Applied Tropical Agriculture
Volume 21, No.2 (Special Issue), 8-13, 2016.
© A publication of the School of Agriculture and Agricultural Technology, The Federal University of Technology, Akure, Nigeria.

Chemical Composition and Sensory Evaluation of Cookies Baked from the Blends from the Blends of Soya Bean and Maize Flours

Atobatele, O.B. and Afolabi, M.O.*

Department of Food Science and Technology, Bowen University Iwo, Osun State
*Corresponding author: Email: seunatoba@gmail.com, afolabiolutoyin@yahoo.com

ABSTRACT

Cookies were produced from the blends of maize flour (MF) and soya bean flour (SF). The functional properties of the MF and SF were determined using standard methods. Proximate composition, mineral analysis and sensory evaluation of the baked cookies from the flour blends were carried out .The SF possessed good water and oil absorption capacities (310%; 160%) than the MF (169%; 120%); the bulk density of SF (0.52%) was significantly lower than that of the MF (0.80%). The protein content of the cookies increased from 4.5% in 100% maize cookies to 7.00% for cookies with 30% soya bean flour. Substitution of soy-flour also significantly increased the ash (1.00%-1.8%), fibre (0.24%-0.94%) and fat (16.10%-18.13%) contents of the cookies. However, the moisture and carbohydrate contents decreased with addition of soy-flour while the mineral contents of the cookies samples increased with increase in soy-flour inclusion. Sensory evaluation showed that the cookies samples were not significantly different (p>0.05) in terms of colour, aroma, crunchiness, sweetness, flavour and general acceptability. Cookies produced from the blends of 70% MF+30% SF were the most acceptable of all the samples.

Keywords: cookies; functional properties; maize flour; nutrients contents; soy-flour

INTRODUCTION

Cookie is conventionally a wheat flour-based food product that has become a major component of human snacks in most part of the world. Most other English-speaking countries would call it a biscuit. In North American English a biscuit is a kind of quick bread similar to a scone. Cookies are small, flat dessert treats, commonly formed into a circular shape. They constitute an important component of the diet (Mishra *et al*., 2012). Cookies are convenient snacks product dried to a very low moisture content taken among young people and adults (Okaka, 1997).

Wheat flour constitutes the basic ingredient for biscuit production because of its gluten proteins, which are not present in flours of other cereals (Kent, 1975). Gluten protein forms elastic dough during baking and gives high organoleptic quality to the finished products (Ihekoronye and Ngoddy, 1985). Unfortunately wheat production is low in Nigeria due to the climatic condition which is unfavourable to the crop leading to the importation of wheat. Nigeria is endowed with many legume crops like soybean (Glycine max) which is cheap and used mostly in the production of milk in most homes. The use of soybean is increasing because of its functional properties and being an economic source of dietary protein and important bio-active components such as isoflavones.

Soy-based foods may provide additional benefits for consumer due to their hypolipidemic and anticholesterolemic properties with reduced allergenicity (Sipos, 1988). Soybeans are considered an inexpensive source of high-quality protein (38%-55%) that are abundantly rich in lysine and essential amino-acid that are deficient in most cereal grains (Dhingra and Jood 2004; Shorgren *et al*., 2006) but low in sulphur amino-acids, lutein and xanthenes. On the other hand, maize is rich in methionine but deficient in lysine and tryptophan (Mishra, 2012) and low in calcium. Therefore, on the basis of complementary, the combination of maize and soybean flours in food formulations could potentially provide most of the nutrients needed by sub-Saharan Africans. This has stimulated the research into the determination of the chemical composition and sensory properties of cookies baked from maize fortified with soy-bean flour. The objective of this study is to develop soy-maize cookies that will be acceptable to the consumers.

MATERIALS AND METHODS

Materials

Dry maize (Zea mays), Soybean (Glycine max) seeds, cooking margarine, Sodium bicarbonate, Sugar,Salt, skimmed milk powder, Condensed milk flavour and Aluminium foil paper were purchased from 'okesa' market in Ado-Ekiti, Ekiti state, Nigeria. Master Chef electric toaster oven (Model MC-1957k, people's republic of china) was used for baking.

Maize flour preparation

Maize flour was produced according to the procedure described by Okoruwa (1995). Dried maize kernels was sorted to remove dirt's and impurities, thereafter it was milled using hammer mill and packaged into high density polyethylene film.

Preparation of soybean flour

Soybean flour was produced using the procedure of Smith and Circle (1972). The soy bean seeds were roasted for 2 hours and dehulled. It was dried, milled and sieved and the soybean flour was packed into polyethylene films till used.

Preparation of maize-soy cookies batter

200g of the maize flour was mixed into 150ml of water to produce the maize gel. The paste was mixed thoroughly and heated to 700C for about 3minutes until the gel was formed. The maize gel was added to the remaining200g maize flour and mixed with other ingredients as shown in Table 1.

Production of maize-soy cookies

The ingredients were added to the gel formed and mixed thoroughly into a batter. The batter was rolled on a flat rolling with a rolled on a floured board using pin to a thickness of 0.2-0.3cm. The rolled batter was cut into shapes and arranged on a greased tray and baked at 150^0c for 20 minutes (colour changes indicate the cookies are done. The cookies were brought out, cooled and packaged in high density polyethylene bag until used.

Chemical composition of the samples

The biscuits and flours were analyzed for moisture contents, crude proteins, Total lipids, Total ashes, Crude fibres, calcium and zinc using AOAC (2005) methods. The carbohydrate contents were determined by difference

Functional properties of the flour

The flour (maize and soy bean) was analyzed for bulk density, water absorption capacity and oil absorption capacity using the methods of Okaka *et al*. (1979) and Lin *et al*. (1974)

Sensory evaluation

The sensory evaluation of the cookies was conducted using 20 member-untrained panellists from different age groups. A 9 point Hedonic scale was used with 1 corresponding to dislike extremely and 9 corresponding to like extremely.

Table 1: Maize-soy biscuit recipe

Ingredients	Quantity
Flour (composite)	400g
Sugar	120g
Margarine	200g
Baking powder	5g
Milk	5g
Egg	80g
Maize gel	½ g of maize flour

Maize-soy flour blends used for cookies production were as follows: 100% maize flour; 95% maize flour + 5% soy-flour; 90% maize flour + 10% soy-flour; 85% maize flour + 15% soy-flour; 80% maize flour + 20% soy-flour; 70% maize flour + 30% soy-flour.

Maize gel formation
↓
Addition of flour
↓
Mixing (Sugar and Margarine)
↓
Addition of other ingredients
↓
Mixing
↓
Shaping/placing on tray
↓
Baking at 120°C for 20 min
↓
Cooling for 15 min
↓
Packaging in polythene bags
↓
Maize-Soy Cookies

Figure 1: Flowchart for the production of maize-soy fortified cookies

Statistical Analysis

Means of triplicate determinations were analyzed using the one way ANOVA with $\alpha=0.05$ (SPSS 20.0 for windows, USA) to determine statistically differences between the quality attributes of samples with Duncan's multiple range test.

RESULTS AND DISCUSSION

Functional properties of the maize flour (MF) soy bean flour (SF)

The bulk density, water absorption and oil absorption capacities of the biscuit samples are shown in Table 2. These parameters are essential to the industrial application of the basic recipes of MF and SF in cookies production.

The bulk density of the MF (0.80g/ml) and SF (0.52g/ml) are significantly different from each other. The bulk density of the SF is relatively higher than the value (0.43g/ml) reported by Apotiola *et al*. (2013) and in agreement with the value (0.58g/ml) recorded by Akubor *et al*. (2003). While that of maize is higher compared to value (0.47g/ml) recorded by Edema *et al*. (2005). The bulk density of the sample describes the degree of compactness of the matrices, an important factor in mixing of ingredients.

The values of the water absorption capacity of the SF (310%) was very high compared to WAC value of maize (170%).The polar groups of proteins, especially ones of amino acids are chiefly responsible for the binding of water and other ingredients (Ihekoronye and Ngoddy,1985). Water absorption capacity is an important pointer to whether the blends can be incorporated into aqueous foods products. WAC is the maximum amount of water that a food material can take up and retain under formulation condition which is related to the dryness and porosity of material (Oyelade *et al*., 2002)

The OAC of MF is (120%) while that of SF is 160% which is similar to values (168.28%) recorded by Edema *et al*. (2005). SF had higher value of OAC which makes it excellent flour for baked products. The samples were significantly different at 5% significance level ($p<0.05$). Good oil absorption capacity of flour in baking improves handling characteristics of products (Akubor, *et al*., 1999). Absorption of oil by baked food products improve the mouth-feel and retain flavour.

Proximate compositions of cookies from maize flour and soy flour

Table 3 shows the proximate composition of cookies produced from composite flour (maize and soy-flour). The carbohydrates, proteins, moistures, ashes, crude fibres and total fats of the cookies were significantly different at 5% level of significance. The highest moisture and carbohydrate contents were recorded in sample with 100% maize flour while the highest value for proteins, fats, ash, fibre was recorded in sample containing 70% maize flour and 30% soy-flour. This was due to the high level of protein and fibre in the soy-flour. The high protein content in the soy-bean supplemented cookies would be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high proteinous foods because of their high cost. (Falola, *et al*., 2011).

Moisture contents of cookies samples

The moisture content of the sample ranged from 5.45% to 6.87% as shown in Table 3. There was significance difference ($p<0.05$) in the moisture content of the cookies. The result shows that the addition of soy-flour caused a reduction in the moisture content of the cookies with 100% maize cookies having the highest value (6.87%) and 70%maize+30%soy-flour cookies having the lowest value (5.45%). This is similar to the work carried out by Edema *et al*. (2005) and Rita *et al*. (2010) in soy and wheat flour composite cake, where there was

Table 2: Functional Properties of Maize flour and Soy flour

Sample	Bulk Density (g/ml)	WAC (%)	OAC (%)
Maize Flour	0.80±0.30	169.33±1.15	120.0±0.00
Soy Flour	0.52±0.10	310.00±10.0	160.0±20.00

Where, WAC: Water Absorption Capacity, OAC: Oil Absorption Capacity
Values are Mean±SE (n=3).

Table 3: Proximate composition (%) of soy-maize fortified cookies

Sample	Protein	Crude Fat	Ash	Crude Fibre	Carbohydrate	Moisture Content
$M_{100}S_0$	$4.59+0.48^d$	16.10 ± 1.00^d	1.00 ± 0.35^d	0.24 ± 0.11^e	71.17 ± 0.30^a	6.87 ± 0.95^a
$M_{95}S_5$	$5.34+0.00^c$	$17.30+1.00^c$	1.30 ± 0.32^c	0.45 ± 0.15^d	69.57 ± 0.10^b	6.02 ± 0.22^b
$M_{90}S_{10}$	$5.99+0.12^b$	17.60 ± 0.11^b	1.55 ± 0.50^b	0.50 ± 0.23^c	68.41 ± 0.11^c	5.87 ± 0.19^b
$M_{85}S_{15}$	$6.39+0.90^b$	17.76 ± 0.57^b	1.80 ± 0.00^a	0.85 ± 0.00^b	67.79 ± 0.66^d	5.39 ± 0.70^c
$M_{70}S_{30}$	$7.00+0.85^a$	18.13 ± 0.57^a	1.86 ± 0.17^a	0.94 ± 0.37^a	66.64 ± 0.02^e	5.45 ± 0.25^c

Where: $M_{100}S_0$: 100% maize flour, $M_{95}S_5$: 95% maize flour +5% soy-flour, $M_{90}S_{10}$: 90% maize flour +10% soy flour, $M_{85}S_{15}$: 85% maize flour +15% soy flour, $M_{70}S_{30}$: 70% maize flour + 30% soy flour. Values are means of triplicate determination ± SD. Means within a column with the same superscript are not significantly different at 5% level of significance.

a decrease in moisture content with increase in soy-flour addition. Smith (1972) reported that the total moisture content of cookies samples should not exceed 14% and 5% was observed the best. The moisture content of these cookies falls within the acceptable moisture level which extends the shelf-life of the product due to low water activity.

Carbohydrate contents of cookies sample

The carbohydrate contents of the cookies are shown in Table 3 and it ranges from 66.64 to 71.17% with the highest value in 100% maize cookies. This value is similar to 72.1% reported by Adeyeye *et al*. (2014) in maize-potato flour cookies. This confirms that maize is a major source of carbohydrate and starch. In various energy based snacks and cookies that requires carbohydrate as their based ingredients, maize can be used. The result showed that the lowest value (66.64%) was recorded in cookies made from the flour blends with 30% soy-flour.

Total fat contents of the cookies

The total fat contents of the cookies samples (Table 3) baked from the flour blends were significantly different ($p<0.05$). The values ranged from 16.10-18.13%. The lowest value was observed in 100% maize cookies (16.10%) and this is relatively high compared to the values (9.9%) obtained by Adeyeye *et al*. (2014) in maize cookies supplemented with sweet potato flour. The highest value was observed in cookies samples with 30% soy-flour and this is due to the high fat content of the soy-flour. The soy-flour used in this research work was not defatted and expected to add cholesterol free high grade lipid in the cookies sample.

Total Ash contents of the cookies

The ash contents of the cookies samples ranges from 1.0 to 1.86%. The samples were different at 5% level of significance ($p<0.05$). Cookies samples from 30%soy-flour had the highest value (1.86%) while 100% maize flour had the lowest (1.0%).Higher ash contents indicated that the mineral content is higher in the soy-flour than in the maize flour. Adeyeye and Akingbala (2014) reported 1.3% for 100% maize cookies. It was observed that there was an increase in the ash contests of the cookies with increasing level of soy-flour in the flour blends.

Fibre contents of the cookies

There was a significant difference between the samples at 5% level of significance ($p<0.05$). The fibre contents of the cookies ranges from 0.24 to 0.94%. The highest fibre value was recorded in the cookies from the flour blends containing 30%soy-flour and the lowest value in the ones baked from 100% maize flour. This was due to the high content of fibre in the soy-flour compared to that of maize flour. Fibre is good for the body as it increases the stool bulk by acting as a vehicle for faecal water. The fibre content consists of hemicelluloses, cellulose and lignin. It contributes to the health of the gastro-intestinal system and metabolic system in man.

Protein contents of the cookies

The protein content of the cookies ranged between 4.59 and 7.0% with the lowest in 100% maize cookies and the highest (7.0%) in the flour blend with 30%soy-flour. There were significant differences ($P<0.05$) among the entire samples except for M90S10 and M85S15 which were not significantly different. The increase in protein content was due to the high content of protein in the soy-flour. Therefore, soy-flour served a complementary purpose in increasing the protein content of products based with maize-flour and also helps in providing the limiting protein (lysine and tryptophan) in maize. The increase in protein content agrees with the findings of Olaoye *et al*.(2006) and Rita *et al*.(2010) but the value is lower than that reported by Mishra (2010) in development and compositional analysis of protein-rich cookies. The soy-fortified cookies will help to alleviate diseases like kwashiorkor that result from higher carbohydrate intake

Mineral contents of the Cookies

The zinc contents (Table 4) of the samples were significantly different at 5% ($p<0.05$) significance level. The highest value (5.39mg/kg) observed in sample formulated with 30% soy-flour. The inclusion of soy-bean increases the zinc content at different levels of addition. The lowest value was observed in 100% maize flour (2.40mg/kg). Zinc is important in the body for wound healing. The calcium levels of the cookies samples were significantly different from each other ($p<0.05$).

Table 4: Mineral contents of soy-maize fortified cookies.

Sample	Zinc (mg/kg)	Calcium (mg/kg)
$M_{100}S_0$	2.40 ± 0.10^c	0.24 ± 0.10^c
$M_{95}S_5$	3.25 ± 0.25^b	0.24 ± 0.10^c
$M_{90}S_{10}$	5.28 ± 0.30^a	0.32 ± 0.10^b
$M_{85}S_{15}$	5.30 ± 0.15^a	0.33 ± 0.10^b
$M_{70}S_{30}$	5.35 ± 0.15^a	0.40 ± 0.10^a

Where: $M_{100}S_0$: 100% maize flour, $M_{95}S_5$: 95% maize flour +5% soy-flour, $M_{90}S_{10}$: 90% maize flour +10% soy flour, $M_{85}S_{15}$: 85% maize flour +15% soy flour, $M_{70}S_{30}$: 70% maize flour + 30% soy flour. Values are means of triplicate determination ± SD. Means within a column with the same superscript are not significantly different at 5% level of significance.

Table 5: Sensory scores of soy- maize fortified cookies

Samples	Aroma	Texture	Crunchiness	General appearance	Colour	Sweetness
$M_{100}S_0$	5.70±1.71^{b}	6.00±1.70^{b}	5.20±1.78^{b}	5.80±1.87^{a}	6.65±1.94^{ab}	5.70±2.03^{b}
$M_{95}S_5$	6.25±1.25^{b}	6.50±1.29^{ab}	6.45±1.00^{b}	5.90±2.45^{a}	7.05±1.55^{ab}	6.65±1.41^{ab}
$M_{90}S_{10}$	6.10±1.00^{b}	5.55±1.55^{b}	6.50±1.20^{b}	6.15±2.26^{a}	6.70±1.00^{ab}	5.95±2.11^{b}
$M_{85}S_{15}$	6.46±1.55^{b}	5.80±1.84^{b}	6.10±1.64^{b}	6.00±2.38^{a}	5.90±1.46^{b}	5.60±2.97^{b}
$M_{70}S_{30}$	6.35±1.74^{b}	6.20±1.93^{b}	6.15±2.09^{b}	6.30±1.87^{a}	6.95±1.03^{ab}	6.50±1.85^{b}
W_{100}	8.00±1.05^{a}	7.90±1.66^{a}	8.70±1.00^{a}	8.00±2.49^{a}	7.80±1.22^{a}	8.40±1.07^{a}

Where: W_{100}: 100% wheat flour; $M_{100}S_0$: 100% maize flour, $M_{95}S_5$: 95% maize flour +5% soy-flour, $M_{90}S_{10}$: 90% maize flour +10% soy flour, $M_{85}S_{15}$: 85% maize flour +15% soy flour, $M_{70}S_{30}$: 70% maize flour + 30% soy flour. Values are means of triplicate determination ± SD. Means within a column with the same superscript are not significantly different at 5% level of significance.

The highest value (0.40mg/kg) was observed in the sample with 70%maize flour while the lowest value (0.24mg/kg) was recorded in 100% maize. This is because soy-bean is rich in calcium which is very good and necessary for the formation and development of bones.

Sensory properties of soy-fortified maize cookies

Table 5 shows the mean sensory scores of soy-fortified maize cookies. Cookies sample with 100% maize have the lowest rating for crunchiness while the sample containing 100% wheat flour has the highest rating. The colour of the cookies samples were not significantly different at ($p<0.05$). The highest colour rating was recorded for the samples baked with 100% wheat flour followed by samples from 70% MF while the lowest rating was observed in samples from 85%MF. Addition of soy-flour improved the yellow colour of the MF to give a more attractive colour. The scores for texture of the samples were not significantly different from each other, but the sample with 70%MF had the next highest rating to the sample from100% wheat flour. The lowest sample rating was observed in sample formulated with 90%MF. Addition of soy-flour improved the texture of the sample up to 30% inclusion level and this may be due to the fact that SF is higher in fat and fats have been associated with crispiness of baked foods which impacted flavour and tenderness to the cookies (Akubor *et al*., 2003). The aroma of the samples was not significantly different from each-other. The highest score was found in cookies from wheat flour while the lowest rating was found in 100%Maize flour. In terms of general acceptability the cookies formulated from 70%MF and 30%SF has the next highest score to the cookies sample from the wheat flour . The lowest rating was observed in sample formulated with 100%MF.

CONCLUSION

Substitution of maize-flour with soy-bean flour has been found to increase the protein, crude fibre, ash, fat and mineral contents of cookies from maize. Cookies with high nutritional content can be produced from different combination of composite flours to alleviate the problems of malnutrition due to low protein intake and also improve the nutritional status of Nigerians.

REFERENCES

Adeyeye, S.A. and Akingbala, J.O. (2014). Evaluation of Nutritional and Sensory Properties of Cookies from maize-potato flour blends. African Journal of Food and Nutrition. 6 (9): 61-70

Akubor, P.I. and Ukwuru, M.U. (2003). Functional properties and biscuit making potential of soybean and cassava flour blends' Plant Foods for Human Nutrition 58: 1-12

Akubor, P.I., Chukwu, J.K. (1999). Proximate composition and selected functional properties of fermented and unfermented Africa oil bean (*Pentaclethra macrophylla*) seed flour blends. Plant Foods for Human Nutrition. 54: 227-238

AOAC (2005). Official Methods of Analysis 18th Edition, Washington, D.C: Association of Official Analytical Chemist.

Dhingra, S. and Jood, S. (2004). Effect of flour blending on functional, baking and organoleptic characteristics of bread. Intl. Journal of Food Science Technology 39 (2): 213-222

Edema, M.O., Sanni, L.O. and Sanni, A.I. (2005). Evaluation of maize-soybean flour blends for sour maize bread production in Nigeria. African Journal of Biotechnology. 4 (9) 911-918

Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated food science and technology for tropics. Macmillan Publishers, London, PP 104-105

Kent, N.L. (1975) Technology of cereals with reference to wheat. 2nd ed, Pergamon press, Oxford, pp 194-211

Lin, M.J., Humbert, E.S. and Sosuiki, F.W. (1974). Functional properties of sunflower products. Journal of Food Science 39:368-371

Liu, K. (1997). Soybeans: chemistry, Technology, and Utilization Gaithersburg, MD: Aspen Publishers. pp. 69.

Mishra, V., Puranik V., Akhatar N. and Rai G.K. (2012). Development and compositional analysis of protein rich soy-maize flour blended cookies. Journal of Food Processing and Technology 3:182

Okaka, J.C. (1997). Cereals and legumes: Storage and Processing Technology. Data and micro system publishers, Enugu, Nigeria pp. 11-124

Okaka, J.C. and Potter, N.N. (1979). Physiochemical and functional property of cowpea processed to reduce beany flavor. Journal of Food Science 44; 1235-1240.

Okoruwa E.A. (1995). Utilization and processing of maize. IITA research guide. 35. p. 29.

Olaoye, O.A., Onilude A.A. and O.A. Idowu, (2006). Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. Africa Journal of Biotechnology. 5:1102-1106.

Oyelade, O.J., Sunny I., Otunola E.T. and Ayorinde, A. (2002). Effect of tempeh addition on selected physico-chemical and sensory attributes of the re-constituted cassava flour. Pakistan Journal of Nutrition. 9 (6): 535-538.

Rita, E. S., Adiza, S. and Sophia D. (2010). Nutritional and sensory analysis of soya bean and wheat flour composite cake'. Pakistan Journal of Nutrition 9 (8): 794-796

Shorgen, R.L., Hareland, G.A. and Wu YU. (2006). Sensory evaluation and composition of spaghetti fortified with soy flour. Journal of Food Science 71: 428-432

Sipos, E.F. (1988). Edible uses of soybean protein. Presented at Soybean Utilization Alternatives Symposium. Uni. of Minnesota, Feb. 16-18, Minneapolis, MN.

Smith, A.K. and Circle, S.J. (1972). Soybeans: Chemistry and Technology. AVI Publishing Company, page 442

Smith, W.H. (1972). Wire-cut cookies. In: Smith, W.H (Ed.). Biscuits, crackers and cookies: Technology, Production and Management. Applied Science publishers, London, pp: 737

*****