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QUALITY EVALUATION OF INSTANT *Mosa* (A FRIED MAIZE BASED SNACK) PRODUCED FROM FERMENTED MAIZE AND SORGHUM FLOUR

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ABSTRACT

The study evaluated the quality of *mosa* produced from fermented maize and sorghum flour. The grains were subjected to fermentation, drying and milling to obtain four samples coded MFDS (Milled Fermented Dried Sorghum), MFDM (Milled Fermented Dried Maize), FDMM (Fermented Dried Milled Maize) and FDMS (Fermented Dried Milled Soghum). Proximate, functional and physiochemical analysis were determined on the flour with sensory evaluation of the fried *mosa* using the traditional fermented wet milled maize as control. The value of protein, fat, crude fiber, ash and carbohydrate ranged from 4.25-7.06, 0.42-0.71%, 0.27-0.46%, 2.17-3.26% and 29.85-88.72% respectively. There was no significant difference ($p>0.05$) between sample FDMS and FDMM in respect to protein, fat and crude fibre. Also, there was no significant difference ($p>0.05$) between samples FDMS and MFDM with respect to ash and carbohydrate. The water absorption capacity, oil absorption, swelling capacity and solubility ranged were 0.65-0.74 g/ml, 26.33-88.33 g/ml, 13.00-81.00 g/ml, 3.93-9.04 g/ml and 0.20-7.00% respectively. FDMS, FDMM and MFDS did not differ significantly ($p>0.05$) in bulk density, swelling capacity and solubility. The value of pH and TTA ranged from 4.19-6.86 and 0.05-0.34 respectively. The colour, taste, flavor, appearance, texture and overall acceptability ranged 6.27-8.10, 4.93-7.80, 4.80-7.40, 6.57-7.50, 4.87-7.47 and 5.73-7.87 respectively. The sensory scores revealed no significant difference ($p>0.05$) between sample FMWM, MFDM, FDMS and FDMM with respect to taste, colour, flavor and overall acceptability. The study shows that a more nutritious mosa can be produced from fermented sorghum grains, followed by drying and milling.

Contribution/Originality: The paper's primary contribution is finding that *Mosa* (a maize based snack) can be produced alternatively from sorghum, and more instantly and conveniently using pre fermented flours thus increasing the utilization of sorghum grains and conveniency of *Mosa* production. The product compared well with the control.

1. INTRODUCTION

Mosa is a yeast-fermented product which is round in shape, and is prepared in Nigeria and some other West African countries from the flour from millet, maize or rice flour (Ayo, Agu, & Famoriyo, 2008a). It is common in the Northern and South-western part of Nigeria. The brown crisp edges and the mild sour taste are considered by many consumers as the quality attribute required of *mosa* (Ayo et al., 2008a). Different types of cereal grain used for

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mosa production have been reported to have different effects on physical qualities of *mosa* such as thickness, weight, volume, volume index and sensory characteristics such as taste, aroma, texture and degree of sourness (Ayo et al., 2008a; Ayo., Agu, Ayo, & Famoriyo, 2008b; Igwe, Oyebode, & Dandago, 2013).

Sorghum (*Sorghum bicolor L.*) is one of the oldest grains (cereals) with a unique adaptation to Africa's climate and it is about the largest cultivated crop in the Northern Guinea Savanna areas of Nigeria tropical region of Africa (Kolawole, Kayode, & Akinduyo, 2007). Nigeria and the United States are the two largest producers of sorghum in the world (FAO, 2003). The use of sorghum to replace conventional cereals may be due to its high bioactive components, minerals, dietary fiber, vitamin E and carotenoids (Cardoso et al., 2015) and its potential to promote health and prevent diseases. Hence, the production of mosa from sorghum will also function as neutraceuticals. Previous study on mosa production has shown that is a yeast-fermented product which is round in shape, and is prepared from flours from millet, maize or rice flour (Ayo. et al., 2008b). However, literature is dearth on the production of *Mosa* from sorghum. Further, the production of *mosa* is laborious and take time to achieve the fermentation of the barter in order to produce the sour taste attribute of *mosa* thereby limiting its consumption. In recent times, many people are after nutritious and convenient foods, hence this study was designed to evaluate the quality of *mosa* from fermented and dried maize and sorghum flours.

2. MATERIALS AND METHOD

Maize grains and Sorghum grains were sourced from a local market in Ikorodu, Lagos state as well as other ingredient used in the production.

3. PREPARATION OF MILLED FERMENTED DRIED FLOUR

Sorghum grains were sorted and dry milled into flour. The sorghum flour was fermented using the method of Elkhalifa, Schiffler, and Bernhardt (2005) with modifications. Sorghum flour was mixed with clean water (1:1) and fermented for 72 h at room temperature (28-30 ^{o}C). This was drained and allowed to dry at 65 ^{o}C for 16 h using a Mitchell Drying Cabinet (England) followed by cooling before sieving through 0.2 mm sieve. The flour was packaged and labeled as Milled Fermented Dried Sorghum Flour. This same procedure was repeated using maize grains to obtain Milled Fermented Dried Maize Flour.

4. PREPARATION OF FERMENTED DRIED MILLED FLOUR

Sorghum grains were sorted to remove to remove foreign and unwholesome materials. The sorted grains were washed before steeping in water at room temperature and allowed to ferment for 72 h. It was then drained and dried at 65 ^{o}C for 16 h using a Mitchell Drying Cabinet (England). This was then allowed to cool before milling and sieving through a 0.2 mm pore size sieve. The flour obtained was labeled as Fermented Dried Milled Sorghum Flour. The above process was repeated for maize grains in order to obtain Fermented Dried Milled Maize flour.

5. PREPARATION OF FERMENTED WET MILLED MAIZE (CONTROL)

Maize seeds were sorted to remove foreign particles. These were then washed and fermented for 72hrs at room temperature (28^{o}C). It was then drain and wet milled using an attrition mill.

6. PREPARATION OF *MOSA* SAMPLES

The method of (Ayo et al., 2008a) with slight modification was used in the preparation of *mosa*. Three hundred gram of flour was weighed and divided into two equal portions. One portion (150g) was cooked in boiling water (1:2) and mixed vigorously with the remaining (150g) uncooked portion. A pinch of salt was added and allowed to cool before deep frying at a temperature of 120^{o}C for eight (8) min. The fried *mosa* obtained was cooled to room temperature. *Mosa* was made from the control following same process but without the addition of water.

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7. ANALYSIS

7.1. Determination of Physicochemical and Functional Properties

The proximate composition of the dried flour obtained was determined as described by AOAC. (2000). Titrable acidity (TTA) and pH were determined by the methods of Sadler and Murphy (2010). The functional properties of the flour was also determined as follows: water absorption capacity (WAC) and swelling index were determined following the methods Sosulski, Humbert, Bui, and Jones (1976) and Adepeju, Gbadamosi, Omobuwajo, and Abiodun (2014) respectively. Bulk density was determined as reported by Nwosu, Ogueke, Owuamanam, and Onuegbu (2011).

7.2. Sensory Evaluation of Mosa Samples

The sensory evaluation of the Mosa including the ones made evaluated for texture, taste, aroma, crust colour, crumb colour and general acceptability of the product by a twenty man panel using a 9-point hedonic scale (1 = extremely dislike, 9 = extremely liked) as described by the (Ertas, Sert, & Demir, 2015).

7.3. Statistical Analysis

All experiments were carried out in triplicate. Data obtained were analyzed by one way analysis of variance (ANOVA) and mean were compared by Duncan Multiple Range Test (SPSS 21.0 version). Differences were considered significant at $p<0.05$).

8. RESULT AND DISCUSSION

8.1. Result

8.1.1. Result on Proximate Composition of Fermented Maize and Sorghum Flour

Table 1 presents the results of proximate properties of the flour. The value of moisture ranged from 4.33-58.67%. Sample FMWS had the highest value while sample MFDS had the lowest value. There was no significant difference ($p>0.05$) between sample FDMS, MFDM and MFDS but there was significant difference between other samples. The value of protein, fat, and crude fiber ranged from 4.25-7.06, 0.42-0.71% and 0.27-0.46% respectively. There was no significant difference ($p>0.05$) between sample FDMS and FDMM. The value of ash ranged from 2.17-3.26%, the highest value was obtained in sample FMWS while the lowest value was found MFDS and there was no significant difference ($p>0.05$) between sample FDMS and MFDM; FDMM, MFDS and FMWM. The carbohydrate content ranged from 29.85-88.72%. Sample MFDS had the highest value while sample FMWS had the lowest value. There was no significant difference ($p<0.05$) between sample FDMS and MFDM but there was significant difference between others.

Table-1. Proximate analysis of the fermented maize and sorghum flour.

Sample	Moisture (%)	Protein (%)	Fat (%)	Crude Fiber (%)	Ash(%)	Carbohydrate (%)
FDMS	$4.60^{c} \pm 0.20$	$6.40^{b} \pm 0.09$	$0.64^{b} \pm 0.01$	$0.41^{b} \pm 0.01$	$2.30^{bc} \pm 0.10$	$85.64^{b} \pm 0.27$
FDMM	$7.00^{b} \pm 0.20$	$6.14^{b} \pm 0.24$	$0.61^{b} \pm 0.02$	$0.40^{b} \pm 0.02$	$3.04^{a} \pm 0.09$	$82.81^{c} \pm 0.48$
MFDM	$4.90^{c} \pm 0.36$	$5.25^{c} \pm 0.48$	$0.53^{c} \pm 0.05$	$0.34^{c} \pm 0.03$	$2.45^{b} \pm 0.18$	$86.54^{b} \pm 0.91$
MFDS	$4.33^{c} \pm 0.42$	$4.25^{d} \pm 0.27$	$0.42^{d} \pm 0.03$	$0.27^{d} \pm 0.02$	$2.17^{a} \pm 0.21$	$88.72^{a} \pm 0.98$
FMWM	$58.67^{a} \pm 0.81$	$7.06^{a} \pm 0.37$	$0.71^{a} \pm 0.04$	$0.46^{a} \pm 0.02$	$3.26^{a} \pm 0.04$	$29.85^{d} \pm 1.23$

Note: *Mean ± standard deviation with same superscripts along the column are not significantly different at ($p>0.05$).
KEY:
FDMS; Fermented Dried Milled Sorghum FDMM; Fermented Dried Milled Maize
MFDM; Milled Fermented Dried Maize MFDS; Milled Fermented Dried Sorghum
FMWM; Fermented Milled Wet Maize (Control).

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8.2. Result on Functional Composition of the Fermented Maize and Sorghum Flour

Table 2 showed the result of functional properties of the maize and sorghum flour. The value of bulk density, water absorption capacity, oil absorption, swelling capacity and solubility ranged from 0.65-0.74 g/ml, 26.33-88.33 g/ml, 13.00-81.00 g/ml, 3.93-9.04 g/ml and 0.20-7.00% respectively. There was no significant difference between sample FDMS, FDMM and MFDS in respect to bulk density, swelling capacity and solubility.

Table-2. Functional Properties of fermented maize and sorghum flour.

Sample	Bulk density (g/ml)	Water absorption capacity (g/ml)	Oil absorption capacity (g/ml)	Swelling capacity (g/ml)	Solubility (v/v)
FDMS	$0.72^{b}\pm0.01$	75.00 ± 6.08^{b}	$61.33^{b}\pm2.08$	$8.66^{a}\pm0.56$	$2.00^{b}\pm0.00$
FDMM	$0.74^{b}\pm0.01$	88.33 ± 3.79^{a}	$62.00^{b}\pm3.00$	$9.04^{a}\pm0.12$	$3.33^{b}\pm1.15$
MFDM	$0.65^{a}\pm0.01$	84.67 ± 5.86^{a}	$81.00^{a}\pm3.00$	$7.51^{b}\pm0.28$	$7.00^{a}\pm1.00$
MFDS	$0.72^{b}\pm0.02$	91.33 ± 3.51^{a}	$80.00^{a}\pm1.00$	$9.29^{a}\pm0.19$	$2.00^{b}\pm0.00$

Note: *Mean ± standard deviation with same superscripts along the column are not significantly different at ($p>0.05$).

Table-3. pH and titrable acidity of the maize and sorghum paste.

Sample	pH	TTA
FDMS	6.86 ± 0.21^{a}	0.05 ± 0.02^{d}
FDMM	6.50 ± 0.02^{b}	0.06 ± 0.00^{d}
MFDM	3.83 ± 0.03^{e}	0.25 ± 0.00^{a}
MFDS	4.45 ± 0.04^{c}	0.19 ± 0.00^{b}
FMWM	4.19 ± 0.02^{d}	0.08 ± 0.00^{c}

KEY: FDMS; Fermented Dried Milled Sorghum FDMM; Fermented Dried Milled Maize MFDM; Milled Fermented Dried Maize MFDS; Milled Fermented Dried Sorghum.

8.3. Result of pH and titrable acidity of Fermented Maize and Sorghum

The result of pH and titrable acidity of the flour samples are presented in Table 3 above. The value of pH and TTA ranged from 4.19-6.86 and 0.05-0.34 respectively. Sample FDMS has the highest value of pH while sample MFDM has the lowest value. There was significant difference ($p<0.05$) between all the samples. Sample MFDM had the highest value (0.34) for TTA while sample FDMS had the lowest value (0.05). There was no significant difference ($p>0.05$) between sample FDMS and FDMM. But there was significant difference ($p<0.05$) between MFDM, MFDS and FMWM.

8.4. Result on Sensory Scores of the Mosa

Table 4 present the scores for the sensory evaluation of the *mosa*. The value of colour, taste, odour, flavor, appearance, texture and overall acceptability ranged 6.27-8.10, 4.93-7.80, 5.23-7.37, 4.80-7.40, 6.57-7.50, 4.87-7.47 and 5.73-7.87 respectively. There was no significant difference ($p>0.05$) between sample FMWM, MFDM, FDMS and FDMM in respect to color, taste, flavor and overall acceptability except sample MFDS. For appearance, there was no significant difference ($p>0.05$) between all the samples while texture did not also differ significantly ($p>0.05$) between sample MFDM, FDMS and FDMM.

Table-4. Sensory scores of Instantly Produced *Mosa*.

Sample	Colour	Taste	Flavour	Appearance	Texture	Overall acceptability
FDMS	7.60 ± 1.63^{ab}	7.80 ± 0.89^{a}	7.40 ± 1.30^{a}	7.50 ± 1.07^{a}	7.47 ± 1.50^{a}	7.63 ± 1.38^{ab}
FDMM	8.10 ± 1.18^{a}	7.27 ± 1.70^{a}	6.80 ± 1.56^{a}	7.37 ± 1.83^{ab}	7.20 ± 1.16^{a}	7.87 ± 1.14^{a}
MFDM	7.37 ± 1.79^{ab}	7.30 ± 2.18^{a}	6.73 ± 2.12^{a}	6.70 ± 1.89^{ab}	7.07 ± 1.39^{a}	6.90 ± 2.20^{b}
MFDS	6.27 ± 1.51^{c}	4.93 ± 2.08^{b}	4.80 ± 2.35^{b}	6.57 ± 1.30^{b}	4.87 ± 1.28^{c}	5.73 ± 1.98^{c}
FMWM	7.20 ± 1.16^{b}	7.40 ± 1.07^{a}	6.57 ± 1.41^{a}	7.10 ± 0.88^{ab}	6.30 ± 1.32^{b}	7.47 ± 1.25^{ab}

Note: *Mean ± standard deviation with same superscripts along the column are not significantly different at ($p>0.05$).
KEY:
FDMS; Fermented Dried Milled Sorghum
FDMM; Fermented Dried Milled Maize
MFDM; Milled Fermented Dried Maize
MFDS; Milled Fermented Dried Sorghum
FMWM; Fermented Milled Wet Maize (Control)

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9. DISCUSSION

The proximate composition of the flour is presented in Table 1. Reduction in moisture of food product leads to better shelf life of the product (Sanni, Adebowale, Filani, Oyewole, & Westby, 2006). The low moisture content (4.33 – 7.00%) in sample FDMS, FDMM, MFDM and MFDS could be attributed to their high dry-matter content which confers that they would have a good keeping quality. According to Peluola-Adeyemi, Obi, and Ugbogu (2016) high moisture content in food product could affect its mechanical and keeping quality; and at lower moisture content the deterioration of baked product would be lowered due to reduced activity of microorganisms. The value for moisture in this study were lower than the value (10.5%) reported by Giami, Achinewhu, and Ibaakee (2005) for maize flour. Protein content is one of the most important quality of any food. The value in this study is lower than 20% which explain that the samples are not good source of protein. These protein value were higher when compared to the values (1.50-2.03%) reported by Amir et al. (2015) for composite flours from maize and sorghum.

Adelakun, Adejuyitan, Olajide, and Alabi (2005) reported that ash content is an indication of mineral contents in food. The value of ash content in this study were higher when compared with the value (1.53-2.33%) reported by Meite, Kouame, Amani, Kati-Coulibaly, and Offoumou (2008) for maize-*citrullus lanatus* composite flours. The value of fat in this study is slightly lower than the value (1.50-1.59) reported by Onwurafor, Umego, and Uzodinma (2017) for sorghum-maize-mungbean malt complementary food. The low value of fat found in the samples could be due to the fact that maize and sorghum contains less amount of fat content.

The fibre content in this samples shows that the samples are good source of fibre. Fibre is reported to help in lowering the serum cholesterol, control blood sugar and other ailments of gastrointestinal tract of man. The value of fibre in this study is lower than the value (1.65-7.94) reported by Jimoh and Abdullahi (2017) for flour produced from selected sorghum cultivars. The relatively high carbohydrate content could make the product a significant source of energy. The carbohydrate value in this study was higher than the value (65.15-76.28%) reported by Jimoh and Abdullahi (2017) for flour produced from selected sorghum cultivars.

The results of the functional properties obtained are shown in Table 2. It has been documented that bulk density depends on interested factors including intensity of attractive interparticle forces, particle size and number of contact points (Peleg & Bagley, 2000). The values obtained are in the value of (0.53-0.69) reported by Mbaeyi-Nwaoha and Onweluzo (2013) for sorghum and pigeon pea flour blends. Similarly, high water absorption capacity may also be attributed to the loose structure of starch polymers while a low value indicate compactness of the starch structure. Hence, the high water absorption capacity value obtained in this study shows that the samples has the potential to bind water. The water absorption values recorded were higher than the values (1.12-1.46%) reported for fermented maize flour by Beugre, Yapo, Blei, and Gnakri (2014). It has been documented that the oil absorption capacity of flour blends may be useful in food preparation that involves oil mixing such as in bakery products where oil is an important ingredient (Banigo & Mepba, 2005). The value of oil absorption capacity in this study is lower when compared to the value (3.43-3.70) reported by Elkhalifa et al. (2005) who worked on functional properties of sorghum flour. Swelling capacity is a function of the product to rise when having interaction with water. The value of swelling capacity obtained in this study indicated that the flours will rise when mix with water. It has been reported that when starch granules are heated with sufficient water, the crystalline structure of starch is disrupted due to breakage of hydrogen bond which causes increased granule swelling (Huang, Wang, & Yu, 2009; Onitilo, Sanni, Daniel, Maziyadixon, & Dixon, 2007). According to Bhupender, Rajneesh, and Baljeet (2013) solubility is an indicator of degree of dispersion of granules after cooking. The solubility value in this study was lower when compared to the value (18.17-36.08%) for chemical, functional and pasting properties of millet flour reported by Eke-Ejiofor and Oparaodu (2019).

The pH value ranged from 3.83-6.86. The significance of pH of a food product is that it could determine the ability of microorganism grow in such product. The pH values in this study were lower to the value (4.3-5.5) for fermented and unfermented maize flour reported by Amankwah, Barimah, Acheampong, Addai, and Nnaji (2009).

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The value for TTA in this study ranged from 0.05-0.25. The significance of TTA in a food product is connected with its ability to influence the flavour of such product (Sadler & Murphy, 2010). The titratable acidity in this study were lower when compared to the value (0.4-0.9) reported by Amankwah *et al.* (2009) for fermented and unfermented maize flour.

Differences in the score attribute, in terms of taste, colour, flavour, appearance, texture and overall acceptability may be due to the differences in wet and dried milled maize and sorghum flour used to produce the product. Colour is an important attribute because it can arouse individual's appetite (Pereira, Correia, & Guiné, 2013). Highest colour score (8.10) was rated for sample FDMM while lowest score (6.20) was rated for sample MFDS. Taste is an important attribute in acceptance of food product. Highest appearance and texture scores (7.50 and 7.47) respectively was observed in sample FDMS while the lowest score (5.10 and 4.63) was obtained in sample MFDS. There was no significant difference between sample MFDM, FDMS and FDMM. The value in this study for overall acceptability were similar when compared to the value (3.90-7.05) reported by Samuel, Ishola, and Otegbayo (2015) who worked on rice- based *mosa* enriched with soybean and crayfish. It is however observed that there was no significant differences (p>0.05) between sample FMWM (control), MFDM, FDMS and FDMM in respect to taste, colour, flavor and overall acceptability. This indicates that acceptable mosa comparable with the control can be produced from fermented dried milled sorghum, milled fermented dried maize and fermented dried milled maize without affecting its quality.

10. CONCLUSION

The production of *mosa*, an important traditional snack prepared from fermented maize flour and sorghum flour was investigated. Proximate and sensory evaluation studies on *mosa* quality revealed that a relatively nutritious and acceptable *mosa* snack can be prepared from fermented dried milled maize and sorghum, which compared well with the control thus removing the laborious and time consuming preparation of traditional *mosa* snack. It is recommended that further studies on *mosa* should be based on the shelf-stablility of mosa flour. This will help facilitate greater acceptability of *mosa*. The microbiology of *mosa* fermentation should also be investigated.

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REFERENCES

Adelakun, O. E., Adejuyitan, J. A., Olajide, J. O., & Alabi, B. K. (2005). Effect of soybean substitution on some physical, compositional and sensory properties of kokoro (a local maize snack). *European Food Research and Technology, 220*(1), 79-82.

Adepeju, A. B., Gbadamosi, S. O., Omobuwajo, T. O., & Abiodun, O. A. (2014). Functional and physico-chemical properties of complementary diets produced from breadfruit (Artocarpus altilis). *African Journal of Food Science and Technology, 5*(4), 105-113.

Amankwah, E. A., Barimah, J., Acheampong, R., Addai, L. O., & Nnaji, C. O. (2009). Effect of fermentation and malting on the viscosity of maize-soyabean weaning blends. *Pakistan Journal of Nutrition, 8*(10), 1671-1675.

Amir, B., Mueen-Ud-Din, G., Abrar, M., Mahmood, S., Nadeem, M., & Mehmood, A. (2015). Chemical composition, rheological properties and cookies making ability of composite flours from maize, sorghum and wheat. *Journal of Agroalimentary Processes and Technologies*, 28-35.

AOAC. (2000). *Methods of the association of official analystical chemists. Official methods of analysis* (18th ed.): Alitington Virgina Association.

Ayo, J. A., Agu, H., & Famoriyo, O. F. (2008a). Effect of different cereals on the quality of Masa. *Pakistan Journal of Nutrition, 7*(4), 530-533.

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Ayo., J. A., Agu, H., Ayo, V. A., & Famoriyo, O. F. (2008b). Effect of Groundnut Paste on the quality of Maize based Masa. *Pakistan Journal of Nutrition, 7*(4), 557-560.

Banigo, E. B., & Mepba, H. D. (2005). *Certain functional properties of wheat-breadfruit composite flours.* Paper presented at the In: Proced.29th Annual Conference of Nigerian Institute of Food Science and Tech.(NIFST).

Beugre, G. A. M., Yapo, B. M., Blei, S. H., & Gnakri, D. (2014). Effect of fermentation time on the physico-chemical properties of maize flour. *International Journal of Research Studies Bioscience, 2*(8), 30-38.

Bhupender, S. K., Rajneesh, B., & Baljeet, S. Y. (2013). Physicochemical, functional, thermal and pasting properties of starches isolated from pearl millet cultivars. *International Food Research Journal, 20*(4), 1555-1561.

Cardoso, L. M., Pinheiro, S. S., Carvalho, C. W. P., Queiroz, V. A. V., Menezes, C. B., Moreira, A. V. B., . . . Pinheiro-Sant'Ana, H. M. (2015). Phenolic compounds profile in sorghum processed by extrusion cooking and dry heat in a conventional oven. *Journal of Cereal Science, 65*(1), 220-226.

Eke-Ejiofor, J., & Oparaodu, F. O. (2019). Chemical, functional and pasting properties of flour from three millet varieties. *Research Journal of Food and Nutrition, 3*(3), 15-21.

Elkhalifa, A. O., Schiffler, B., & Bernhardt, R. (2005). Effect of fermentation on the functional properties of sorghum flour. *Food Chemistry, 92*(1), 1-5.

Ertas, N., Sert, D., & Demir, M. K. (2015). Functional properties of tarhana enriched with whey Concentrate. *Agronomy Research, 13*(4), 919–928.

FAO. (2003). Chapter 2 food security: Concepts and measurement. In FAO (Ed.), Trade reforms and Food Security (pp. 25-34). Rome: Food and Agriculture Organization of the United State.

Giami, S. Y., Achinewhu, S. C., & Ibaakee, C. (2005). The quality and sensory attributes of cookies supplemented with fluted pumpkin (Telfairia occidentalis Hook) seed flour. *International Journal of Food Science and Technology, 40*(6), 613-620.

Huang, M. F., Wang, H. Y., & Yu, J. G. (2009). Preparation and properties of green thermoplastic B. Saunders Company.

Igwe, E. C., Oyebode, Y. B., & Dandago, M. A. (2013). Effect of fermentation time and leavening agent on the quality of laboratory produced and market samples of masa (a local cereal based puff batter). *African Journal of Food, Agriculture, Nutrition and Development, 13*(5), 8415-8427.

Jimoh, W. L., & Abdullahi, M. S. (2017). Proximate analysis of selected sorghum cultivars *Bayero Journal of Pure and Applied Sciences, 10*(1), 285 - 288.

Kolawole, O. M., Kayode, R. M. O., & Akinduyo, B. (2007). Microbial analysis of Burukutu and Pito produced in Ilorin, Nigeria. *African Journal of Biotechnology, 6*(5), 587-590.

Mbaeyi-Nwaoha, I. E., & Onweluzo, J. C. (2013). Functional properties of sorghum (S. bicolor L.)-pigeonpea (Cajanus cajan) flour blends and storage stability of a flaked breakfast formulated from blends. *Pakistan Journal of Nutrition, 12*(4), 382-397.

Meite, A., Kouame, K. G., Amani, N. G., Kati-Coulibaly, S., & Offoumou, A. (2008). Physico-chemical and sensory features of breads fortified with the flours of seeds of citrulluslanatus. *Journal of science. Pharmacology and Biolology, 9*(1), 32-43.

Nwosu, J. N., Ogueke, C. C., Owuamanam, C. I., & Onuegbu, N. (2011). The effect of storage conditions on the proximate and rheological properties of soup thickener brachystegia enrycoma (Achi). *Report and Opinion, 3*(5), 52-58.

Onitilo, M. O., Sanni, L. O., Daniel, I., Maziyadixon, B., & Dixon, A. (2007). Physico-chemical and functional properties of native starches from cassava varieties in southwest Nigeria. *Journals of Food Science and Agricultural Environment, 5*, 108–114.

Onwurafor, E. U., Umego, E. C., & Uzodinma, E. O. (2017). Chemical, functional, pasting and sensory properties of sorghum-maize-mungbean malt complementary food. *Pakistan Journal of Nutrition, 16*(11), 826-834

Peleg, M., & Bagley, E. B. (2000). *Physical properties of foods.* Westport, Connecticut: AVI Publishing Co. Inc.

Peluola-Adeyemi, O. A., Obi, T. E., & Ugbogu, D. I. (2016). Effect of temperature and time on the physical properties of head produced from wheat-cocoyam flour using response surface methodology. *Journal of food Technology Research, 3*(2), 63-71.

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Pereira, D., Correia, P. M., & Guiné, R. P. (2013). Analysis of the physical-chemical and sensorial properties of Maria type cookies. *Acta Chimica Slovaca*, *6*(2), 269-280.

Sadler, G. D., & Murphy, P. A. (2010). pH and titratable acidity In: Food Analysis (Nielsen SS ed.) (4th ed., pp. 219-238). New York, USA: Springer.

Samuel, F. O., Ishola, O. R., & Otegbayo, B. O. (2015). Nutritional and sensory evaluation of rice-based Masa Enriched with Soybean and Crayfish. *Food and Nutrition Sciences*, *6*(02), 234-241.

Sanni, L. O., Adebowale, A. A., Filani, T. A., Oyewole, O. B., & Westby, A. (2006). Quality of flash and rotary dried fufu flour. *Journal of Food Agriculture and Environment*, *4*(3and4), 74-78.

Sosulski, F. W., Humbert, F. S., Bui, K., & Jones, J. D. (1976). Functional properties of rapeseed flours, concentrates and isolates. *Journal of Food Science (USA)*, *41*(6), 1349-1352.

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