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Assessment of nutritional and sensory qualities of whole grains cookies formulated from vegetables and mushrooms

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Malnutrition and obesity keeps increasing in the developing countries alongside, the burden of diet-related diseases, therefore, regular food is expected to be functional by providing additional health benefits; other than basic nutritional needs. In this study, 10, 25 and 50 % of two edible mushrooms namely; *Termitomyces robustus* and *Lentinus squarrosulus* and four vegetables; Basella alba, *Launea taraxacifolia, Senecio biafrae*, and *Crassocephalum ruben* were used to substitute whole grain flours of wheat, millet, guinea corn and yellow corn, separately, in formulation of cookies, with the aim of improving the nutritional properties and health benefit potential of the cookies**.** Proximate composition of the cereal flours were in the range of 7.27±0.06 -11.56 ±0.20% (moisture), 0.52±0.05 - 2.51±0.26 % (Ash), 8.48^{a}±0.44- 14.97^{d}±0.10% (protein), 8.72^{a}±0.86-12.35^{e}±0.13 (fat), 0.19^{a}±0.05 - 1.91^{e}±0.03 % (fibre) and 63.78±0.43- 68.84^{b}±0.56 % (carbohydrate). The nutritional and sensory qualities of representative cookies from each formulation were determined. Generally, supplementation with the vegetables and mushrooms had positive effect on the mineral, vitamins and proximate compositions, which is an indication of good nutritional quality; also the non-wheat flours compared favourably with the wheat flour nutritional-wise. Although, there was significant difference in sensory quality and acceptability of the non-wheat and wheat cookies, the results show that it is possible to use the named mushrooms, vegetables and grains to partially (≤ 10 %) substitute for wheat flour in the production of flour -based food systems with acceptable physical characteristics.

Keywords: Functional, Cookies, Phytochemicals, Nutritional, Antioxidant.

1. Introduction

Death related to nutritional conditions was among the top ten causes of death, which accounted for over 50 per cent of the 55.4 million deaths worldwide, reported in 2019 by the World Health Organisation (**2020).** Bioactive nutritional remedies are gaining more prominence in place of synthetic drugs with various side effects, since several researches have demonstrated a clear link between unhealthy diet and some common chronic health conditions (Malik et al., 2010, p.2481). The advances in scientific research support the idea that diet may fulfil nutritional needs and exerts a beneficial role in some diseases (Otles, and Cagindi, 2012, p. 121). The demand for "healthy" foods has therefore increased in many parts of the world in recent years (Ozen, Pons and Tur, 2012, p. 472); the production and consumption of functional foods that could provide a health benefit beyond the basic nutritional functions are gaining much importance, and in a developing country like Nigeria, affordability is of paramount importance.

Studies have established that mushrooms, fruits and vegetables are rich sources of nutraceuticals and are recommended for healthy living. Despite the compelling evidences that diets rich in fruits, vegetables, mushrooms, whole grains, legumes and low-fat foods improve health conditions (Polak, Phillips, and Campbell, 2015, p.198; Das et al., 2021, p.2), and can lower the risk of chronic conditions like diabetes, cancer, heart disease and stroke, compliance to healthy diet recommended by the world Health Organisation **(**2019, p.14) and life style cannot be rated high still in many parts of world. Nigeria has a wide variety of fruits, vegetables, wild mushrooms and medicinal plants; many of which can be explored for functional foods, but they are underutilized.

Cookies are popular ready- to -eat snacks among both the young and elderly globally. Attractive attributes such as wide consumption base, shelf-stability, and convenience (Feyera, 2020, p.101) qualify cookies to be excellent delivering means for nutrients and bioactive compounds including vitamins, minerals, antioxidants, and fibre (Corbo, Bevilacqua, Petruzzi, Casanova and Sinigaglia, 2014, p. 1192) and therefore possess great potential as functional foods. Cookies are prepared mainly with wheat flour, fat, and sugar, but can be enriched or fortified with nutraceuticals rich ingredients to serve as formulated innovative food to meet the dietary needs of different targeted populations such as children, aged and those with special health conditions (Davidson as cited by Goubgou *et al*., 2021, p.2). This fortification potential and various processing technology have been employed to improve nutritional quality of cookies and the potential health benefits (Goubgou *et al*., 2021 p.2).

Wheat flour is the principal component and most preferred flour for cookies and pastry products, it is rated higher than other cereals as a result of its unique rheological properties. Different varieties of cereals like corn, sorghum, and millet are grown in Nigeria, but wheat cultivation remains a big challenge in tropic regions (Ikuomola, Otutu, Oluniran, and Yildiz, 2017, p. 3). Huge amount of foreign reserves are expedited on wheat importation in Nigeria (Racheal and Margaret, 2016 p. 1); this economic burden will continue as long as the locally cultivated cereals are neglected in the production of flour for pastry (Ikuomola, *et al.,* 2017 p. 2-3). There is need to encourage the use of our local produce for improved and sustainable economy. It is pertinent to explore the use of alternative local flours as supplements or substitutes for wheat flour in the baking industry (Ikuomola, *et al.,* 2017 p.2). Supplementation or substitution of refined wheat flour with locally cultivated cereals like sorghum, corn and millet for cookies and pastry products may help Nigeria economy and reduce the amount spent annually on wheat importation (Racheal and Margaret, 2016 p. 1)**.** Thus, the need to explore other non-wheat cereals and underutilized rich sources of natural nutraceuticals for our health benefits. The study is aimed at assessing the nutritional and sensory qualities of functional cookies formulated from blends of whole grain flours of millet, guinea corn, yellow corn and wheat; the above mentioned mushrooms and vegetables, with the aim of exploiting their health promoting potentials.

2. Materials and Methods

2.1 Sample collection and preparation

The samples used in this study include four vegetables namely: *Basella alba* (amunututu, vine spinach), *Launea taraxacifolia* (yanrin, wild lettuce), *Crassocephalum rubens* (ebure, belongs to asteraceae family) and *Senecio biafrae* (worowo, African plant, in sun flower family), and two edible mushrooms; *Termitomyces robustus* (ewe, the common edible mushroom) and *Lentinus squarrosulus* **(**erirokiro, white tough lether-like mushroom**)**. The grains were *Sorghum bicolor* (guinea corn or sorghum), *Zea mays* (maize or corn)*, Pennisetum typhoides* (millet) and *Triticum aestivum* (whole grain and commercial processed wheat). They were purchased at the Oba market in Akure and authenticated at the Center for Research and Development (CERAD), the Federal University of Technology, Akure, Nigeria.

2.1.1 Preparation of samples

The vegetables were rinsed with water, cut into smaller pieces, air-dried, ground and sieved to give 40 mm mesh size powder. Both the pileus (cap) and stipes (stem) of the mushrooms were scraped and thoroughly cleaned with damped clean foam to remove dirt, cut into smaller pieces and then oven dried at 60 ^oC. The grains were properly picked to remove stones and dirt before grinding into powder. The powdery samples were stored in air-tight containers and kept in refrigerator prior to use (Borokini, *et al*., 2016; Borokini, Lajide, Olaleye, Boligo, and Athayde, 2016).

2.2 Preparation of cookies

Exactly 10 g, 25 g and 50 g of each ground mushroom and vegetable were weighed and added to 90 g, 75 g and 50 g of each grain flour giving rise to 90, 75, and 50% of each supplemented flour concentration, respectively, and with other ingredients (butter-5.0 g, 1 whole egg (approximately 10.0 g), baking powder (1.0 g), and milk (5.0 g) were processed into supplemented cookies (functional foods) along with 100% grain flour cookies.

2.3 Nutritional analysis

Proximate composition (fat, crude fibre, and ash) were determined on dry basis by the standard method of Association of Official Analytical Chemist (2006), the protein content was determined using the micro-Kjedahl method (N x 6.25) and the carbohydrate determination was calculated by difference. The energy values were derived by multiplying the amounts of protein, carbohydrate and fat by the factors of 4, 4 and 9 (K cal), respectively (EC. Directive 90/496/EEC, 1990). The mineral elements were determined using Atomic Absorption Spectrophotometer, vitamins A, B_1, C and E, were determined by spectrophotometric methods (Borokini, Lajide, Olaleye, Boligo and Athayde*,* 2016, p. 25).

2.4 Sensory Evaluation

A 10 member trained sensory panel consisting of 4 male and 6 female students who are regular consumers of biscuits and familiar with the attributes, investigated the sensory qualities of each batch of the prepared cookies. Panelists evaluated the attributes against a control cookie prepared with a processed wheat flour. The cookies samples were coded with letters and numbers. The panelists evaluated cookies samples for colour, taste, flavour/aroma, texture and overall acceptability characteristics on a 9 point descriptive scale with 9 = like extremely, 8 = like very much, 7= like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly 3 = dislike moderately 2 = dislike very much and 1= dislike extremely.

2.5 Statistical Analysis

The experimental results were expressed as the mean ± S.D. and statistical significance of difference in parameters amongst groups determined by one way ANOVA followed by Duncan's multiple range tests. Significance was accepted at P>0.05.

3. Results and Discussion

3.1 Results

3.1.1 Proximate Compositions of grain flours and supplemented cookies

All the grain flours contained relatively lower percentage of ash (0.52±0.05- 2.51±0.26), protein (8.48±0.44 - 14.97±0.10), and crude fibre (0.19±0.05-1.91±0.03) (Table 1) than those of the vegetables and mushrooms used to supplement the cookies as reported in the previous studies. The nutritional composition of the raw materials used for supplementation, as reported previously ranged from 19.22 ±0.13 in *B. alba* to 42.77 ±0.57 in *T. robustus* for Crude protein, 7.07±0.04 in *L. squarrosulus* to 21.48±0.32 in *S. biafrae* for ash content, 10.21±0.01in *T. robustus* to 23.05±0.06 in *L. taraxacifolia* for total dietary fibre, and 3.71±0.16 in *L. squarrosulus* to 14.85±0.14 in *L. taraxacifolia,* for crude fat (Borokini and Olaleye *et al*., 2016; Borokini, Lajide, Olaleye, Boligo and Athayde*,* 2016; Borokini, Lajide, 2017).

Supplementing the different grain flours with 10, 25 and 50% of each of the mushrooms or vegetables increased the ash contents of the cookies compared to the ash contents of the control 1 (0.825), control 2 (1.134) and 100% grains flour cookies (Table 2). The protein content (s) of the non-supplemented cookies (100% grains cookies) were lower than that of one or the two commercial cookies in some cases, however, supplementing the grains flour with either 10, 25 or 50% mushrooms or vegetables increased the protein contents of the cookies with very few exceptions. There was also significant increase (p ≤ 0.005) in the protein contents with increased supplementations in most of the cookies. The crude fibre contents of the control cookies are significantly lower than the non-supplemented and supplemented cookies, supplementation with the vegetables and mushrooms increased significantly (p ≤ 0.005) the crude fibre contents with exceptional few. Carbohydrate content of the cookies ranged between 63.78±0.43 (corn) and 68.84±0.56 (millet). The non- wheat cookies compare favourably with the wheat cookies in terms of proximate compositions.

3.1.2 Minerals composition of grain flours and supplemented cookies

The range (mg/100 g), of the mineral elements in the cereal flours as revealed in Table 3 were: calcium (0.02 -23.66), phosphorus (7.70 – 16.70), potassium (1.88- 13.47), sodium (2.30 – 12.46), magnesium (0.22 – 15. 93), iron (0.004 – 5.89), copper (0.01 – 0.34), zinc (0.001 -22. 31), manganese (0.001 – 3.09) and lead (0.001). Analysis of the selected cookies supplemented with the vegetables and mushrooms (Table 4) showed that iron, zinc, potassium, magnesium and phosphorus compositions of the analyzed cookies are generally higher than those of the control cookies while the sodium and calcium are lower in this study with few exceptions. The result also revealed that supplementation generally increase the mineral compositions.

3.1.3 Vitamins composition of grain flours and supplemented cookies

β-carotene, a precursor of vitamin A was detected in corn flour at higher concentrations (13.54±0.01) than all other whole grain flours, followed by wheat (12.99±0.01) (Table 5). There was no significant difference in the amount of vitamin A in sorghum and millet. Sorghum and wheat whole grain contained the highest concentration of vitamin B_1; thiamine (324.23±0.00), followed by millet (312.11±0.01) and least in corn (143.44±0.02), among the whole grain flours. Ascorbic acid was also detected in all the cereal flours, at very low concentrations. Tocopherol (vitamin E) was highest in millet (1081.25±0.0), followed by whole grain wheat (816.04^{d}±0.02), least in corn (343.23±0.01) but not detected in sorghum. For the cookies, the vitamin contents of the commercial biscuits, used as the control are generally higher than many of the formulated cookies (Table 6), but supplementation with vegetables and mushrooms increased their vitamins composition.

3.1.4 Sensory properties of selected representative cookies

Sensory evaluation of selected cookies revealed that there were significant differences ($p \leq 0.05$) in the crispiness, colour, aroma, taste and acceptability of supplemented cookies and the controls (Table **7**). All the assessed parameters of the non-supplemented corn cookie were significantly different from those of controls except the colour, and supplementation reduced the preference except in crispiness. There were significant differences ($p \leq 0.05$) in the crispiness, colour, aroma, taste and acceptability of non-supplemented cookies and the controls.

Table 1: Proximate compositions of grain flours (%)

	Corn	Guinea corn	Millet	Wheat	Processed wheat
Moisture (%)	11.56^{d}±0.20	8.00^{b}±0.12	7.27^{a}±0.06	7.56^{a}±0.05	11.15^{c}±0.03
Ash (%)	2.51^{e}±0.26	1.62^{b}±0.03	1.87^{d}±0.04	1.74^{c}±0.02	0.52^{a}±0.05
Fibre (%)	1.67^{d}±0.04	1.55^{c}±0.04	1.18^{b}±0.04	1.91^{e}±0.03	0.19^{a}±0.05
Protein (%)	8.66^{a}±0.46	10.26^{b}±0.45	8.48^{a}±0.44	12.71^{c}±0.51	14.97^{d}±0.10
Fat (%)	11.82^{d}±0.05	10.37^{b}±0.26	12.35^{e}±0.13	11.50^{c}±0.05	8.72^{a}±0.86
Carbohydrate (%)	63.78^{a}±0.43	68.20^{b}±0.43	68.84^{b}±0.56	64.58^{a}±0.40	64.45^{a}±0.51
Dry Matter	88.44^{a}±0.20	92.00^{c}±0.12	92.73^{d}±0.06	92.44^{d}±0.05	88.85^{b}±0.030
CV (Kcal)	396.16^{a}±1.52	407.16^{b}±1.81	420.44^{d}±0.84	412.69^{c}±0.09	396.19^{a}±4.37

Values represent means of triplicate readings ± S.D. Values with the same superscript along the row are not significantly different ($p \geq 0.05$). n = 3

Table 2: Proximate composition of selected representative cookies

	Ash (%)	Fiber (%)	Protein (%)	Fat (%)	Dry Matter (%)	Cal. Value (Kcal)
Control 1	0.83^{a}±0.18	0.88^{a}±0.08	14.86^{a}±0.99	19.65^{d}±0.11	94.04^{c}±0.01	467.6^{f}±0.90
Control 2	1.13^{a}±0.16	1.16^{b}±0.03	18.34^{c}±1.01	16.22^{bc}±1.14	94.68^{d}±0.06	450.61^{e}±5.16
C100	2.27^{b}±0.05	2.49^{c}±0.07	12.69^{a}±0.98	18.88^{c}±0.03	95.02^{cd}±0.12	455.40^{e}±0.81
CLs-10	3.66^{c}±0.06	4.82^{d}±0.16	15.92^{b}±0.50	14.15^{a}±0.03	95.53^{e}±0.03	418.95^{c}±0.11
CCr-25	3.92^{d}±0.00	3.71^{e}±0.18	17.96^{d}±0.09	11.57^{a}±0.01	91.25^{a}±0.01	392.29^{b}±0.71
G-100	1.92^{b}±01	2.93^{d}±0.02	17.09^{b}±0.10	16.70^{c}±0.05	92.64^{a}±0.02	434.70^{c}±0.07
GBa-25	3.18^{e}±0.06^{e}	8.47^{e}±0.20	19.84^{d}±0.19	8.46^{a}±0.09	95.57^{f}±0.11	377.98^{b}±0.17
GSb-50	5.50^{f}±0.01	15.46^{e}±0.09	19.08^{d}±0.09	15.57^{a}±0.39	92.33^{a}±0.05	363.38^{a}±2.13
M-100	2.08^{b}±0.06	5.09^{e}±0.16	15.02^{a}±0.71	19.44^{d}±0.05	93.19^{a}±0.50	441.26^{d}±1.36
MLt-25	3.39^{d}±0.02	6.95^{f}±0.01	17.99^{c}±0.01	16.71^{bc}±0.11	93.36^{b}±0.01	415.65^{b}±0.45
W-100	1.71^{c}±0.0.03	1.75^{c}±0.02	17.20^{b}±0.06	17.26^{c}±0.03	91.86^{b}±0.15	439.91^{c}±0.920
WTr-25	2.29^{d}±0.06^{d}	5.94^{e}±0.10	22.55^{d}±0.00	15.36^{b}±1.14	96.35^{f}±0.06	429.28^{b}±4.789
PW-100	1.05^{a}±0.03	12.31^{e}±0.51	22.10^{c}± 0.48	14.48^{b}±0.09	88.67^{a}±0.07	373.66^{b}±1.74
PWBa-50	4.64^{e}±0.01	12.88^{e}±0.01	21.10^{c}±0.50	11.41^{a}±0.04	92.39^{b}±0.03	356.56^{a}±0.31

Values represent means of triplicate readings ± S.D. Values with the same superscript along the column are not significantly different ($p \geq 0.05$). n = 3. CONTROL 1 and 2= Commercial biscuits, C-100= 100% corn flour, CLs-10 = 10% *L. squarrosulus* supplemented corn cookie, CCr-25=25%, *C. rubens* supplemented corn cookie, G-100= 100% guinea corn flour; GBa-25 = 25%, *B.alba* supplemented guinea corn cookie, GSb-50= 50% *S. biafrae* supplemented guinea corn cookie. M-100= 100% millet flour, MLt-25= 25%, *L. taraxacifolia* supplemented millet cookie, W-100= 100% wheat flour, WTr-25=25% *T. robustus* supplemented wheat cookie, PW-100= 100% processed wheat flour, PWBa-50= 50% *b. alba* supplemented processed wheat cookie

Table 3: Mineral compositions of grain flours (mg/100 g)

	Na	K	Ca	Fe	Zn	Cu	Mn	Mg	Pb	P
Corn	2.35	1.88	0.02	0.01	0.02	0.01	N.D	0.32	0.001	7.70
Guinea Corn	2.30	1.97	0.02	0.01	0.001	N.D	0.001	0.24	0.001	6.60
Millet	3.15	2.36	0.02	0.01	0.02	0.01	0.001	0.22	0.001	12.20
Wheat	2.53	2.14	0.02	0.004	0.02	0.01	0.01	0.23	0.001	8.40
Processed Wheat	12.46	13.47	23.66	5.89	22.31	0.34	3.09	15.93	ND	16.70

Values represent means of triplicate readings ± S.D. Values with the same superscript along the row are not significantly different ($p \geq 0.05$). n = 3

Table 4: Mineral composition of selected representative cookies (mg/100 g)

	Fe	Mg	Zn	Na	K	Ca	P
CONTROL 1	0.18	17.69	0.62	424.78	54.87	17.69	27.90
CONTROL 2	0.16	12.59	0.94	531.49	50.39	1.57	30.75
GSb-50	1.32	5.27	1.65	659.34	1005.49	4.39	89.88
MLs-50	0.91	11.40	2.39	198.35	495.87	2.48	67.71
CBa-50	1.14	24.51	1.13	314.29	842.86	4.76	82.11
MLs-10	0.73	25.91	1.91	54.55	340.91	1.82	74.58
C100	0.43	21.30	1.04	404.35	247.83	1.74	62.22
CLt-50	0.65	40.09	6.45	266.40	911.21	532.71	59.94
GCr-10	0.44	22.12	1.06	530.97	1314.16	1.77	73.20
PWTr-50	2.04	9.71	4.08	189.32	859.22	2.91	95.88
WSb-50	1.52	14.73	1.88	281.25	1031.25	4.46	90.37
MLs-25	0.80	19.19	2.41	281.25	776.79	2.68	72.89

CONTROL 1 & 2 = Commercial biscuits. GSb-50 = 50%, S.biafrae supplemented guinea corn cookie. GSb-50 = 50%, *S. biafrae* supplemented guinea corn cookie cookie. MLs-50 = 50% *L. squarrosulus* supplemented millet cookie. CBa-50 = 50% *B. alba* supplemented corn cookie. MLs-10 = 10% *L. squarrosulus* supplemented millet cookie. C100 = 100 % corn flour. CLt-50 = 50% *L. taraxacifolia* supplemented corn cookie. GCr-10 = 10% *C. rubens* supplemented guinea corn cookie. PWTr-50 = 50% *T. robustus* supplemented processed wheat cookie. WSb-50 = 50%, *S. biafrae* supplemented wheat cookie.MLs-25 = 25% *L. squarrosulus* supplemented millet cookie.

Table 5: Vitamin contents of grain flours (µg/g)

	β-carotene	Thiamine	Ascorbic acid	Tocopherol
Corn	$13.54^{c}\pm0.01$	$143.44^{a}\pm0.02$	$1.38^{b}\pm0.01$	$343.23^{b}\pm0.01$
Guinea Corn	$12.03^{a}\pm0.01$	$324.23^{c}\pm0.00$	$1.90^{c}\pm0.01$	$0.00^{a}\pm0.00$
Millet	$12.03^{a}\pm0.02$	$312.11^{b}\pm0.01$	$1.28^{b}\pm0.01$	$1081.25^{e}\pm0.01$
Wheat	$12.99^{b}\pm0.01$	$324.23^{c}\pm0.01$	$0.70^{a}\pm0.01$	$816.04^{d}\pm0.02$
Processed Wheat	$14.17^{d}\pm0.05$	$345.92^{d}\pm0.08$	$4.04^{d}\pm0.20$	$725.81^{c}\pm7.35$

Values represent means of triplicate readings ± S.D. Values with the same superscript along the column are not significantly different ($p \geq 0.05$). n = 3.

Table 6: Vitamin compositions of selected representative cookies

	VITA	VITB$_1$	VITC	VITE
CONTROL1	$72.36^{k}\pm0.01$	$130.10^{i}\pm0.58$	$4.97^{i}\pm0.02$	$39.65^{k}\pm0.52$
CONTROL2	$43.42^{g}\pm0.30$	$134.25^{j}\pm0.87$	$5.01^{i}\pm0.01$	$34.80^{i}\pm0.23$
GLs-10	$25.84^{e}\pm0.01$	$116.30^{h}\pm0.01$	$4.54^{h}\pm0.29$	$31.60^{h}\pm0.46$
PWLt-10	$60.72^{h}\pm0.01$	$82.65^{c}\pm0.17$	$2.67^{c}\pm0.02$	$36.25^{j}\pm0.98$
GSb-10	$17.62^{a}\pm0.07$	$62.25^{a}\pm0.64$	1.68a±0.01	$18.80^{c}\pm0.23$
WBa-10	$71.72^{j}\pm0.01$	$92.05^{d}\pm0.29$	$2.79^{d}\pm0.01$	$21.50^{d}\pm0.01$
MCr-10	$64.74^{i}\pm0.01$	$161.50^{k}\pm0.01$	$5.25^{j}\pm0.03$	$43.65^{l}\pm0.75$
C100	$24.24^{d}\pm1.15$	$80.90^{c}\pm0.12$	$2.20^{b}\pm0.01$	$13.50^{b}\pm0.01$
MTr-25	$32.43^{f}\pm0.01$	$192.00^{l}\pm0.46$	$7.23^{k}\pm0.01$	$58.40^{m}\pm0.23$

Values represent means of triplicate readings ± S.D. Values with the same superscript along the column are not significantly different ($p \geq 0.05$). n = 3. CONTROL 1 & 2 = Commercial biscuits. GLs-10 = 10% *L. squarrosulus* supplemented guinea corn cookie. PWLt-10 = 10% *L. taraxacifolia* supplemented processed wheat cookie. GSb-10 = 10%, *S. biafrae* supplemented guinea corn cookie. WBa-10 = 10% *B. alba* supplemented wheat cookie MCr-10 = 10% *C. rubens* supplemented millet cookie. C100 = 100% corn flour. CSbl-10 = 10%, *S. bicolor* leaves supplemented corn cookie.

Table 7: Sensory property of selected cookies

	Cripsiness	Colour	Aroma	Taste	Acceptance
Control 1	7.50^{b}±0.85	7.60^{b}±0.84	8.00^{d}±0.94	6.50^{c}±2.27	7.60^{c}±0.70
Control 2	7.30^{b}±1.25	7.10^{b}±1.10	7.20^{cd}±1.48	6.50^{c}±2.27	7.80^{c}±0.79
C100	4.70^{a}±2.16	7.00^{b}±1.16	6.60^{c}±1.78	6.30^{bc}±1.89	4.10^{b}±1.60
CTr-10	4.60^{a}±2.12	3.90^{a}±1.73	5.20^{b}±1.40	4.80^{abc}±1.55	4.20^{b}±0.63
GC-100	4.40^{a}±2.01	7.00^{a}±1.16	5.30^{a}±2.67	5.20^{a}±1.81	5.10^{a}±1.37
GLs-50	5.00^{a}±1.94	7.10^{a}±1.29	7.40^{b}±1.08	5.40^{a}±1.17	4.40^{a}±0.97
M-100	6.40^{b}±1.78	5.80^{b}±2.30	3.70^{a}±2.11	5.90^{b}±0.74	4.40^{bc}±1.58
MBa-25	4.00^{a}±1.33	3.30^{a}±1.57	3.60^{a}±1.17	3.10^{a}±0.88	3.20^{ab}±1.14
W-100	6.40^{b}±0.70	7.60^{c}±0.84	7.70^{cd}±0.95	6.60^{c}±1.43	6.80^{b}±1.03
WLt-10	4.80^{b}±1.99	4.70^{b}±1.70	4.30^{b}±1.34	4.20^{b}±1.32	4.20^{a}±0.92

Values represent means of triplicate readings ± S.D. Values with the same superscript along the column are not significantly different ($p \geq 0.05$). n = 3. CONTROL 1 and 2= Commercial biscuits, C-100= 100% corn flour, CTr-10=10 % *T. robustus* supplemented corn cookie, G-100= 100% guinea corn flour, GLs-50 = 50 % *L. squarrosulus* supplemented guinea corn cookie. M-100= 100% millet flour, MBa-25=25 %, *B. alba* supplemented millet cookie, W-100= 100% wheat flour, WLt-10 = 10 % *L. taraxacifolia* supplemented wheat cookie.

3.2 Discussion

3.2.1 Nutritional of compositions of cereal flours

Refined wheat flour mostly used in preparing cookies was analyzed along the whole grains of *S. bicolor* (guinea corn), *Z. mays* (yellow corn), *P. typhoides* (millet) and *T. aestivum* (wheat), to serve as the control and the proximate compositions presented in Table 1. The moisture content was low generally. There were significant differences in the ash contents of millet, sorghum and that of whole grain wheat. The crude protein was unexpectedly highest in the processed wheat flour (14.970 ± 0.10), followed by the whole grain wheat flour (12.71±0.51), and then guinea corn (10.26±0.45), this may further justify the preference for wheat flour among cereals. The crude protein of corn and millet were not significantly different in this study. The whole grain wheat flour had the highest crude fibre (1.91±0.03) while the processed had the least (0.186±0.05). Though, the whole grain wheat and the processed wheat may not have come from the same source, the significant difference in their ash and crude fibre contents may suggest that part of the minerals stored in the bran and fibre must have been lost during milling process (Goubgou *et al*., 2021, p.9). The crude fibre content of all the cereal flours were significantly different. Crude fat was highest in millet (12.35±0.13), followed by corn (11.82±0.05) and least in the processed wheat flour (8.72±0.86). The dry matter ranges between 92.73±0.06% in millet to 88.44±0.20% in corn. There was no significant difference in the dry matter contents of millet and wheat flour. The higher the dry matter, the more the minerals are expected to be concentrated. The carbohydrate contents of corn, wheat and processed wheat flours are significantly same, so also, guinea corn and millet. The calorie value was calculated using crude fat, protein and carbohydrate; and was found to be highest in millet (420.44±0.84) and least in corn (396.16^{a}±1.52). There was no significant difference in the calorie value of corn and processed wheat in this study. The proximate analysis of the cereals were in the range similar to the proximate data reported in previous studies, except for crude fat (Enyisi, Umoh, Whong, Abdullahi, and Alabi, 2014, p.3; Adeniyi and Ariwoola, 2019, p.3; Treviño-Salinas *et al*., 2021, p.548).

The processed wheat flour unexplainably possessed higher macro and trace elements than the whole cereals samples. Lead was found in trace amount in whole grain flours but not detected in the processed wheat flours. The results of the mineral analysis was at variance with the ash content of the cereal flours. The processed wheat flour was also found to possess higher concentrations (µg/g) of the vitamins except tocopherol (E). The reason for the higher concentrations of vitamins and mineral elements in the processed wheat flour than the whole grain flours might be fortification of the wheat flour with minerals and vitamins during processing.

3.2.2 Nutritional compositions and sensory properties of the vegetables and mushroom supplemented cookies

The low values of moisture or high percentage of dry matter in the cookies, as revealed in Table 2 is desirable for good shelf stability and texture. Incorporating vegetables and mushrooms into the cookies resulted in significant ($p \leq 0.005$) decrease in the fat contents of most of the cookies and calorific values of many of the cookies while there was no significant change in some few compared to the controls (19.65 and 16.22) and the non-supplemented cookies. The reason for the reduced fat contents cannot be categorically stated, however supplementation led to significant decrease in caloric contents of most of the cookies which is important for the nutritional effects of the mushrooms and vegetables, the energy values were however adequate and are within the recommended daily requirement as the Dietary Reference Intakes (2006) indicated (p. 82-93). The supplemented could be eaten more often than conventional energy dense cookies because they generally had lower calories. The reduced carbohydrate content and increased fibre content of the supplemented cookies are beneficial for easy digestion, as noted by Ikuomola *et al.,* (2017, p.7) and prevention of constipation. The reduced fat content after supplementation with vegetables and mushrooms is also good for shelf stability (Ndife, Abdulraheem, and Zakari*,* 201, p. 470).

Compared with the cereal flours, supplementation increased the microelements such as iron, zinc, and calcium in the cookies (Tables 3-4), these microelements act as cofactors for various antioxidant enzymes (Dhalaria *et al*., 2020, p. 5) and the overall health-promoting effects were increased. Relatively high values obtained for the vitamins contents of the commercial processed wheat flours (Tables 5- 6) and the cookies made from it might be an indication that the control cookies are made from vitamin fortified flour. Vitamin is a major micronutrient that the body requires for the proper functioning of its metabolism, and since human body cannot naturally synthesize these nutrients, food is the main source of natural vitamins that contribute to reduction in risk of chronic diseases by boosting the immune system and anti-oxidation activities (Dhalaria *et al*., 2020, p. 5).

There was no significant difference in crispiness and colour of the 100 % millet cookie and the controls but in aroma and taste as revealed in Table 7; supplementation with *B. alba* reduced their preferences except the aroma. The control and the non-supplemented wheat cookies are significantly the same in colour and taste ($p \geq 0.05$) but different in crispiness, aroma and acceptability. Supplementation with *L. taraxacifolia* also reduced the preference. The controls had the best result followed by 100 % grain cookies. At, 10 % supplementation of the different grains flour with grounded mushrooms, and vegetables, the desirability of the cookies reduced and increased level of substitution did not make significant difference in most cases. Li *et al*., (2020, p.7) also reported sensory acceptability of cookies made from residues of enzyme-assisted aqueous extraction of soybeans REAE (a new source of soybean dietary fiber) at less than 30% substitution. Although, the formulated cookies can provide functional benefits, the excessive dietary fiber can result in deterioration of dough properties (Li *et al*., 2020, p.7).

4. Conclusion

Most of the supplemented cookies had higher ash, crude fibre and crude protein than the controls and non-supplemented (100 % grain flour cookies) and reduced fat and calorific values. The results of the study clearly showed that the use of locally available mushrooms and vegetables improves the nutritional content of cookies, although the sensory attributes decreased above 10 % substitution. The study suggests that nutritionally improved cookies, with desirable sensory attributes can be produced using mushrooms and vegetables blends with non-wheat cereals at 10 % substitution level. If the gluten -free vegetable biscuits with no sugar could score significant rating score in terms of consumer acceptability, with little improvement in flavor, taste and texture with health friendly ingredients, production of highly nutritious, health promoting cookies with acceptable sensory characteristics from non -wheat flour and local vegetables is possible. Modifying the recipe to improve the taste, and aroma without compromising the health potential may increase the consumer acceptability. The use of fruits, dates and other sweetener from natural sources or increasing the nutritional awareness of consumers by emphasizing the health promoting potential of food over our fancy is recommended.

Conflict of Interest

The author declares that there is no conflict of interest.

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References

Adeniyi, O. O., & Ariwoola, O. S. (2019). Comparative proximate composition of maize (Zea mays L.) varieties grown in South-western Nigeria. *International Annals of Science,* 7(1), 1-5. https://doi.org/10.21467/ias.7.1.1-5.

Borokini, F. B., Lajide L., & Olaleye M. T (2017). Nutritional and chemical compositions of two underutilized vegetables in Nigeria. *Bangladesh Journal of Scientific and Industrial Research,* 52(3), 201-208. https://doi.org/10.3329/bjsir.v52i3.34156

Borokini, F. B., Lajide L., Olaleye M. T., Boligo A. & Athayde M, (2016). Assessment of nutritional and chemical profile of wild *Crassocephalum ruben* and *Launaea taraxacifolia. Food Studies; An*

Interdisciplinary Journal, 6(4), 22-29. https://doi.org/10.18848/2160-1933/CGP/v06i04/21-30

Borokini, F. B., Lajide L., Olaleye M. T., Boligo A., Athayde M, & Adesina, I. A. (2016). Chemical profile and antimicrobial activities of two edible mushrooms (*Termitomyces robustus and Lentinus squarrosulus*). *Journal of Microbiology, Biotechnology and Food Science,* 5(5), 416-423. DOI:10.15414/jmbfs.2016.5.5.416-423

Corbo M. R., Bevilacqua A., Petruzzi L., Casanova F. P. & Sinigaglia M. (2014). Functional beverages: the emerging side of functional foods, commercial trends, research, and health implications. *Comprehensive Reviews in Food Science and Food Safety*. (Vol.13). Institute of Food Technologists, 1192-1206. https://doi.org/10.1111/1541-4337.12109

Das, A. K.; Nanda, P. K.; Dandapat, P.; Bandyopadhyay, S.; Gullón, P.; Sivaraman, G. K., … Lorenzo, J. M. (2021). Edible mushrooms as functional ingredients for development of healthier and more sustainable muscle foods: A flexitarian approach. *Molecules*, 26(2463), 1-25. https://doi.org/10.3390/ molecules26092463

Davidson, I. (2019). *Biscuit, cookie and cracker production: Process, production and packaging equipment*, (2nd ed.). London: Elsevier Inc. https://doi.org/10.1016/C2017-0-03385-2.

Dhalaria, R., Verma, R., Kumar, D., Puri, S., Tapwal, A., Kumar, V., .. Kuca K. (2020). Bioactive compounds of edible fruits with their anti-aging properties: A comprehensive review to prolong human life. *Antioxidants*, 9(11), 1-38. DOI: 10.3390/antiox9111123

Dietary Reference Intakes (2006). The essential guide to nutrient requirements. National academies of sciences, engineering, and medicine. Washington, DC: The National Academies Press. https://doi.org/10.17226/11537. p.1-1330

Enyisi, S. .I, Umoh, V. J., Whong, C. M. Z., Abdullahi, I. O. & Alabi, O. (2014). Chemical and nutritional value of maize and maize products obtained from selected markets in Kaduna State, Nigeria. *African Journal of Food Science and Technology,* 5(4), 100-104. http:/dx.doi.org/10.14303/ajfst.2014.029

Feyera, M. (2020). Review on some cereal and legume based composite biscuits. *International Journal of Agricultural* Science and *Food Technology,* 6(2), 101-109. https://dx.doi.org/10.17352/2455-815X.000062

Goubgou, M., Songré-Ouattara, L. T., Bationo, F. Lingani-Sawadogo, H., Traoré, Y., & Savadogo, A. (2021). Biscuits: A systematic review and meta-analysis of improving the nutritional quality and health benefits. *Food Production, Processing and Nutrition,* 3(26), 1-18. DOI: 10.1186/s43014-021-00071-z

Ikuomola, D. S., Otutu, O. L., Oluniran, D. D., & Yildiz, F. (2017). Quality assessment of cookies produced from wheat flour and malted barley (*Hordeum vulgare*) bran blends. *Cogent Food & Agriculture*, 3(1), 1-12. http://dx.doi.org/10.1080/23311932.2017.1293471

Li, Y., Sun, Y., Zhong, M., Xie, F., Wang, H., Li, L., … Zhang, S. (2020): Digestibility, textural and sensory characteristics of cookies made from residues of enzyme-assisted aqueous extraction of soybeans. *Scientific Reports,* 10 (4222), 1-9. https://doi.org/10.1038/s41598-020-61179-9

Malik, V. S., Popkin B. M., Bray G. A., Despres J. P., Willet W. C. & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: A meta-analysis. *Diabetes Care, 33*(11), 2477-2483. DOI: 10.2337/dc10-1079

Ndife, J., Abdulraheem, L. O. & Zakari, U. M. (2011). Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends. *African Journal of Food Science,* 5(8), 466-472. http://www.academicjournals.org/ajfs

Otles, S., & Cagindi, O. (2012). Safety considerations of nutraceuticals and functional foods. In: McElhatton, A., do Amaral Sobral, P. (eds) novel technologies in food science. Integrating food science and engineering knowledge into the food chain, vol 7. Springer, New York, NY. pp 121–136. https://doi.org/10.1007/978-1-4419-7880-6_5

Ozen A. E., Pons A., & Tur J. A. (2012). Worldwide consumption of functional foods: A systematic review. *Nutrition Reviews, 70*(8), 472–481. https://doi.org/10.1111/j.1753-4887.2012.00492.x

Polak, R., Phillips, E. M., & Campbell, A. (2015). Legumes: Health benefits and culinary approaches to increase intake. *Clinical Diabetes*, 33(4), 198-205. doi: 10.2337/diaclin.33.4.198.

Racheal, O.O., Margaret, A.A. (2016). Quality characteristics of cookies produced from composite flours of unripe plantain, wheat and watermelon seed. *Indian Journal of Nutrition*, 2 (2), 1-8. https://www.researchgate.net/publication/343690336

Treviño-Salinas, M., Perales-Torres, A., Castillo-Ruíz, O., Montes-García, N., Lizarazo-

Ortega, C., Navarro-Cortez, R., & Rodríguez-Castillejos, G. (2021). Proximal analysis and profile of fatty acids on six varieties of white grain sorghum with potential use in human consumption. *Journal of food,* 19 (1), 547-551. https://doi.org/10.1080/19476337.2021.1928757

World Health Organization (2019). Healthy diet. WHO Library Cataloguing in Publication Data Regional Office for the Eastern Mediterranean Healthy diet / World Health Organization. Regional Office for the Eastern Mediterranean p. WHO-EM/NUT/282/E

World Health Organization (2020). World Health Organization's Global Health Estimates, 2020 report. https://www.who.int/news/item/09-12-2020-who-reveals-leading-causes-of-death-and-disability-worldwide-2000-2019.

