample A is 2.15 gs^{-1} while that of sample E is 0.65 gs^{-1}. The fat absorption capacity equally decreased as more and more was incorporated indicating diluting effect of SPF on WF fat absorption capacity. The mechanism of fat absorption is attributed mainly to the physical entrapment of oil and the binding of fat to the apolar chain of protein (Wang and Kinsella, 1976). Wheat flour recorded the highest foaming capacity of 4.12% while sweet potato flour had 1.28%. The foaming capacity of all the blended samples followed the same trend as other properties discussed earlier. Sample with the higher percentage of sweet potato flour (i.e. sample E) recorded the least foaming capacity of 1.17%. Bulk density value for WF (100%) was 7.47 g/cm^3 while SPF recorded 6.83 g/cm^3. As more and more SPF was incorporated into WF, the bulk density was on the decrease. The values for the samples ranged between 5.25-6.75 g/cm^3 with sample E recording the least value. Bulk density is generally affected by the particle size and density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry (Karuna *et al*., 1996). Swelling power is an indication of the water absorption index of the granules during heating (Loos *et al*., 1981). The swelling power for WF was 12.75% which was greater than that of SPF of 5.73%. The same trend was observed for swelling solubility and their values were on the decrease as more and more SPF was incorporated into WF. Sample A (100% WF) was more viscous than SPF. The viscosity value for WF was 73B.U while SPF recorded 35B.U. This might be due to the higher gluten content in wheat flour.

Conclusion: The study showed that blending sweet potato flour with wheat flour had significant effect on the functional properties of the flour blends. Blending SPF with WF up to 20% level produced samples which can be used for production of bakery goods with improved functional properties and reduced retro-graduation, staling rate and production time.

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