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PARTIAL REPLACEMENT OF WHEAT FLOUR WITH MUSHROOM *(Pleurotus tuber-regium)* POWDER AND COCOYAM *(Colocasia esculenta)* FLOUR IN THE PRODUCTION OF COOKIES

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ABSTRACT
The effect of substituting wheat flour with cocoyam and mushroom flours on the chemical, antinutritional and sensory properties of cookies were investigated. Cookies were prepared by replacing wheat flour with cocoyam and mushroom flour blends at different proportions. There were significant ($p<0.05$) differences in all the quality attributes analyzed. The protein content of the composite flour blends ranged from 9.46-12.72%. The protein content increased with increasing cocoyam and mushroom addition. Similar trend was observed in the protein content of the composite cookie samples (9.48-11.48%). The moisture contents of the flour and cookie samples were below 10% (6.81 – 8.03%) which suggests reduced chances of spoilage by microorganisms and consequently increased shelf life. The water absorption capacity of the wheat –cocoyam-mushroom flour blends were in the range of 65-109% and oil absorption capacity ranged from 170 – 205%. The bulk density values increased (0.33 – 0.37 g/cm^3) as the rate of addition of cocoyam and mushroom increased. The cookies were well accepted by the members of the sensory panel with samples 50:40:10 and 100:0:0 having the same mean score value of 7.6 in their general acceptability rating which translates to like very much in the hedonic scale.

Keywords: Wheat, cocoyam, mushroom, and cookies

Introduction

With increasing globalization, there has been a reduction in the use of traditional foods by many societies across the world. Associated with this reduced use is a loss of knowledge relating these foods to their environment, the nutritional and medicinal values associated with them, how they are collected, stored and prepared, are often overlooked as well as loss of cultural values associated with them (Yen, 2014). However, Kuhnlein *et al.* (2009) defined 'traditional foods' as foods that indigenous peoples have access to locally in the natural environment which they can farm or wild harvest without having to purchase them. 'Underutilized' commonly refer to species whose potential have not been fully realized. 'Indigenous food' signifies food naturally existing or originating in a place or country rather than arriving from another place (Tontisirin, 2014). With regards to the geographical distribution, often a species could be underutilized in some regions but not in others. Understanding the unique local species and varieties of food often requires new identification; food analysis and dietary assessment methods that help define the utilization and application of the food and its systems to the community context in which they are applied.

Mushrooms being one of the neglected and underutilized species represent one of the world's greatest untapped resources of nutritious food and are becoming an increasingly important source of food and medicinal purposes. Mushrooms contain large amounts of dietary fiber, proteins, vitamins, and minerals. A number of mushrooms are used for medicinal purposes as they contain valuable bioactive compounds that include phenolic compounds (Oktay *et al.*, 2015). However, undernutrition and malnutrition are major health problems around the world and the underlying cause is inadequate food intake in terms of both quality and quantity (Black *et al.*, 2003).

Mushrooms have a great nutritional value since they are quite rich in protein, with an important content of essential amino acids and fiber, and poor in fat (Reid *et al.*, 2017). Edible mushrooms also provide a nutritionally significant content of vitamins (B1, B2, B12, C, D and E) (Heleno *et al.*, 2010). Edible mushrooms could be a source of many different nutraceuticals such as unsatured fatty acids, phenolic compounds, tocopherols, ascorbic acid and carotenoids. Thus, they might be used directly in diet and promote health, taking advantage of the additive and synergistic effects of all the bioactive compounds present (Pereira *et al.,* 2012).

The most cultivated mushroom worldwide is *Agaricus bisporus*, followed by *Lentinula edodes*, *Pleurotus spp.* and *Flammulina velutipes* (Aida *et al.*, 2009). These species require shorter growth time when compared to other edible mushrooms, they demand few environmental controls, and they can be cultivated in a simple and cheap way (Bonatti *et al.*, 2004).

In Nigeria cocoyam is one of the under exploited tropical root plant that is very nutritious but its utilization is still at the subsistence level and it is highly neglected crop (Chukwu *et al.,* 2009). Cocoyams are of many varieties but the most important ones are the *Colocasia esculenta* (taro) and the *Xanthosoma sagittifolium* (tannia) (Nwanekezi *et al,* 2010). Some researchers have decried the extinction of cocoyam in Nigeria (Igbabul *et al.,* 2014) despite its numerous nutritious and health benefits. Cocoyams are grown primarily for their edible starch storage corms and cormels called tubers, and secondarily as a leafy vegetable (Aregheore and Perera, 2003). It is a staple food for millions of people living in the tropics and subtropics (Nwanekezi *et al.*, 2010). Nutritionally, the tubers contain easily digestible starch and are known to contain substantial amounts of protein, fibre, vitamin C, thiamine, riboflavin, potassium, sodium, phosphorus, magnesium, calcium and niacin. The leaves are rich in iron, folic acid and beta carotene (Opara, 2002; Niba, 2003).

Wheat flour, the main ingredient for most snacks production is imported by countries with unfavourable climates for growing wheat. This importation has placed a considerable burden on the foreign exchange reserves of the economies of such importing countries (Okpala and Egwu, 2015). This has led to the development and use of composite flours for production of biscuits, bread and other pastry products. Composite flour has been defined as a mixture of several flours obtained from roots and tubers, cereals, legumes etc. with or without the addition of wheat flour (Okpala and Egwu, 2015). Hence, supplementation with mushroom and cocoyam will be an excellent vehicle for providing proteins, particularly in baked snack foods which are widely consumed due to their long shelf life and good eating quality. This research seeks to investigate the effect of partial replacement of wheat flour with mushroom - cocoyam flour blends in the production of cookies.

Materials and methods

The major raw materials in this research work specifically were wheat (*Triticum aestirum*), edible cocoyam (*Colocasia esculenta*) also known as taro and edible mushroom (*Pleurotus tuber- regium*). The cocoyams were supplied by the cocoyam programme of the National Root Crops Research Institute, Umudike Abia State. The mushrooms were bought from Isiala Ngwa and were identified by the Department of Plant Science and Biotechnology, Michael Okpara Univeristy of Agriculture, Umudike Abia State. The wheat grains and other ingredients used for baking were purchased from Umuahia main market in Abia State.

Production of cocoyam flour

Cocoyam flour was produced as described by Okpala *et al.* (2013) with little modification. Freshly bought cocoyam tubers (corms) without infection symptoms or infestation were thoroughly washed in a running tap water to remove any adhering soil, dirt and dust. Afterward, the corms were peeled, washed, blanched with 0.25% of sodium metabisulphite solution for 15min and cut into thin slices. The cut slices were dried in oven at 55^{0}C for 18h. The dried cocoyam chips were milled into flour, sieved to obtain fine flour of uniform size. The cocoyam flour were stored in airtight plastic containers at room temperature until needed.

Production of wheat flour

The method of Ndife *et al.* (2014) was used in the production of wheat flour. The whole wheat seeds were cleaned, washed and oven dried. The dried whole wheat were milled using attrition mill and sieved into fine flour of uniform particle size, by passing them through a 2 mm mesh sieve. The sieved wheat flour were packaged in airtight containers.

Production of mushroom powder

The method of production described by Sheikh *et al.* (2010) with little modification was used in the production of mushroom powder. The fresh mushrooms were processed to remove dirts and unwholesome portion. The mushrooms were properly washed and drained. The mushrooms were then oven dried at 60^{o}C. for 2h. After cooling to room temperature, the dried mushrooms were milled into powder, sieved and stored in airtight containers for further utilization.

Formulation of flour blends

Five blends were prepared by mixing wheat flour, cocoyam flour and mushroom powder in the following percentage proportion:100:0:0; 70:20:10;

60:30:10;50:40:10 and 40:50:10. Hundred percent (100%) wheat flour formulation was used as the standard.

Production of cookies

The method described by Okpala and Chinyelu, (2011) was used in the production of the composite cookies.

Proximate analysis

Protein, fat, moisture, fibre and ash were determined using methods described by AOAC (2000). Carbohydrate content was determined by difference.

Functional properties of flour blends

Bulk density, pH, wettability, foam capacity and emulsion capacity were determined using methods described by Onwuka (2005). Water and oil absorption capacities were determined according to the methods described by Onimawo and Akubor (2005).

Mineral determination

The mineral components (magnesium, calcium, potassium, zinc, iron and sodium) were analyzed using an Atomic Absorption Spectrophotometer (AAS, Model SP9, Pychicham UK).

Antinutrient determination

The oxalate and phytate determinations were done using the methods described by (Onwuka, 2005). The Tannin content of the samples were determined by Folin Denis Colometric method (Krik and Sawyer, 1998) while the method of Harborne (1973) was used in the determination of alkaloids. The phenol determination was done using the method described by AOAC (1990).

Sensory evaluation

The sensory evaluation was carried out using twenty semi-trained panelists comprising of staff and students of the Michael Okpara University of Agriculture, Umudike who were regular consumers of cookies and were not allergic to any food. Samples were scored based on the following attributes: appearance, taste, aroma, crispness and general acceptability; based on a 9-point hedonic scale with 1 representing dislike extremely, 5, neither like nor dislike and 9 like extremely (Ihekoronye and Ngoddy, 1985).

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA). Means were separated using Duncan's new multiple range test (DNMRT) using the Statistical Package for the Social Sciences (SPSS) version 17.0.

Results and Discussion

Proximate composition of wheat – cocoyam-mushroom composite flour blends

Table 1 shows the result of the proximate composition of the wheat-cocoyam- mushroom composite flour. There were significant ($p<0.05$) differences in the chemical composition of the composite flour samples. The moisture contents of the flour samples were all below 10% (6.81 – 8.03%) which suggests reduced chances of spoilage by microorganisms and consequently increased shelf life (Kure *et al.,* 1998). The moisture content of the flour samples were within the range acceptable for effective flour storage for further processing without the risk of microorganism contamination. Flours with moisture content less than 14% can resist microbial growth and hence storage stability (Ojo *et al.,* 2017). The protein content of the flour blends were in the range of 9.46 – 12.72% with sample 40:50:10 (wheat: cocoyam: mushroom) having the highest protein value of 12.72%. It was observed that the protein content of the flour blends increased with increased inclusion of cocoyam flour and mushroom powder. The flour samples also showed decreasing level of carbohydrate content as the level of cocoyam and mushroom were added (74.04 – 79.91%).

Proximate composition of wheat –cocoyam-mushroom composite cookies

The proximate composition of cookies produced is shown in Table 2. There were significant differences in the result of the proximate composition of the cookie samples. The moisture contents were in the values of 9.55 – 10.42%. High moisture content makes food products prone to attack by microbial organisms leading to spoilage. The rate of spoilage is closely related to the amount of moisture present. The higher the amount of moisture present, the higher the rate of spoilage (Sanful *et al.,* 2013). The protein content ranged from 9.48% to 11.48%. Yadav *et al.* (2011) reported that cookies produced with plantain and chickpea flour blends had protein contents which ranged between 7.1% and 9.2%. The protein content of the cookies increased as the rate of addition of cocoyam increased with addition of 10% mushroom powder in each sample. The protein quality of roots and tubers is sufficiently improved by cereal flours (FAO, 1990). There were significant differences in the values obtained for the crude fibre of the cookie samples. The values for fibre ranged between 1.47% and 2.98%. The highest fat content (3.12%) was obtained from cookies made with 100% wheat flour while sample 70:20:10 had the least value of 2.17%. Similar results were reported by Dhingra and Jood (2002) for wheat flour bread. High levels of fat are undesirable in food products because they could lead to rancidity in foods leading to the development of unpleasant and odorous compounds (Ihekoronye and Ngoddy, 1985). The ash content ranged from 0.73% for sample 100:0:0 (wheat: cocoyam: mushroom) to 2.06% for sample 40:50:10. The ash content of the cookie samples increased with increasing mushroom inclusion. This in agreement with the findings of Hung and Nhi (2012), which reported that mushroom are rich in mineral elements. The carbohydrate levels were in the range of 72.33 – 74.61%. Products from composite flours tend to have less carbohydrate and higher protein content levels when compared to those produced from 100% wheat flour.

Functional properties of wheat – cocoyam-mushroom composite flour blends

Functional properties of the composite flours determine the food application and end use of such materials for other applications. Table 3 shows the functional properties of the wheat-cocoyam-mushroom composite flour blends. The values of the bulk density in this study ranged from 0.33 to 0.38 g/cm^3. Ekunseitan *et al.* (2016) reported 0.71-0.82 g/cm^3 for wheat-mushroom-HQCF composite flour blends. The bulk density is affected by the particle size and the density of the flour which is very important in determining the packaging requirements, material handling and the application in wet processing in food industry (Adebowale *et al.,* 2008). The differences in the chemical composition of the individual flours blended together may explain the difference in values obtained for their bulk density (Ekunseitan *et al.,* 2016).

There was significant difference in water absorption capacity (WAC) of the wheat-cocoyam- mushroom flour blend (P<0.05). Sample 40:50:10 had the highest mean value of 109% while samplen70:20:10 had the lowest mean value of 65%. Niba *et al.* (2001) stated that WAC is important in bulking and consistency of product as well as baking applications. WAI measures the volume occupied by the starch granule or starch polymer after swelling in excess water which can be used as an index of gelatinization (Altan *et al.,* 2008). Water absorption characteristics represent the ability of a product to associate with water under conditions where water is limited (Singh, 2001). The oil absorption capacity values were found to be between 118 – 205%. Ekunseitan *et al.* (2016) reported oil absorption capacity of 67.70 – 79.45 for wheat-mushroom-HQCF blends. It is a function of the lipophilic nature of flour constituents. Increase in oil absorption capacity may also be attributed to the presence of more hydrophobic proteins which showed superior binding of lipids (Ekunseitan *et al.,* 2016) and this could explain the reason why samples with mushroom which is rich in protein had higher values of oil absorption capacity. Oil gives soft texture and good flavor to food. Therefore absorption of oil by food products improves mouth feel and flavor retention. The foaming capacity of the flours ranged from 61.00 – 72.50%. Wheat flour had the highest foaming capacity (72.50%) compared to the other flour bend samples. Foaming capacity is assumed to be dependent on the configuration and nature of protein molecules, as flexible proteins have good foaming capacity (Ibeanu *et al.,* 2016). This may suggest the usefulness of the flour in improving textural and leavening characteristics. Akubor *et al.* (2000) reported that food ingredients with good foaming capacity and stability can be used in bakery products.

Mineral composition of wheat – cocoyam-mushroom cookies

The mineral composition of the cookie samples are presented in Table 4. Values for calcium, magnesium, potassium, sodium, zinc and iron ranged from 30.48 – 65.26, 31.21-42.65, 412.47-460.82, 1.89-8.56, 2.74-4.38 and 2.10-3.19 mg/100 g, respectively. The results obtained in this study showed that calcium content increased with increasing cocoyam and mushroom flour inclusion. High calcium content in mushroom has been reported by Stamets (2003). Similar trend was observed in the magnesium and potassium content of the flour blends, respectively. However, no specific trend was observed in the zinc content.

Antinutritional factors of wheat – cocoyam-mushroom cookies

The antinutrients determined are presented in Table 5. All the values determined have low values. The oxalate values of the cookies were in the range of 0.7 – 0.11mg/100g. It is known that oxalate forms insoluble complex with calcium ions, and it is often anticipated that oxalate containing foods when consumed may interfere with calcium metabolism (Igbabul et al., 2014). The phytate contents ranged from 0.06 – 0.18mg/100g. Phytate is the main inhibitors of many nutrients and mainly inhibits the absorption of iron and, to some extent, zinc (Kordylas, 1990). According to Akindahunsi and Oboh (1999) the phytate content of mushrooms was low when compared to green leafy vegetables whose phytate content was exceptionally high. Phytic acid forms very stable complexes with mineral ions rendering them unavailable for intestinal uptake because the first step in mineral absorption requires that the mineral remain in the ionic state (Lopez *et al.,* 2002) thus inducing mineral deficiencies. Sandberg and Anderine (1986) suggested that food processing such as cooking, fermentation, autoclaving and milling can reduce or eliminate the level of phytic acid by altering the inositol hexaphosphate to other degradation forms, e.g. penta-, tetra-, tri-, di- and monophosphate. Tannins were in the range of 0.09 – 0.21mg/100g. Tannins are known to retard growth through reduced digestion and/or absorption (Laurena *et al.,* 1984). Akindahunsi and Oyetayo (2006) and

Aletor (1995) reported that tannin concentrations in mushrooms were low. These levels might not affect the nutritional potentials of the mushroom parts since they were all less than 10% of the total dry weight of the samples (Osagie, 1996; Woldegiorgis *et al.*, 2015). The result of the antinutritional factors for oxalate, alkaloids and phenol are 0.07-0.11, 0.05-0.25 and 0.04-0.13mg/100g respectively. The values were within acceptable limits for consumption and as such poses no danger to safety.

Sensory evaluation of wheat –cocoyam- mushroom cookies

Presented in Table 6 are the sensory scores obtained for cookies made from wheat-cocoyam –mushroom flour blends. There were significant differences in all the attributes (taste, crispiness, aroma, appearance and general acceptability) determined. The taste attribute of the cookies ranged between 6.8 – 7.6 with sample 100:0:0 having the highest mean score value of 7.6 followed closely by sample 50:40:10 while the least in taste was sample 60:30:10 (6.8) and sample 70:20:10 (6.9). Sample 50:40:10 had the highest mean score of 7.4 while sample 40:50:10 had the least value of 6.1 in taste attribute. The crispiness of the samples ranged between 6.6 – 7.4. Crispiness has been reported to be the most important quality attribute in biscuits (Yahya, 2004). The cookie samples were well accepted by the members of the panelist; samples 50:40:10 and 100:0:0 had the same mean score of 7.6 in their general acceptability rating while samples 60:30:10 and 40:50:10 had same value of 6.7. The mean score translates to like moderately in the hedonic scale.

Conclusion

Sample 40:50:10 had the highest protein content with the flour blend having 12.72% while the cookies produced from the sample flour blend had protein content of 11.48%. Wheat flour can be substituted with cocoyam flour up to 50% inclusion level and with mushroom powder at 10%. This will help to meet the protein requirement for the Nigerian populace especially children. These flour blends can also be used in various food product formulations which will help to ensure proper utilization of these crops.

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Table 1: Proximate composition of wheat-cocoyam flour blends enriched with mushroom (%)

TREATMENT/ SAMPLE	100:0:0 WHEAT:CF:M	70:20:10 WHEAT:CF:M	60:30:10 WHEAT:CF:M	50:40:10 WHEAT:CF:M	40:50:10 WHEAT:CF:M
MOISTURECONTENT	$7.04^{a} \pm 0.03$	$6.81^{a} \pm 0.01$	$7.85^{ab} \pm 0.01$	$7.57^{bc} \pm 0.01$	$8.03^{d} \pm 0.01$
PROTEINCONTENT	$9.46^{a} \pm 0.02$	$9.71^{ab} \pm 0.01$	$9.94^{abc} \pm 0.01$	$10.13^{cd} \pm 0.01$	$12.72^{cd} \pm 0.01$
ASH CONTENT	$1.06^{a} \pm 0.01$	$1.00^{a} \pm 0.01$	$1.46^{a} \pm 0.01$	$1.01^{ab} \pm 0.01$	$1.40^{ab} \pm 0.01$
FAT CONTENT	$0.84^{a} \pm 0.01$	$0.60^{a} \pm 0.01$	$0.69^{ab} \pm 0.02$	$0.43^{bc} \pm 0.01$	$0.54^{cd} \pm 0.01$
FIBRE CONTENT	$1.71^{a} \pm 0.02$	$2.25^{a} \pm 0.02$	$2.48^{a} \pm 0.01$	$2.62^{ab} \pm 0.02$	$3.28^{bc} \pm 0.01$
CARBOHYDRATES	$79.91^{a} \pm 0.01$	$79.64^{a} \pm 0.01$	$77.54^{ab} \pm 0.01$	$78.25^{abc} \pm 0.01$	$74.04^{cd} \pm 0.01$

**Means bearing different superscripts on the same rows are significantly different (P ≤ 0.05).*

CF: Cocoyam flour

M: Mushroom powder

Table 2: Proximate composition of wheat - cocoyam cookies enriched with mushroom powder (%)

TREATMENT/ SAMPLE	100:0:0 WHEAT:CF :M	70:20:10 WHEAT:CF: M	60:30:10 WHEAT:CF: M	50:40:10 WHEAT:CF: M	40:50:10 WHEAT:CF: M
MOISTURECONTENT	9.55^{a} ± 0.02	10.23^{a} ± 0.02	10.27^{a} ± 0.01	10.42^{ab} ± 0.01	10.28^{bc} ± 0.01
PROTEIN CONTENT	0.53^{a} ± 0.01	10.57^{ab} ± 0.01	11.16^{ab} ± 0.02	11.28^{bc} ± 0.02	11.48^{bcd} ± 0.02
FIBRE CONTENT	1.47^{a} ± 0.01	2.19^{a} ± 0.01	2.33^{a} ± 0.02	2.49^{ab} ± 0.02	2.98^{bc} ± 0.01
LIPID CONTENT	3.12^{a} ± 0.01	2.17^{ab} ± 0.01	2.33^{abc} ± 0.01	2.21^{bc} ± 0.01	2.53^{bcd} ± 0.01
ASH	0.73^{a} ± 0.01	0.99^{a} ± 0.01	1.18^{ab} ± 0.01	1.28^{ab} ± 0.01	2.06^{bc} ± 0.02
CARBOHYDRATE	74.61^{a} ± 0.02	73.88^{a} ± 0.01	72.75^{a} ± 0.04	72.33^{a} ± 0.04	73.65^{a} ± 0.01
DRY MATTER	90.46^{a} ± 0.02	89.78^{a} ± 0.02	89.73^{ab} ± 0.01	89.58^{bc} ± 0.01	89.72^{cd} ± 0.01
ENERGY VALUE (kcal)	368.62^{a} ± 0.01	357.45^{ab} ± 0.12	356.57^{ab} ± 0.07	354.31^{bc} ± 0.08	351.41^{bc} ± 0.11

**Means bearing different superscripts on the same rows are significantly different (P ≤ 0.05).*
CF: Cocoyam flour
M: Mushroom powder

Table 3: Functional properties of wheat - cocoyam flour blends enriched with mushroom

TREATMENT/ SAMPLE	100:0:0 WHEAT:CF: M	70:20:10 WHEAT:CF: M	60:30:10 WHEAT:CF: M	50:40:10 WHEAT:CF: M	40:50:10 WHEAT:CF: M
Bulk density (g/cm^{3})	0.36^{a} ± 0.01	0.38^{a} ± 0.01	0.33d^{ab} ± 0.01	0.37^{bc} ± 0.01	0.35^{bcd} ± 0.01
Water absorption capacity (g/g)	100^{a} ± 0.01	65^{ab} ± 0.01	85^{ab} ± 0.01	75^{ab} ± 0.01	109^{bc} ± 0.01
Oil absorption capacity (g/g)	118^{a} ± 0.01	200^{a} ± 0.00	170^{a} ± 0.01	185^{ab} ± 0.01	205^{ab} ± 0.01
EmulsionCapacity (%)	4.32^{a} ± 0.02	4.34^{a} ± 0.01	4.29^{ab} ± 0.01	5.32^{bc} ± 0.01	4.35^{bc} ± 0.01
Foam capacity (%)	72.50^{a} ± 0.71	71.00^{a} ± 1.41	61.01^{ab} ± 1.41	61.00^{ab} ± 1.41	67.00^{bc} ± 1.41
Wettability (%)	110.0^{a} ± 0.00	99.50^{a} ± 0.71	158.00^{a} ± 1.41	112.5^{a} ± 0.71	104.00^{ab} ± 0.00
pH (s)	6.85^{a} ± 0.21	6.74^{a} ± 0.38	6.40^{ab} ± 0.10	6.39^{abc} ± 0.01	6.58^{cd} ± 0.17

**Means bearing different superscripts on the same rows are significantly different (P ≤ 0.05).*
CF: Cocoyam flour
M: Mushroom powder

Table 4: Mineral composition of the wheat-cocoyam cookies enriched with mushroom (mg/100g)

TREATMENT / SAMPLE	100:0:0 WHEAT:CF: M	70:20:10 WHEAT:CF: M	60:30:10 WHEAT:CF: M	50:40:10 WHEAT:CF: M	40:50:10 WHEAT:CF: M
Potassium	412.47^{a} ± 1.92	453.61^{a} ± 1.68	455.35^{ab} ± 2.10	458.29^{bc} ± 2.06	460.82^{cd} ± 2.25
Calcium	30.48^{a} ± 0.51	52.36^{a} ± 0.65	55.85^{a} ± 0.75	59.56^{ab} ± 0.24	65.26^{abc} ± 0.84
Sodium	1.89^{a} ± 1.60	6.90^{a} ± 1.42	7.82^{ab} ± 1.73	8.12^{ab} ± 1.26	8.56^{bc} ± 1.80
Magnesium	31.21^{a} ± 0.16	35.40^{a} ± 0.14	37.37^{a} ± 0.15	39.13^{ab} ± 0.11	42.65^{bc} ± 0.18
Zinc	4.38^{a} ± 0.10	2.74^{ab} ± 0.11	2.95^{bc} ± 0.10	3.08^{bc} ±0.12	3.26^{bcd} ± 0.13
Iron	2.10^{a} ± 0.13	2.55^{a} ± 0.12	3.04^{ab} ± 0.11	3.12^{bc} ±0.12	3.19^{cd} ± 0.12

**Means bearing different superscripts on the same rows are significantly different (P ≤ 0.05).*
CF: Cocoyam flour
M: Mushroom powder

Table 5: Antinutritional factors of wheat-cocoyam cookies enriched with mushroom (mg/100g)

TREATMENT / SAMPLE	100:0:0 WHEAT:CF: M	70:20:10 WHEAT:CF: M	60:30:10 WHEAT:CF: M	50:40:10 WHEAT:CF: M	40:50:10 WHEAT:CF: M
Tanning	$0.09^{a} \pm 0.00$	$0.10^{a} + 0.00$	$0.14^{a} + 0.01$	$0.11^{a} + 0.08$	$0.21^{a} \pm 0.03$
Alkaloid	$0.05^{a} \pm 0.01$	$0.09^{a} \pm 0.02$	$0.13^{a} \pm 0.01$	$0.15^{a} \pm 0.01$	$0.25^{a} \pm 0.01$
Oxalate	$0.11^{a} \pm 0.01$	$0.11^{a} \pm 0.01$	$0.09^{a} \pm 0.01$	$0.09^{a} \pm 0.01$	$0.07^{a} \pm 0.01$
Phenol	$0.04^{a} \pm 0.00$	$0.04^{a} \pm 0.00$	$0.05^{a} \pm 0.00$	$0.05^{a} \pm 0.00$	$0.13^{a} \pm 0.00$
Phytate	$0.06^{a} \pm 0.00$	$0.07^{a} \pm 0.00$	$0.08^{a} \pm 0.00$	$0.08^{a} \pm 0.00$	$0.18^{a} \pm 0.00$

**Means bearing different superscripts on the same rows are significantly different ($P \leq 0.05$).*
CF: Cocoyam flour
M: Mushroom powder

Table 6: Sensory properties of wheat-cocoyam cookies enriched with mushroom

TREATMENT/ SAMPLE	100:0:0 WHEAT:CF: M	70:20:10 WHEAT:CF: M	60:30:10 WHEAT:CF: M	50:40:10 WHEAT:CF: M	40:50:10 WHEAT:CF: M
TASTE	$7.6^{a} \pm 0.84$	$6.9^{a} \pm 1.20$	$6.8^{ab} \pm 1.44$	$7.4^{bc} \pm 1.04$	$7.2^{bcd} \pm 0.04$
CRISPNESS	$7.1^{a} \pm 1.12$	$6.9^{a} \pm 1.35$	$7.1^{a} \pm 1.44$	$7.4^{a} \pm 1.34$	$6.6^{a} \pm 1.34$
AROM	$7.4^{a} \pm 1.27$	$6.8^{ab} \pm 1.28$	$6.7^{ab} \pm 1.30$	$7.0^{bc} \pm 1.41$	$6.4^{cd} \pm 1.20$
APPEARANCE	$7.3^{a} \pm 0.02$	$6.8^{ab} \pm 1.37$	$6.9^{ab} \pm 1.66$	$7.4^{ab} \pm 1.27$	$6.1^{bc} \pm 1.89$
GENERAL ACCEPTABILITY	$7.6^{a} \pm 0.84$	$7.1^{ab} \pm 1.00$	$6.7^{bc} \pm 1.43$	$7.6^{bc} \pm 1.31$	$6.7^{cd} \pm 1.01$

**Means bearing different superscripts on the same rows are significantly different ($P \leq 0.05$).*
CF: Cocoyam flour
M: Mushroom powder