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Research

Nutritional quality attributes of biscuit produced from wheat supplemented with sprouted finger millet flour

[1]*Adewole, S. A., [2]Ologunde, M. O., [3]Oyesiji, O. O., [4]Adewole, O. A., [5]Adaramola, F. B., [6]Ola, O. I., [7]Adetayo, M. O. and [8]Ukangwa, N. A.

[1] Department of Agriculture and Industrial Technology, Babcock University, Ilishan Remo, Nigeria.
[2, 3] Department of Food Science, Faculty of Food and Consumer Sciences, Ladoke Akintola University of Technology, Ogbomosho, Nigeria
[4,7, 8] Department of Biochemistry, Babcock University, Ilishan-Remo, Nigeria.
[5]Department of Basic Sciences, Chemistry Unit, Babcock University, Ilishan-Remo, Nigeria.
[6]Department of Food Technology, Gateway (ICT) Polytechnic, Sapade, Nigeria.

Corresponding author < adewoles@babcock.edu.ng >

Abstract

This study investigated the effect of sprouting on nutritional parameters of finger millet flour and biscuits made from its blends (at different ratios) with wheat flour. Finger millets were sprouted between 24 and 96 hr. Unsprouted and 96 hr - Sprouted finger millet flours were evaluated for proximate, mineral and anti-nutrients compositions. Results of the proximate composition of finger millet flours showed that sprouting caused decreased in contents of fat (1.31-0.93 %), fibre (3.62 – 3.50 %), carbohydrate (74.00 – 70.80 %), and increase in the contents of moisture (10.00 – 11.87 %), protein (8.60–9.51 %), ash (2.47–3.39 %) . The proximate composition of the biscuit ranged from 7.48-8.93, 10.81-11.92, 2.47-3.60, 3.98-4.36, 1.78-3.54, and 7.89-7.36 % for moisture, crude protein, crude fat, crude fibre, ash and carbohydrate respectively. The mineral contents increased from 326.40–332.80, 133.00–135.00 and 237.50–240.20 mg/100 g for Calcium, Manganese and Phosphorus respectively. Oxalate, phytate, saponin and tannin contents decreased from 14.98 – 12.13, 16.17 – 13.10, 61.65 – 38.31 and 12.17- 10.02 mg/100 g respectively. This study showed that supplementation of wheat flour with sprouted finger millet improved the nutritional qualities of the flour and the biscuits made from it.

Keywords: Biscuits, Nutritional, Finger Millet, Wheat, Sprouting **.**

Introduction

Finger millet or ragi (*Eluesine coracana. L*) is an important minor cereal in the semi-arid regions of Africa and India (Obilana and Manyasa, 2002) and it has become one of the staple cereals for a wide segment of the population. Finger millet has been regarded as one of the most nutritious and healthy cereals with high protein, mineral and fibre contents which made it unique among the minor cereals (Wafula *et al*., 2018). Although underutilized, it is valuable because its methionine content, which is lacking in diet of hundreds of millions of the poor who lives on starchy staples such as cassava, plantain, polished rice and maize meal (Amadon *et al*., 2013). Its high dietary fibre content contributes significantly to its low glycaemic index; thus making it useful for controlling blood glucose levels and considered an ideal food for diabetic individuals (Lakshmi *et al*., 2002). It is eaten in like manner to a number of food products that are related to those manufactured from sorghum and other millets. Finger millet products include fermented and non-fermented porridges, pancake-like flatbreads, biscuit and fermented alcoholic and non-alcoholic beverages (Murty and Kumar, 1995). The escalating cost of wheat importation and difficulty in cultivating wheat in the tropics has focused attention on the necessity to explore the use of alternative local flours as supplements or substitutes for wheat flour in the baking industry. With the changing view toward health and taste, people are demanding functional food, composite flour food which provides the health benefits as well as urging sensory characteristics. Wheat-Finger Millet composite flour can be converted into variety of new food products such as noodles, vermicelli, pasta products, papads, roller dried finger millet-based soup mixes, bakery products such as bread and biscuits (Gull *et al.,* 2016). Bakery products are the most popular processed food items in the world (Caleja *et al*., 2017). Of these, biscuits represent the largest category of snack foods among bakery products because they are made from simple, cheap and easily available raw materials. They are widely consumed because they have a very acceptable taste and their low water activity allows a long shelf life (Chauhan *et al*., 2015). Biscuit is defined as a small thin crisp cake made from dough (Nwosu, 2013). This work was carried out with a view to enhance the nutritional qualities of biscuit by substituting wheat flour with sprouted finger millet flour.

Materials and method

Collection of sample

The finger millet grains were obtained from Ahmadu Bello University Experimental farm in Zaria while commercially available wheat flour was procured from a local market in Oshogbo, Osun State, Nigeria. Finger millet grains were cleaned to remove foreign matter such as dust particles, seeds of other grains/crops and other impurities such as stones and weeds. This was divided into two portions. One portion of the grains was pulverized and sieved to obtain fine powder for the control sample. The wheat flour was used as purchased without any further modification. The flour samples were packaged and stored using a high density polyethylene material for further analytical work.

Sprouting of finger millet grains

Sprouting of finger millet was done as described by Syed *et al.* (2011). The seeds were soaked by submerging in water in glass containers for 24 hr at room temperature (28 ±1 °C). After soaking, the seeds were taken out from the glass container and the adherent moisture removed by gently rolling them on thick absorbent cloth. The pre-soaked seeds were allowed to sprout on sterile germinating trays lined with filter paper and kept moist by layers of damp cotton wool. The seeds were germinated at room temperature (28 ±1 °C). Sprouting was carried out for each treatment

(0, 24, 48, 72 and 96 hr) and dried using cabinet dryer (45 °C for 12 hr). The germinated seeds were ground, sieved and packaged and stored using a polyethylene bags until further analysis.

Formulation of flour blends

Table 1 shows the formulation of various blends of sprouted finger millet and wheat flours together with other ingredients used in the production of the biscuits.

Preparation of biscuit

About 15 g of margarine and 3 g of sugar were creamed to a smooth consistency; water, vanilla and milk were also added and mixed properly. The dry ingredients; flour, baking powder, skimmed milk powder and salt were mixed together to form a dough. The dough was kneaded into uniform thickness, cut into shapes, placed in greased pans and baked at 200 °C for 20 min. The biscuits were packaged in cellophane bags prior to analysis.

Table 1: Formulation of ingredients for the production of biscuit

Samples	Wheat flour (%)	Sprouted finger millet flour (%)	Margarine (g)	Skimmed milk powder	Vanilla (mL)	Salt (g)	Baking powder (g)	Water (mL)	Sugar (g)
A	100	0	15	5	4	2	0.2	47	3
B	90	10	15	5	4	2	0.2	47	3
C	80	20	15	5	4	2	0.2	47	3
D	70	30	15	5	4	2	0.2	45	3
E	60	40	15	5	4	2	0.2	45	3
F	50	50	15	5	4	2	0.2	45	3

Sample A =100 WF, Sample B = 90:10%, WF + 96hr SFMF, Sample C =80:20%, WF + 96hr SFMF Sample D=70:30%, WF + 96hr SFMF, Sample E =60:40%, WF + 96hr SFMF, Sample F =50:50%, WF + 96hr SFMF, WF= White flour, SFMF = Sprouted finger millet flour

Proximate and mineral analysis

The samples were analyzed for moisture, ash, crude fibre, protein (N*6.25), crude fat and the carbohydrate determined by difference according to the method described by AOAC (2005). Minerals (Ca, Mn and P) were extracted from dry ashed samples and determined by Atomic Absorption Spectrophotometer according to AOAC (2005).

Antinutritional factors

The oxalate content of the samples was determined using titration method described by Inuwa *et al.* (2006). Phytate content was determined using the method of Inuwa *et al.* (2011). Saponin content of the sample was determined according to Okwu & Emenike, (2006) while the tannin content of the flour samples were determined as described by Makkar *et al*. (1996) using Folin Denis Reagents.

Sensory evaluation of biscuit

Sensory evaluation was carried out with 40 panellists in the sensory laboratory. Each panellist was served with biscuit made from the flour blends. Water was provided for rinsing between the samples. Panellists were required to evaluate the colour, flavor, taste, texture, crispiness, and overall acceptance of the biscuit using the 9-point hedonic scale with 1 dislike extremely and 9 like extremely.

Statistical analysis

The results of the experiment was subjected to analysis of variance (ANOVA) and the mean was separated with the use of Duncan's multiple range test to detect significant difference ($p<0.05$) among the sample.

Results and discussion

Proximate composition of finger millet flour and biscuit

The proximate compositions of the unsprouted and sprouted finger millet flour as well as the biscuits made from the different flour blends are shown in Table 2. The moisture content of unsprouted and sprouted flour samples of finger millet varied between 10 ± 0.04 to 11.87 ± 0.06 %. This showed that the moisture content only increased slightly after sprouting. Moisture content is an indicator of shelf life stability. Increase in moisture content enhances microbial contamination and chemical reactions that could lead to reduction in the food quality and stability (Abioye *et al*., 2018) The moisture contents of the flour samples were below 14 % recommended for long period of storage and therefore have good potential for long term storage (Adeleke and Odedeji, 2010, Ogunlakin *et al*., 2012). There was an apparent increase in content of protein from 8.60 ± 0.06 to 9.51± 0.04 % after sprouting. This was in agreement with earlier reports of increased protein during sprouting of various cereals, legumes, and seeds (Inyang and Zakari, 2008). The increase could be attributed to synthesis of enzymic protein (e.g proteases) during sprouting. The fat content in this present study decreased from 1.31 ± 0.01 to 0.93 ± 0.05 % after sprouting. The decrease in the fat content could be due to hydrolysis and utilization of fats as an energy source for biochemical reactions during sprouting (Jan *et al*., 2017). Thus, decreased fat content implied an increased shelf-life for the sprouted seeds compared to the unsprouted one.

The result of the proximate composition of biscuits from wheat-sprouted finger millet flour blends showed that the moisture content of the biscuits significantly increased from 7.48 ± 1.00^{a} % in 100 % wheat flour (control) to 8.93 ± 1.00^{e} % in 40 % finger millet flour supplementation. The overall low moisture content indicated potentials for longer shelf life of the product. Also, the protein and fat contents of the biscuits decreased from 11.92 ± 1.00^{f} to 10.81 ± 1.00^{a} % and 3.60 ± 1.00^{f} to 2.47 ± 1.00^{a} % respectively with increasing levels of finger millet addition. This decreased could be attributed to the low fat contents of the sprouted finger millet. The crude fibre contents ranged from 3.98 ± 1.00^{a} to 4.36 ± 1.00^{f} with 50 % supplementation having the lowest value while the 20 % supplementation had the highest crude fibre contents. According to Schneeman (2002) crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. Meanwhile, ash contents ranged from 1.78 ± 1.00^{a} to 3.54 ± 1.00^{f} % with 30 % supplementation having the highest while the un-supplemented wheat flour had the least. The increased ash content could be attributed to the high ash content of the sprouted finger millet which was reported to contain high minerals. The carbohydrate content ranged from 70.89 ± 1.00^{a} - 71.36 ± 1.00^{d} %. There was increased in the carbohydrate contents with increasing levels of finger millet supplementation. There was no significant difference between sample B and C and sample D and E respectively

Table 2: Chemical composition of finger millet flour and biscuit produced from wheat / 96 hr sprouted finger millet flour

Samples	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude Fibre (%)	Ash (%)	CHO (%)
A	7.48± 1.00[a]	11.92 ± 1.00[f]	3.60 ± 1.00[f]	4.33 ± 1.00[d]	1.78 ± 1.00[a]	70.89 ± 1.00[a]
B	7.87 ± 1.00[b]	11.71 ± 1.00[e]	3.33 ± 1.00[e]	4.34 ± 1.00[e]	1.94 ± 1.00[b]	70.99 ± 0.07[b]
C	8.30 ± 1.00[c]	11.49 ± 1.00[d]	3.06 ± 1.00[f]	4.36 ± 1.00[f]	2.20 ± 1.00[c]	71.00 ± 0.07[b]
D	8.36 ± 1.00[d]	11.19 ± 1.00[c]	2.78 ± 1.00[c]	4.22 ± 1.00[c]	3.54 ± 1.00[f]	71.16 ± 0.06[c]
E	8.94 ± 1.00[e]	10.85 ± 1.00[b]	2.53 ± 1.00[b]	4.00 ± 1.00[b]	2.43 ± 0.06[d]	71.27 ± 0.06[c]
F	8.93 ± 1.00[f]	10.81 ± 1.00[a]	2.47 ± 1.00[a]	3.98 ± 1.00[a]	2.42 ± 0.06[d]	71.36 ± 1.00[d]
UFMF	10.00 ± 0.04	8.60 ± 0.06	1.31 ± 0.01	3.62 ± 0.04	2.47 ± 0.02	74.00 ± 0.09
SFMF	11.87 ± 0.06	9.51 ± 0.04	0.93 ± 0.05	3.50 ± 0.01	3.39 ± 0.13	70.80 ± 0.02

Mean values followed by the same letter (s) within the same column are not significant ($p \geq 0.05$,). Sample A-F = Biscuits, Sample A = 100 WWF, Sample B = 90:10 %, WF + 96 hr SFMF, Sample C = 80:20 %, WF + 96 hr SFMF, Sample D = 70:30 %, WF + 96 hr SFMF, Sample E = 60:40 %, WF + 96 hr SFMF, Sample F =50:50 %, WF + 96 hr SFMF, WF = White flour, SFMF = Sprouted finger millet flour, UFMF= unsprouted finger millet flour

Effect of sprouting on the mineral contents of finger millet flour

The results of the effects of sprouting on the mineral composition (calcium, manganese and phosphorus) of finger millet flour are shown in Table 3. The results showed that sprouting had significant effects on the mineral content of finger millet. Sprouting caused increase in calcium, manganese and phosphorus contents from 326.40 ± 0.09 - 332.80 ± 0.00, 133 ± 0.00 - 135 ± 0.01mg/100 g and 237 ± 0.02 - 240 ± 0.00 g/100 g respectively. The increase in Ca, Mn and P contents after sprouting might be attributed to the breakdown of phytate which binds (chelate) the minerals to the seed tissue. Phosphorus works closely with calcium to build strong bones and teeth. It is stored in the bone as calcium phosphate. Food rich in these nutrients would enhance the health of both children and adults.

Table 3: Effect of sprouting (96 hr) on the mineral contents of finger millet flour

Sample	Calcium (mg/100g)	Manganese (mg/100g)	Phosphorus (mg/100g)
UFMF	326.40 ± 0.09	133.00 ± 0.00	237.50 ± 0.02
SFMF	332.80± 0.00	135.10 ± 0.01	240.20 ± 0.00

UFMF = unsprouted finger millet flour; SFMF= 96 hr-Sprouted finger millet flour

Effect of sprouting on the Anti-nutritional factors in finger millet sprouted at varied time period

The effects of sprouting on the anti-nutritional factors; oxalate, phytates, saponins, oxalates and tannins contents of finger millet flour are presented in Table 4. The results showed that there was a significant reduction in the levels of all the anti-nutrients as the sprouting period increases. Greater reduction in the anti-nutrients was observed at 96 hr sprouting period. Oxalate, phytate, saponin and tannin contents decreased from 14.98 ± 1.00^{e} – 12.13 ± 1.00^{a}, 16.17 ± 1.00^{e} – 13.10 ± 1.00^{a}, 61.65 ± 1.00^{e} – 38.31 ± 1.00^{e} mg/ 100 g and 12.17 ± 1.00^{e} - 10.02 ± 1.00^{a} respectively. The decrease in these levels of the anti-nutrients could be due to the activities of enzyme which caused the degradation (Bishnoi *et al.*, 1994).

Table 4: Effect of sprouting on anti-nutrient content of finger millet in mg/100g

T	Oxalate	Phytate	Saponin	Tannin
0 hr	14.98 ± 1.00^{e}	16.17 ± 1.00^{e}	61.65 ± 1.00^{e}	12.17 ± 1.00^{e}
24 hr	14.13 ± 1.00^{d}	15.71 ± 1.00^{d}	58.09 ± 1.00^{d}	11.57 ± 1.00^{d}
48 hr	13.64 ± 1.00^{c}	15.55 ± 1.00^{c}	50.35 ± 1.00^{c}	10.29 ± 1.00^{c}
72 hr	12.51 ± 1.00^{b}	13.65 ± 1.00^{b}	44.81 ± 1.00^{b}	10.05 ± 1.00^{b}
96 hr	12.13 ± 1.00^{a}	13.01 ± 1.00^{a}	38.31 ± 1.00^{a}	10.02 ± 1.00^{a}

All values are means of triplicate determination $\pm$ standard deviation (SD). All values with different superscripts in the same column are significantly different at $p<0.05$.
T = Treatment time, hr = hour.

Sensory Characteristics of biscuit made from finger millet and wheat flour

The sensory evaluation of biscuit produced from the composite flour of wheat and sprouted finger millet flour are as shown in Table 5. The result showed that the biscuit produced from the wheat flour had good overall acceptability. However, biscuits made from 10 % and 20 % wheat flour supplementations showed comparable sensory qualities with the biscuit made from 100 % wheat flour. Biscuit produced from sample F were neither like nor dislike (4.00). From the overall acceptability, it was found that supplementation of wheat flour by up to 20 % finger millet was most acceptable. Thus, it is recommended that up to 20 % sprouted finger millet supplementation of wheat flour is suitable for the production of biscuit with acceptable sensory attributes.

Table 5: Sensory attributes of biscuit produced from wheat /96 hr sprouted finger millet flour

Samples	Crumb colour	Crust colour	Taste	Texture	Crispiness	Flavour	Overall acceptability
A	6.67±1.00[c]	6.33±0.26[b]	6.67±0.4[b]	7.00± 1.00[d]	6.33±0.26[c]	7.00±0.24[d]	7.00±0.24[d]
B	6.00±1.00[b]	6.00±0.26[b]	7.00±0.4[b]	6.00±1.00[c]	6.00±0.26[c]	6.00±1.00[c]	6.00±1.00[c]
C	6.00±1.00[b]	6.00±0.26[b]	6.67±0.4[b]	6.00±1.00[c]	5.00±1.0[b]	6.67±0.24[d]	6.67±0.24[d]
D	6.00±1.00[b]	5.33±0.26[a]	5.33±0.13[a]	5.33±0.2[b]	5.00±1.0[b]	5.00±0.24[b]	5.00±0.24[b]
E	4.33±0.24[a]	5.00±0.26[a]	5.00±0.13[a]	5.00±0.24[ab]	4.33±0.24[a]	4.67±0.24[b]	4.67±0.24[b]
F	4.00±0.24[a]	5.00±0.26[a]	4.67±0.13[a]	4.67±0.24[a]	4.00±0.24[a]	4.00±1.00[a]	4.00±1.00[a]

Values bearing the same superscript within the same column are not significantly ($p>0.05$) different from each other. Sample A =100 WF, Sample B = 90:10%, WF + 96hr SFMF, Sample C =80:20%, WF + 96hr SFMF, Sample D=70:30%, WF + 96hr SFMF, Sample E =60:40%, WF + 96hr SFMF, Sample F =50:50%, WF + 96hr SFMF, WF= White flour, SFMF = Sprouted finger millet flour

Conclusion

This study showed that sprouting caused increased in the nutritional qualities as well as reduction in the anti-nutrient composition of finger millet flour. There was also an increase in the crude fibre, ash, and carbohydrate contents of the biscuit produced from wheat and sprouted finger millet flour blend as the level of finger millet supplementation increased. This study concluded that acceptable and good quality biscuits could be produced from composite flour of wheat and sprouted finger millet. The potential usability of sprouted finger millet flour as supplementation material in biscuit production was established in this study and this will thereby reduce pressure on the use of wheat flour alone in biscuit production.

References

Abioye V.F, Olatunde S.J and Elias G (2018). Quality Attributes of Cookies Produced From Composite Flours of Wheat, Germinated Finger millet flour and African yam bean. *International Journal of Research – Granthaalayah*. .6 (11).

Adeleke, R.O., and Odedeji, J.O. 2010. Functional properties of wheat and sweet potato flour blend. *Pakistan Journal of Nutrition.* 96:535–538.

Amadou, I, Gounga, M.E, Guo-Wei, L. 2013. Millets: Nutritional composition, some health benefits and processing - A review. Emir. *J. Food Agric*., 25 (7): 501-508.

AOAC, "Official method of analysis (18th edition.). Association of Official Analytical Chemists," Washington DC., USA, 2005.

Bishnoi, S., Khetarpaul, N. and Yadav, R.K. 1994. Effect of domestic processing and cooking methods on phytic acid and polyphenol contents of pea cultivars (*Pisum sativum*). *Plant Foods Hum. Nutr*. 47: 381-388.

Caleja, L, Barros, L and Antonio, A.L. 2017 "A comparative study between natural and synthetic antioxidants: Evaluation of their performance after incorporation into biscuits*". Food Chemistry*., 216: 342-346.

Chandra, A.K., Sanjukta, M., Lahari, D. and Tripathy, S. (2004). Goitrogenic content of Indian Cyanogenic plant foods & there in vitro anti-thyroidal activity. *Ind. J. Med. Res*., 119:180-185.

Chauhan, D. Saxena, C and Singh, S. 2015 "Total dietary fibre and antioxidant activity of gluten free biscuit made from raw and germinated amaranth (Amaranthus spp.) flour". LWT - *Food Science Technology.* 63: 939-945

Gull, A, Prasad, K, and Kumar, P. 2016. Nutritional, antioxidant, microstructural and pasting properties of functional pasta. *J. Saudi Soc. Agric. Sci*. 1-7.

Inuwa, H.M, Aina, V.O, Baba G, Aimola, I. and Amao, T. 2011. Comparative Determination of Antinutritional Factors in Groundnut Oil and Palm Oil. Adv. *Journal of Food Science and Technology*. 3(4): 275 – 279.

Inyang, C.U and Zakari, 2008. Effect of Germination and fermentation of Pearl Millet on Proximate, Chemical and Sensory Properties of Instant "Fura" – A Nigeria cereal Food. *Pakistan Journal of Nutrition*., 7 (1): 9-12.

Jan, R, Saxena, D.C, and Singh, S. 2017. Physico-chemical, textural, sensory and antioxidant characteristics of gluten-Free cookies made from raw and germinated Chenopodium (*Chenopodium Album*) flour. LWT- *Food Science and. Technology*, 71, 281- 287.

Makkar, A.O.S, and Goodchild, A.V. 1996. Qualification of Tannins. A Laboratory Manual Int. Centre for Agriculture. A Laboratory Manual Int. Centre for Agriculture Research in the Dry Areas (ICARDA), Aleppo, Syria, I.V + 25pp.

Murty, D.S, and Kumar, K.A. 1995. Traditional Uses of Sorghum and Millets. 185-222 in: Sorghum and Millets: Chemistry and Technology. D.A.V. Derdy, (ed): AACC International. St. Paul, M.N.

Nwosu J.N 2103. "Production and Evaluation of Biscuits from Blends of Bambara Groundnut (*Vigna subterran*) and Wheat (*Triticum Eastrum*) flours". *International Journal Food Nutr. Sci*., 2: 21-53.

Obilana, A.B. and Manyasa, E. 2002. Pseudocereals and Less Common Cereals. Millets. In: P.S. Belton and J.R.N. Taylor (Eds.).pp. 177-217.Pseudo cereals and less common cereals: Grain properties and utilization potential. Springer-Verlag: New York.

Ogunlakin, G.O, Oke, M.O., Babarinde, G.O and Olatunbosun, D.G. 2012. Effect of drying methods on proximate composition and physico-chemical properties of cocoyam flour. *American Journal of. Food Technology*. 7: 245-250.

Okwu, D.E, and Emenike, I N. 2006. Evaluation of the phytonutrients and vitamin contents of citrus fruits. *Intl. J. Mol. Med. Adv. Sci*., 2 (1):1-6.

Schneeman, B.O. 2002. Gastrointestinal physiology and functions. *British. Journal of Nutrition*. 88 (2):159-163.

Syed, A.S, Aurang, Z, Tariq, M, Nadia, N, Sayed, J.A, Muhammad, S, Abdul, A, Asim, M. 2011. Effects of sprouting time on biochemical and nutritional qualities of Mungbean varieties. *African Journal of*

Agriculture. Res. 6(22):5091-5098.

Wafula, W.N, Korir, N.K, Ojulong H.F, Siambi, M, and Gweyi-Onyango, J.P. 2018. Protein, Calcium, Zinc, and iron contents of finger millet grain response to varietal differences and phosphorus application in Kenya. Agron. 2018: 8:24.