# Effect of pre-treatment on sweet-potato flour for cookies production

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## Abstract

The sweet-potato flour was produced by varying the blanching temperature from 60°C, 70°C, 80°C, to 90°C. Sweet-potato samples were blended with wheat flour and other ingredients to produce cookies. The proximate analysis, functional properties, and pasting properties were carried out on the pre-treated sweet-potato flour; physical characteristics and sensory evaluation of the cookies were determined. Results showed that there were no significant differences ($P < 0.05$) in the bulk densities, pasting time, and fat content of the sweet-potato flour samples. There were significant differences ($P > 0.05$) in the physical analysis, such as width, thickness, weight, and spread ratio of sweet-potato-wheat cookies. No significant differences were observed in the texture from sensory evaluation of the cookies though there were significant differences in the color, taste, and aroma.

**Key words:** Sweet-potato, pre-treatment, flour, cookies, proximate

## Introduction

Sweet-potato (Ipomoea batatas L) is the seventh most important food crop in the world. It is grown in many tropical and subtropical regions. Among the world's major food crops, sweet-potato produces the highest amount of edible energy/ha/day (Horton and Fano, 1985). Sweet-potato flour can serve as a source of energy and nutrients (carbohydrates, beta-carotene (provitamin A), minerals (Ca, P, Fe, and K), and can add natural sweetness, color, flavor, and dietary fiber to processed food products (Woolfe 1992). Because of the distinct properties, the use of sweet-potato flour in the preparation of bread is restricted. Biscuits are baked dry products, usually with a golden brown crust and crispy texture (Fellows 1997).

Wheat flour is generally used for biscuit production with other ingredients, such as margarine (shortening), sweeteners (sugar), leavening agent, eggs, milk, salt, flavorings (Hui 1992). Recently, the use of composite flour was evolved in the bakery world for cakes and biscuits. Composite flour is the name given to a combination of two or more types of flour in a specific ratio for baking. Wheat flour is lacking in some essential amino acids, such as lysine, methionine, and threonine (Rayar et al. 1990). The deficient nutrients can be supplemented through the use of composite flour. Gluten is present only in wheat flour; the use of composite flour changes the texture of biscuits especially in types, where strength is dependent on some appropriate level of gluten development (Okaka and Anjekwu 1980). The availability of our local crops, their reduction in postharvest losses through the processing of some into flour and the cost of the importation of wheat flour, led to the use of sweet-potato flour (Ukhum and Ukpebor 1991). Hence, the main objective is to study the effects of pre-treatment on sweet-potato flour for cookies production.

## Materials and methods

The variety of sweet-potato that was used was the yellow skinned type with cream flesh purchased from Oke-odo market in Lagos. Other ingredients, such as salt, sugar, margarine, baking powder, milk, vanilla flavoring, wheat flour, and eggs, were also purchased from the same market.

**Production of sweet-potato flour.** Sweet-potato flour was produced following the method described by Adeleke and Odedeji 2010. Sweet-potato tubers were sorted and washed to remove sand, dirt, and other adhering materials. The cleaned tubers were peeled using a sharp stainless steel knife and sliced using a kitchen slicer to obtain a sliced thickness of 6 ± 1 mm. The slices were then washed and placed in a sieve to remove excess water. The slices were blanched at different temperature (60°C, 70°C, 80°C, and 90°C) for 5 min. to inactivate the enzyme that causes browning before being dried in the cabinet dryer. The dried slices were milled in a disc attrition machine to obtain flour. The flour was then sieved, packed in a polythene bag, and stored at ambient temperature (Adeleke and Odedeji 2010).

**Cookies formulation.** The formulation for standard biscuits or cookies according to Oyewole et al. (1996) was followed for the production of sweet-potato cookies: wheat flour (200 g), margarine (100 g), sugar (70 g), baking powder (2 g), salt (0.2 g), vanilla flavoring (0.2 g), milk (100 g), egg (48.30 g).

**Production method.** Sugar (70 g) was added to margarine (100 g) in a Kenwood Mixer and mixed at medium speed until fluffy (for about 12 min). Egg (48.30 g) and milk (50 g) were added while mixing and then mixed for approximately 30 min. Sifted flour (200 g), baking powder (2 g), and vanilla flavoring (0.2 g) were slowly added into the mixture. The mixture was kneaded until dough formation. It was then rolled on a flat board sprinkled with flour to a uniform thickness of about 0.4 cm using a wooden rolling pin and guiding stick. Circular cookies of 5.8 – 6 cm diameter were cut, placed on oiled baking trays, and baked at 160°C for about 15 min.

**Analytical determinations.** The moisture, protein, ash, crude fiber, and fat contents of the samples were determined using the AOAC (2000) and Njintang et al. (2008) methods. The starch and total sugars content were determined using a colorimetric method (Dubois et al. 1956). Absorbance was read at 490 nm using a spectrophotometer (model Spectronic 601, Milton Roy Company, USA). Swelling power and solubility were determined by the method described by Leach et al. (1959). Water absorption capacity (WAC) was determined using the method described by Sosulski (1962). Bulk density was determined using the method of Wang and Kinsella (1976).

Pasting properties were determined using a Rapid Visco Analyser (RVA) (model RVA 3D+; Network Scientific, Australia). The sample was turned into slurry by mixing 3 g with 25 ml of water inside the RVA can. This was inserted into the tower which was then lowered into the system. The slurry was heated from 50 to 95°C and cooled back to 50°C within 12 min; the can was rotated at a speed of 160 rpm with the continuous stirring of the contents with a plastic paddle. Parameters estimated were peak viscosity, setback viscosity, final viscosity, pasting temperature, and time to reach peak viscosity.

**Physical evaluation of cookies.** The weights, thickness, width, and spread ratio were measured before and after baking. A micro meter screw gauge was used to determine the thickness of the cookies and the spread ratio was calculated as spread ratio / width.

**Sensory evaluation of cookies.** Ten panelists who were familiar with cookies were used for the sensory evaluation. Evaluations were made on a 9 point hedonic scale with 9 = like extremely and 1 = dislike extremely. The cookies were assessed for color, aroma, texture, and overall acceptability.

**Statistical analysis.** Each analytical determination was carried out in three replicates. Data were subjected to analysis of variance (ANOVA) using SAS version 8e software (SAS Institute Inc., Cary, NC, USA) at $P < 0.05$. Means were separated using Duncan's Multiple Range Test.

## Results and Discussion

The effects of pretreatment on the chemical properties of sweet-potato flour are presented in Table 1. There was a significant difference at the 5% level in the moisture content of the blanched sweet-potato flour. Moisture content values ranged from 5.11 to 7.54%, showing the effectiveness of drying. The blanched sweet-potato flours are at the minimum limit of moisture content for flour (Adeleke and Odedeji 2010). The moisture content goes a long way in suggesting the shelf life of the product. The moisture content of all the flours was below the 10% stipulated standard of the revised regulation of the Standard Organization of Nigeria (Sanni et al. 2004). There was significance difference in the protein content of the sweet-potato flour at 5% level; values ranged from 6.50 to 7.78%. Flour from 90 °C had the lowest protein value and this is due to the naturally low protein content of sweet-potato roots (FAO 1990). The values of ash ranged from 2.42 to 2.70% and the crude fiber content of the sweet-potato flour was between 2.35 and 2.85%. At the 5% level, there was a significance difference between the ash values of the flours that were generally low. High ash and crude fiber content in food depicts those materials that are indigestible in the human body. There was a significant difference between the starch content of the samples; values ranged from 26.93 to 35.10%. The starch content was generally high, because the main constituent of all the flours used was carbohydrate. There was no significant difference between the sugar content of the sweet-potato flours since flours naturally contain little or no sugar and the quantity of sugar used in baking the cookies were uniform. At the 5% level, there was no significance difference between the crude fat values of the sweet-potato flours which ranged from 3.54 to 3.89%.

Table 2 shows the results of functional properties of blanched sweet-potato flour. At the 5% level, there was no significance difference in the bulk densities of the varying temperature. Bulk densities ranged from 120 to 150. This is usually affected by the particle size and density of the flour and it is very important in determining the packaging requirement, materials handling and application in wet processing in the food industry (Karuna et al. 1996). There were significant differences in the water absorption of the blanched sweet-potato flours with the sample at 60°C having the highest value of 257.88%. There were significant differences in the swelling power and solubility of the samples. Swelling power is an indication of the absorption index of the granules during heating (Loos and Graham, 1981). Swelling property indicates the power holding capacity and has generally been used to demonstrate differences between various types of starches and to examine the effect of starch modification (Crosbie 1991). The swelling power of flours is often related to their protein and starch contents (Woolfe 1992). Higher protein contents in flour may cause the starch granules to be embedded within a stiff protein matrix which subsequently limits the access of the starch to water and restricts the swelling power (Singh et al. 2003). The swelling power and solubility provide evidence of the magnitude of interaction between starch chains within amorphous and crystalline domains. The extent of this interaction is also influenced by the amylose to amylopectin ratio, and by the characteristics of amylose/amylopectin in terms of molecular weight/distribution, degree and length of branching and conformation (Hoover 2001).

Results of the pasting properties of the blanched sweet-potato flours are shown in Table 3. When starch-based foods are heated in an aqueous environment, they undergo a series of changes known as gelatinization and pasting. These are two of the most important properties that influence quality and aesthetic considerations in the food industry, since they affect texture and digestibility as well as the end use of starchy foods (Adebowale et al. 2005). There were no significant differences in the pasting profiles of the blanched sweet-potato flours except for the pasting temperature. The peak viscosity which is the ability of starches to swell freely before their physical breakdown (Sanni et al. 2004) ranged from 58.36 to 97.46 RVU. It occurs at equilibrium between swelling (which increases velocity) and granule rupture and alignment (which cause its decrease). Sample 80°C had the highest peak viscosity (97.46 RVU) and sample 60°C had the lowest of 58.36 RVU. Jin et al. 1994 reported that a high hot paste viscosity generally represents low cooking losts and superior eating quality. Newport Scientific (1995) indicated that starches with low paste stability and high breakdown have very weak cross-linking within granules. This indicates that there is less stability to paste breakdown. The trough, which is the minimum viscosity value in the constant temperature phase of the RVU profile and measures the ability of paste to withstand breakdown during cooling, ranged from 25.84 to 65.25 RVU. Sample 90°C had the highest trough value of 40.21RVU and sample 60°C had the lowest of 7.08 RVU. The pasting temperature is the temperature at which irreversible swelling of the starch granules occur, leading to the formulation of a viscous paste in an aqueous solution.

Table 4 shows the result of the physical properties of sweet-potato cookies. The weight of the cookies before and after baking shows significance differences ($P < 0.05$), this was due to the thickness of the paste that has no gluten, the stretching ability is low, so the sweet potato paste was thicker than wheat paste while it was rolled into sheets to avoid breakage. The spread ratio after baking shows significance differences ($P < 0.05$) among the cookies samples.

Table 5 shows the result of the sensory analysis of the cookies. There was no significance difference in the texture of the samples ($P<0.05$). The taste, color, aroma, and overall acceptability show that there was a significance difference among the samples. Sample 60°C shows wide significance differences ($P < 0.05$) in the overall acceptability. Sweet-potato cookies made from flours blanched at 60°C are most acceptable, cookies from flours made from 70°C and 90°C blanching temperatures and the control were slightly or partially accepted. Respondents were neither like nor dislike sweet potato cookies made from flour at 80 °C blanching temperature.

Table 1: Chemical properties of sweet-potato flour.

| Parameters | 60 °C | 70 °C | 80 °C | 90 °C | SEM |
|---|---|---|---|---|---|
| Fat | 3.78a | 3.89$^{a}$ | 3.54$^{a}$ | 3.65$^{a}$ | 0-08 |
| Protein | 6.79$^{c}$ | 7.34$^{b}$ | 7.78$^{a}$ | 6.50$^{d}$ | 0.19 |
| Ash | 2.70$^{a}$ | 2.42$^{b}$ | 2.51$^{b}$ | 2.44$^{b}$ | 0.04 |
| Sugar | 1.70$^{b}$ | 2.05$^{a}$ | 1.69$^{b}$ | 1.20$^{c}$ | 0.11 |
| Starch | 29.87$^{b}$ | 26.93$^{d}$ | 35.10$^{a}$ | 28.88$^{c}$ | 1.14 |
| Crude fiber | 2.35$^{c}$ | 2.45b$^{c}$ | 2.60$^{b}$ | 2.85$^{a}$ | 0.07 |
| Moisture | 6.90$^{b}$ | 7.54$^{a}$ | 5.24$^{c}$ | 5.11$^{c}$ | 0.40 |

Mean value with different superscripts in the same row are significantly different (P<0.05)

Table 2: Functional properties of sweet-potato flour at different blanching temperature

| Parameters | 60 °C | 70 °C | 80 °C | 90 °C | SEM |
|---|---|---|---|---|---|
| Swelling power | 7.92$^{a}$ | 8.39$^{b}$ | 8.70$^{a}$ | 8.20$^{c}$ | 0.14 |
| WAC | 257.88$^{a}$ | 209.85$^{c}$ | 175.94$^{d}$ | 38.28$^{b}$ | 11.68 |
| Solubility | 19.69$^{d}$ | 20.21$^{b}$ | 19.97$^{c}$ | 20.46$^{a}$ | 0.11 |
| Bulk density | 1.50$^{a}$ | 1.50$^{a}$ | 1.30$^{a}$ | 1.20$^{a}$ | 0.55 |

Mean value with different superscripts in the same row are significantly different (P<0.05

Table 4: Physical characteristics of sweet-potato cookies

| Parameters | 60 °C | 70 °C | 80 °C | 90 °C | Control |
|---|---|---|---|---|---|
| Thickness | 6.06$^{b}$ | 8.03$^{a}$ | 6.06$^{b}$ | 4.07$^{c}$ | 0.53 |
| Weight | 11.55$^{a}$ | 12.40$^{a}$ | 13.10$^{a}$ | 7.25$^{b}$ | 0.95 |
| Spread ratio | 8.30$^{b}$ | 5.85$^{d}$ | 7.46$^{c}$ | 10.12$^{a}$ | 0.58 |
| Width | 5.05$^{a}$ | 4.70$^{b}$ | 4.55$^{c}$ | 4.15$^{c}$ | 0.12 |

Mean value with different superscripts in the same row are significantly different (P<0.05)

Table 5: Sensory analyses of sweet-potato cookies

| Parameters | 60 °C | 70 °C | 80 °C | 90 °C | Control |
|---|---|---|---|---|---|
| Color | 7.20$^{a}$ | 6.40$^{b}$ | 5.80$^{b}$ | 6.40$^{b}$ | 6.40$^{b}$ |
| Taste | 7.70$^{a}$ | 5.40$^{b}$ | 5.20$^{b}$ | 5.10$^{b}$ | 6.60$^{ab}$ |
| Aroma | 6.60$^{a}$ | 5.70$^{bc}$ | 5.30$^{c}$ | 5.50$^{c}$ | 6.30$^{ab}$ |
| Texture | 6.80$^{a}$ | 6.40a | 6.00$^{a}$ | 6.10$^{a}$ | 6.20$^{a}$ |
| Overall Acceptability | 7.50$^{a}$ | 6.30$^{b}$ | 5.50$^{c}$ | 5.80$^{bc}$ | 6.40$^{b}$ |

Mean value with different superscripts in the same row are significantly different (P<0.05)

Table 3: Pasting properties of sweet-potato flour at different blanching temperature

| Parameters | 60 °C | 70 °C | 80 °C | 90 °C | SEM |
|---|---|---|---|---|---|
| Peak1 (RVU) | 58.38$^{d}$ | 73.83$^{b}$ | 97.46$^{a}$ | 66.05$^{c}$ | 5.54 |
| Trough1 (RVU) | 7.08$^{c}$ | 8.59$^{c}$ | 36.13$^{b}$ | 40.21$^{a}$ | 5.76 |
| Break down (RVU) | 51.29$^{b}$ | 65.25$^{a}$ | 61.34$^{b}$ | 25.84$^{d}$ | 5.81 |
| Final viscosity (RVU) | 12.33$^{c}$ | 14.33$^{c}$ | 49.75$^{b}$ | 54.58$^{a}$ | 7.38 |
| Set back (RVU) | 5.25$^{b}$ | 5.75$^{b}$ | 13.63$^{a}$ | 14.38$^{a}$ | 1.61 |
| Peak time (min) | 3.90$^{b}$ | 3.85$^{c}$ | 4.04$^{b}$ | 4.22$^{a}$ | 0.06 |
| Pasting temp (°C) | 50.20 | 50.23$^{a}$ | 50.20$^{a}$ | 50.25$^{a}$ | 0.03 |

Mean value with different superscripts in the same row are significantly different (P<0.05)

## Conclusion

The study has shown that different blanching temperatures have an effect on the quality of flour produced, hence the different flours produced from the varying blanching temperatures differed in quality. The functional properties have effects on the blanched flours. Flour produced at 60 °C had the highest water absorption capacity and this gave it a higher affinity to absorb water during production. Sweet-potato cookies made from flours blanched at 60 °C were most acceptable. Sweet-potato is an acceptable alternative crop that could be used in the production of cookies.

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