ORIGINAL ARTICLE

Preparation and Improved Quality Production of Flour and the Made Biscuits from Shitake Mushroom (*Lentinus edodes*)

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ABSTRACT

Background: The popularity of biscuits comes from their attributes such as high palatable, dense nutrients, quickly released energy, and available in convenient sizes, as well as in various forms. In addition, the biscuits formulation can easily be modified to meet the nutritional demands of the targeting consumers. **Purpose:** The purpose of this study is to investigate the substitutional portion of the Shiitake mushroom flour for wheat flour in the production of high-quality biscuits with improved nutritional values. **Materials and Methods:** The collected samples of Shiitake mushroom fruiting bodies were well washed using tap water, and then using distilled water to make the research material as clean and neutral as possible. The clean sample was dried in the oven at 65°C for 24 hs, then ground to a fine powder of 212 µm, making it ready for physiochemical characterization before it was being taken to the biscuit production step. **Results:** Nutritional analysis of the made biscuits using 5%–15% of substitution with shiitake mushroom powder showed the most significantly increased contents of fiber and protein compared to the made biscuit from wheat flour only. **Conclusion:** By incorporating wheat flour with shiitake mushroom powder in the production of biscuit, the improved nutritional values and the development of new recipes for making high-quality biscuit from shiitake mushroom were successfully obtained.

Key words: Antioxidant, biscuits, fiber content, nutritional value, shiitake mushroom powder, shiitake powder supplemented biscuits, total phenolic content

INTRODUCTION

Edible mushrooms are widely consumed in many global nations as an important food item for the crucial roles in human health as medicinal values and enhancing nutrition. As mushrooms are rich sources of proteins, vitamins, and minerals of which are considered in between meat and vegetable,[1] and, edible mushrooms own the low content of carbohydrate, calories, and fat as well as their protective role against chronic diseases.[2] The medical functions of edible mushroom species are of reducing cholesterol, lowering blood pressure, strengthening the immune system against diseases, combating tumors, as well as improving the liver functions.[3] In addition, mushrooms are immense sources of nutraceuticals[4] that are responsible for their antioxidant,[5] antitumor, and antimicrobial properties.[6] Among many others, Shiitake mushroom is one of the most reputed mushrooms for being health-promoting food and products derived from shiitake are suitable for the healthy food industry.[7] *Lentinus edodes* is a scientific name of shiitake mushroom which is one of the most heavily cultivated and popular edible mushrooms in the world. It was originally cultivated in East Asian countries but is now also broadly cultivated in Europe and the United States.[8]

Lentinan was demonstrated to have antitumor activity and to increase the survival time of patients with inoperable gastric cancer and women with recurrent breast cancer following surgical therapy.[9]

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Biscuit has been one of the oldest baked goods and consumed extensively all over the world by all age groups. The popularity of biscuits comes from their attributes such as high palatable, dense nutrients, quickly released energy, and available in convenient sizes, as well as in various forms. In addition, the biscuits formulation can be modified easily to meet the nutritional demands of the target consumers.[10]

Wheat flour is the traditional ingredient applied in the production of biscuits which is insufficient in numerous nutrients including proteins, vitamins, minerals, and dietary fiber. Wheat flour also lacks essential amino acids such as lysine and tryptophan.[11] Therefore, partial replacements or supplement of wheat flour with other nutritional ingredients to produce functional bakery products are highly recommended.[12] Shiitake mushroom powder added to other food ingredients would give a unique and pleasant flavor and after-taste to meals[13] so the utilization of mushrooms in many types of products such as in soups, sauces, and pickles is popular in many countries.

Although numerous studies on the evaluation and utilization of mushrooms in general, and Shiitake mushrooms have been conducted as mentioned above, there is no information about how to utilize the functional as well as nutritional properties of Shiitake mushrooms to prepare as well as improve the flour and the made biscuits from shiitake mushroom. Hence, it is scientifically and economically important to know whether the made flour shiitake mushroom can be used to produce high-quality biscuits with improved nutritional values. Furthermore, a consequence of various proportions of shiitake to wheat flour in biscuits formation needs to be determined to make high-quality final biscuits products. In summary, this study has been conducted to determine the suitable process for preparation and possibly improved quality production of flour and the made biscuits from the shiitake mushroom.

MATERIALS AND METHODS

Preparation of shiitake mushroom flour

The Shiitake mushroom fruiting bodies were collected cleaned with distilled water to remove dirt, sand, soil, other field damage portion, and other undesirable materials before use. The cleaned mushrooms were then sliced into smaller sizes with a knife and then placed on the tray with wax-paper and dried in an oven at 65°C for 24 h. The dried mushroom was then ground in a Waring blender (model Philips HR2118 600W) and sifted through diameter 70 mesh (212 μm) from the laboratory. The Shiitake mushroom powder was kept in sealed polyethylene bags at 4°C until analysis and biscuits making.

Preparation of wheat shiitake mushroom biscuits

The wheat shiitake mushroom four composites was prepared by replacing 5%, 10%, and 15% of wheat flour with Shiitake flour, and with other ingredients were weighed accurately as the formulation shown in Table 1.

As shown in the well-prepared Table, A is noticed as a symbol of control biscuits produced from 100% wheat flour. At the same time, B is marked biscuits produced from 95% wheat and 5% Shiitake mushroom flour, C is marked biscuits produced from 90% wheat and 10% Shiitake mushroom flour, and D is marked biscuits produced from 85% wheat and 15% Shiitake mushroom flour:

A = 100: 0 ratio of wheat Shiitake mushroom flour in biscuits
B = 95: 5 ratio of wheat Shiitake mushroom flour in biscuits
C = 90: 10 ratio of wheat Shiitake mushroom flour in biscuits
D = 85: 15 ratio of wheat Shiitake mushroom flour in biscuits

Proximate composition analysis of Shiitake flour and wheat flour

The proximate analysis of the composite flours and developed biscuits moisture, protein, ash, crude fiber, fat content, and energy values was determined using the methods described by AOAC.[14]

Total carbohydrate content

Total carbohydrates were calculated by difference (AOAC, 1990).

% Carbohydrate = 100 – % (protein + fat + ash+ fiber + moisture)

Energy values

The total metabolizable energy is expressed in kilocalories (kcal/100 g), which was calculated by considering Atwater's conversion factors: (4× *g* protein) + (4× *g* carbohydrates [total carbohydrates – food fiber]) + (9× *g* total lipids) as recommended by Osborne and Voogt.[15]

Functional properties analysis of the composite flour samples

Bulk density

Bulk density was determined following the method described by Eleazu and Ironua[16] and AOAC, 2006.[17] The bulk density of the sample (g/ml) was calculated as the weight of the sample per unit volume of sample.[18]

Table 1: Ingredients applied in the preparation of developed biscuits

Ingredients	Samples (g)			
	A	B	C	D
Wheat flour	100	95	90	85
Shiitake flour	0	5	10	15
Powdered sugar	62	62	62	62
Butter	37	37	37	37

Water absorption capacity (WAC)

The WAC of the sample was determined using the method as described by Eleazu and Ironua,[16] and Onabanjo and Dickson[19] with a minor modification.

Oil absorption capacity (OAC)

Oil capacity of the flour was determined using the method as described by Adepeju *et al*.[20] and Eleazu and Ironua.[16]

Emulsion activity (EA) and emulsion stability (ES)

The EA and stability were measured by adopting the method of Yasumatsu *et al*.[21]

Proximate composition analysis of developed biscuits

Moisture, protein, crude fiber, ash, fat, total carbohydrate content, and energy values of prepared biscuits were determined by the same methods used for Shiitake flour analysis.

Assay of developed biscuits

Extraction preparation

Developed biscuits were ground into powder by Phillips warring blender. Then, the samples were extracted with methanol:water (80:20, v/v; 30 ml). The extract was centrifuged at 5000 g for 15 min at 4°C. The residue was then re-extracted 4 times with methanol:water (80:20, v/v; 30 mL). The combined extracts were evaporated under reduced pressure (rotary evaporator), revolumed in methanol at 20 mg/ml (stock solution) and stored at 4°C for further use. Successive dilutions were made from the stock solution and submitted to evaluate the antioxidant activity and total phenolic content of the samples.[22]

Determination of total phenolic content

Total phenolics in all samples were determined using Folin-Ciocalteu reagent according to the method of Singleton and Rossi[23] using gallic acid as a standard.

Physical properties measurements of biscuits

Strictly followed the proposed methods of Srivastava *et al*.[24] After calculating the volume, density was obtained by the ratio of the weight of volume.[25] The expansion coefficient was determined using the method of millet seeds dislocation.[26] and it was calculated as:

$$Ec=\frac{V_2 - V_1}{V_1} \times 100\%$$

Where Ec is the expansion coefficient (in percent), V_2 is the volume of the baked dough, and V_1 is the volume of the raw dough.

Sensory evaluation

The consumer acceptance of four different samples of biscuits was evaluated using a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely.[27]

Statistical analysis

Data were subjected to analysis of variance using the Minitab version 16.0. Results were presented as means ± standard deviations of triplicate experiments. Significant difference was established at $P \leq 0.05$

RESULTS

Proximate analysis of Shiitake mushroom flour

The results of analysis proximate attributes of Shiitake mushroom powder are shown in the Table 3. Also, the same analyzed attributes of wheat flour for a possible comparison.

Functional properties of composite flours L

The results of the functional properties of Shiitake mushroom powder sample and flour blends include wheat and Shiitake mushroom flour are presented in Table 2, of which consisting of bulk density, WAC, OAC, EA, and ES.

Physical properties of developed biscuits

The effect of replacing 5%, 10%, and 15% of wheat flour with Shiitake mushroom powder on physical properties of biscuits was studied, and the data are tabulated in Table 3 consisting of such parameters as diameter, thickness, spread ratio, density, and expansion coefficient.

Proximate values of developed biscuits

Table 4 presents the nutritional composition of biscuits prepared from the composite flour of wheat flour substituted with Shiitake powder at different ratios 5%, 10%, and 15% compared to the control sample (biscuits A).

Total phenolic content of the developed biscuits

It could be noticed that Shiitake mushroom is a good source of total phenolic and it had a great free radical scavenging activity. Furthermore, there was a significant difference in total phenolic compounds (TPC) that was accompanied by an elevation in the scavenging activity between Shiitake mushroom powder sample and biscuit formulations.

Sensory evaluation

Sensory evaluation of the product was conducted based on 9 points hedonic scale for appearance, color, flavor, texture, and overall acceptability. A semi-trained panel of 70 members was randomly selected to evaluate the sensory properties of the developed biscuits. The sensory evaluation was performed in laboratory with clean sensory cabinets containing fresh water. The panelists were instructed to

Table 2: Effect of incorporating Shiitake mushroom powder on the functional properties of the composite flours

Samples	Bulk density (g/cm³)	WAC (g/g)	OAC (g/g)	pH	EA (%)	ES (%)
A	0.72±0.0007^{a}	0.705±0.05^{b}	0.91±0.04^{b}	6.08±0.006^{a}	33.5±0.007^{b}	35±0.014^{c}
B	0.72±0.0028^{a}	0.925±0.02^{b}	1.06±0.11^{ab}	6.02±0.006^{b}	35.5±0.007^{ab}	37.5±0.007^{bc}
C	0.67±0.0064^{b}	0.98±0.156^{b}	1.2±0.03^{a}	5.97±0.015^{c}	38.85±0.045^{ab}	42±0.014^{ab}
D	0.63±0.0023^{c}	1.575±0.05^{a}	1.1±0.09^{ab}	5.93±0.012^{d}	44.75±0.018^{a}	47.5±0.02^{a}

Values in the table represent the means±standard deviations (n=3 replicates). The values denoted by different letters in the same column are significantly different ($P \leq 0.05$). a, b, c, d: Means with the same column with different letters are significantly different ($P<0.05$). A (control)=100:0, 100% wheat flour. B=95:5, 95% of wheat flour incorporated with 5% of Shiitake mushroom flour blends. C=90:10, 90% of wheat flour incorporated with 10% of Shiitake mushroom flour blends. D=85:5, 85% of wheat flour incorporated with 5% of Shiitake mushroom flour blends. WAC: Water absorption capacity. OAC: Oil absorption capacity. EA: Emulsion activity. ES: Emulsion stability

Table 3: Effect of Shiitake mushroom powder on the physical parameter of biscuits

Sample	Diameter (cm)	Thickness (cm)	Spread ratio (cm)	Density (g/cm³)	Expansion coefficient (%)
A	5.2±0.2^{a}	0.48±0.03^{a}	10.91±0.17^{b}	0.69±0.1^{b}	27.20±4.39^{a}
B	4.93±0.06^{ab}	0.44±0.05^{a}	11.22±1.14^{b}	0.83±0.11^{ab}	24.47±1.67^{a}
C	4.97±0.06^{ab}	0.40±0.03^{ab}	12.56±0.82^{ab}	0.78±0.07^{ab}	17.91±0.08^{ab}
D	4.80±0.1^{b}	0.33±0.015^{b}	14.42±0.62^{a}	0.97±0.02^{a}	8.17±1.24^{b}

Values in the table represent the means±standard deviations (n=3 replicates). The values denoted by different letters in the same column are significantly different ($P \leq 0.05$). A (control)=100:0, 100% wheat flour biscuits. B=95:5, 95% of wheat flour incorporated with 5% of Shiitake mushroom biscuits. C=90:10, 90% of wheat flour incorporated with 10% of Shiitake mushroom biscuits. D=85:5, 85% of wheat flour incorporated with 5% of Shiitake mushroom biscuits

Table 4: Proximate composition values of developed biscuits

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Total Carbohydrate (%)	Energy (kcal)
A	2.53±0.13^{c}	0.88±0.19^{b}	6.39±0.17^{b}	23.82±0.44^{a}	ND	66.64±0.53^{b}	504.86±5.03^{a}
B	4.18±0.20^{ab}	1.097±0.52^{ab}	6.66±0.1^{b}	17.87±0.33^{b}	0.4±0.14^{b}	70.43±0.81^{a}	465.98±2.42^{b}
C	3.48±0.38^{b}	1.32±0.04^{ab}	6.8±0.15^{ab}	17.64±0.2^{b}	0.6±0.21^{ab}	70.99±0.06^{a}	469.88±0.93^{b}
D	4.79±0.45^{a}	1.67±0.03^{a}	7.2±0.22^{a}	18.50±0.09^{b}	0.9±0.14^{a}	66.62±0.06^{b}	465.51±1.58^{b}

Values in the table represent the means±standard deviations (n=3 replicates). The values denoted by different letters in the same column are significantly different ($P \leq 0.05$); ND: Not detected. A (control)= 100:0, 100% wheat flour biscuits. B=95:5, 95% of wheat flour incorporated with 5% of Shiitake mushroom biscuits. C=90:10, 90% of wheat flour incorporated with 10% of Shiitake mushroom biscuits. D=85:5, 85% of wheat flour incorporated with 5% of Shiitake mushroom biscuits

Table 5: Proximate values of wheat flour and Shiitake flour

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Total carbohydrate (%)	Energy (kcal)
Wheat flour	13.13±0.148^{aB}	0.96±0.02^{bE}	6.93±0.24^{bC}	5.25±0.18^{aD}	ND	73.87±0.007^{aA}	369.87±1.46^{a}
Shiitake flour	9.51±0.078^{bC}	6.96±0.02^{aD}	25.05±0.41^{aB}	5.97±0.25^{aD}	9.8^{C}	52.525±0.841^{bA}	363.87±1.46^{b}

Values in the table represent the means±standard deviations (n=3 replicates). DWB: Dry weight basis. ND: Not detected. a, b, c: Means with the same column with different letters are significantly different ($P<0.05$). A, B, C, D, E: Means with the same row with different letters are significantly different ($P<0.05$)

evaluate the above attributes of the samples and to rate each attribute. A 9-point hedonic scale with 1 (dislike extremely) and 9 (like extremely) was used

DISCUSSION

Proximate analysis of shiitake mushroom flour

From Table 5, data on proximate analysis of the prepared

shiitake mushroom flour clearly showed that the Shiitake mushroom flour used in this study was found to be richer in carbohydrate composition than protein and total fat and that the obtained result seemed acceptable which is within in the range from 51.97% to 66.00% compared with the works done by Regula and Suvulski[28] (66.00%), Hung and Nhi[29] (65.1%), and Jyoti *et al*.[30] (51.97%). Other studies reported that the carbohydrate contents of *L. edodes* varied 67.5-78% on a dry weight basis.[31,32] Shiitake mushroom is low in fat, of high percentage of polyunsaturated fatty acids, including in the aroma components.[33,34]

Functional properties of composite flours

Data on functional properties of composite flour presented in Tables 2 and 6 revealed that bulk density depends on the particle size and initial moisture content of flours.[35] Bulk density illustrated the downward trend of increasing to incorporate of Shiitake mushroom flour with wheat flour. It was clear that the decreased the proportion of wheat flour reduces the bulk density of composite flours. The highest bulk density of composite flour of sample, A and B suggest its suitability to be used as a thickener in food products and for use in food preparation since it helps to reduce paste thickness which is an important factor in convalescent and child feeding.[35]

As shown in Table 6, the high-WAC of composite flour D suggests that the flours can be used in the formulation of some foods such as sausage, dough, and processed cheese besides bakery products. Protein has both hydrophilic and hydrophobic nature, and therefore they can interact with water in foods according to Chandra *et al*.[35] The good WAC of composite flour D may prove useful in products where good viscosity is required such soups and gravies due to different protein concentration from wheat and Shiitake mushroom powder, their degree of interaction with water and conformational characteristics.[36]

As can be easily seen in Table 6, among four flour blends, data on the flour blend C were found the highest value which was significantly different to the sample A without Shiitake mushroom powder adding which amounted 120% and 91%, respectively. About sample B and D, both of them allocated 106% and 110%, respectively, that were the insignificant difference and lower than the sample C. It could be attributed that the higher the OAC of a flour sample, the better the cookie quality. OAC characteristic is required in ground analog, doughnut, pancakes, baked foods, and soups. Absorption of oil by food products improves mouthfeel and flavor retention. Oil retention also improves the quality of biscuits because oil contributes to the soft texture of cookies.[37] Therefore, the possible reason for incorporating wheat flour and Shiitake mushroom powder to produce biscuits. Increasing Shiitake mushroom powder in composite flour resulted in raising higher fat absorption capacity. The higher OAC in flour blend, the more improvement of palatability and extension of shelf life particularly in biscuit products where fat absorption is desired.[38] The major chemical component affecting OAC is a protein which is composed of both hydrophilic and hydrophobic parts.[39] Hence, the flour blend C is ideal in biscuits making, B and C sample are also acceptable.

Table 6: Functional properties of Shiitake mushroom flour

Physical property	Value*
Bulk density (g/cm^3)	0.372±0.001
Water absorption capacity (g/g)	5.77±0.11
Oil absorption capacity (g/g)	2.57±0.09
pH	5.79±0.017

Values in the table represent the means±standard deviations (n=3 replicates). The values denoted by different letters in the same column are significantly different ($P \leq 0.05$)

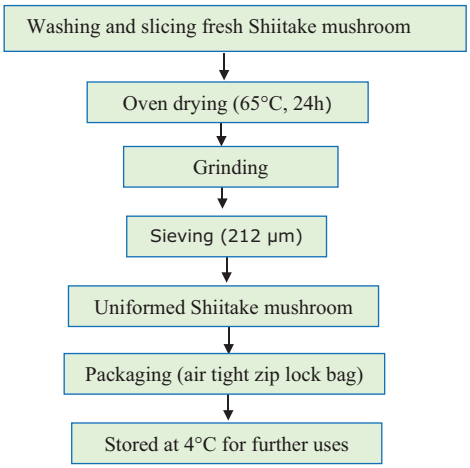

Figure 1: Flowchart for the preparation of Shiitake mushroom flour

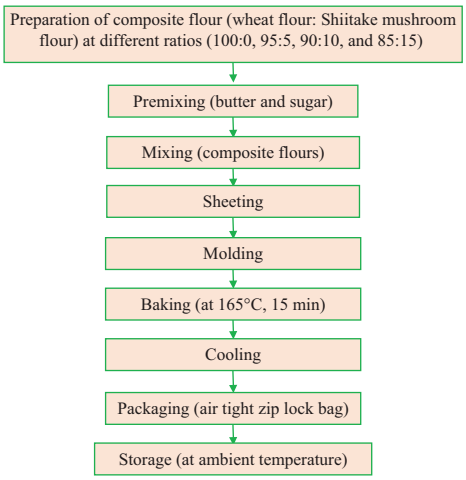

Figure 2: Flowchart for the preparation of biscuits

Physical properties of developed biscuits

As displayed in Table 3, a supplement of Shiitake mushroom powder at different proportion produced a significant change in physical characteristics. To be specific, the diameter of biscuits decreased as the inclusion of Shiitake mushroom powder raised particularly biscuits D had significantly ($P \leq 0.05$) lesser diameter data compared to biscuits A which amounted between 4.80 cm and 5.2 cm, respectively. The diameter of biscuits B and C fluctuated around 5% of Shiitake mushroom powder that was not significantly different from each other. Reportedly, the higher the spread ratio of the biscuit the more desirable it is Chauhan *et al*.[40] Hence, biscuits D prepared from 15% of Shiitake mushroom powder may be the most preferred based on spread ratio that allocated 14.42 cm and was significantly different from biscuits A and B. Thus, Shiitake mushroom powder partially encumbered when added up to 15% into composite flour then making biscuits sample D.

Flowchart for the preparation of Shiitake mushroom flour is shown in the Figure 1 and the Flowchart for the preparation of the developed biscuits is shown in the Figure 2.

Proximate values of developed biscuits

As illustrated in Table 4, the presence of high-fat content in the biscuits means high calorific value and also serves as a lubricating agent that improves the quality of the product, in terms of flavor and texture. In addition, fat is a rich source of energy and is essential as carriers of fat-soluble Vitamins A, D, E, and K.[41] Following these reasons, in spite of higher fat content compared to protein one's biscuits incorporated with Shiitake mushroom powder, are desirable for production. Last but not least, biscuits B, C, and D owning fat results do not exceed 25% leading to not occurring rancidity in foods and the development of unpleasant and odorous compounds.[41]

As shown in Figure 3, the addition of Shiitake mushroom powder to formulation B, C, and D promoted an increase in protein content that only biscuits D was significantly different to the control samples. As can be seen, this gradual increase in protein content is due to the addition of a various level of Shiitake mushroom powder in biscuits. Furthermore, this incorporation is the desirable increasing rate of protein values that biscuits may contain essential amino acids.

Total phenolic content of the developed biscuits

TPC such as flavonoids, phenolic acids, and tannins are considered to be major contributors to the antioxidant capacity of plants.[29] The Folin–Ciocalteu phenol method is not an antioxidant test but an alternative assay for the quantitation of phenolic compounds.[42] The content of TPC in dry mushroom extracts was determined by Folin–Ciocalteu procedure[43] using gallic acid as a standard. Absorbance was measured at 765 nm. The content of TPC has been expressed as mg of gallic acid equivalent (GAE) per g of dry mushroom extract (mg GAE/g). Phenolic compounds undergo a complex redox reaction with phosphotungstic and phosphomolybdic acids present in the reagent.[44]

In the present study, the level of phenolic content of Shiitake

Table 7: TPC of developed biscuits

Sample	Total phenolic content (μg GAE/g)
Shiitake mushroom	1504.98±18.52^{a}
A	119.21±2.38^{e}
B	667.39±2.21^{d}
C	873.29±5.28^{c}
D	1293.45±5.20^{b}

Values in the table represent the means±standard deviations (n=3 replicates). The values denoted by different letters in the same column are significantly different ($P \leq 0.05$). TPC: Total phenolic content, GAE: Gallic acid equivalent

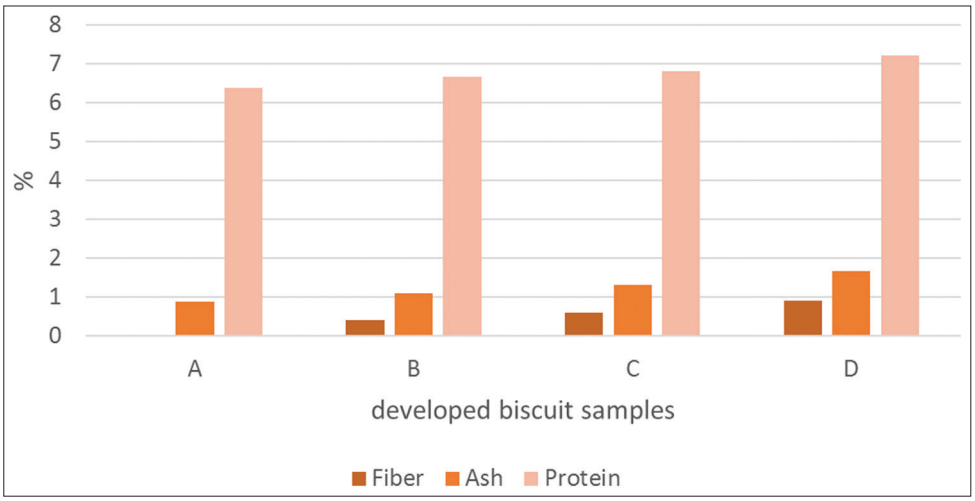

Figure 3: Effect of incorporating different ratio of Shiitake mushroom flour on the ash, fiber, and protein content of biscuits

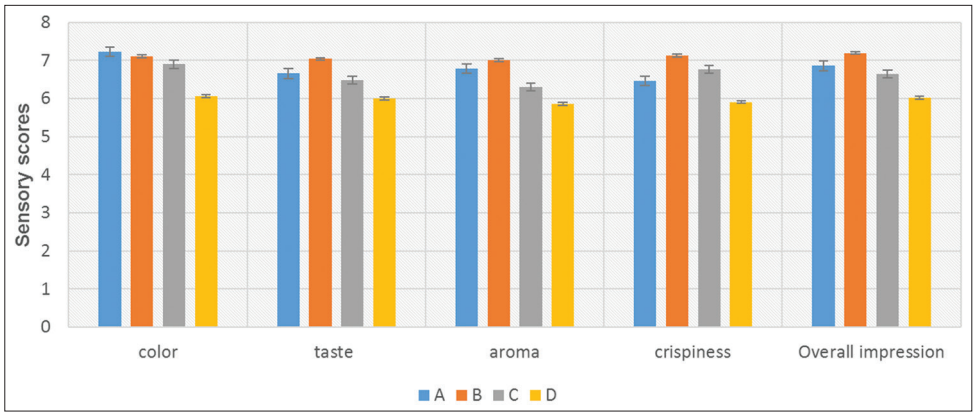

Figure 4: Effect of different levels of Shiitake mushroom powder substitution into biscuit samples on sensory parameters

Table 8: Sensory evaluation scores of developed biscuits in term of color, taste, aroma, crispiness, and overall impression in 5-point scale

Sample	Color	Taste	Aroma	Crispiness	Overall impression
A	7.23±1.406^{a}	6.66±1.45^{ab}	6.79±1.33^{ab}	6.47±1.46^{bc}	6.86±1.2^{a}
B	7.11±1.291^{a}	7.04±1.46^{a}	7.01±1.35^{a}	7.13±1.17^{a}	7.20±1.19^{a}
C	6.90±1.298^{a}	6.49±1.41^{ab}	6.31±1.38^{bc}	6.77±1.4^{ab}	6.64±1.25^{a}
D	6.07±1.563^{b}	6.00±1.75^{b}	5.86±1.87^{c}	5.91±1.64^{c}	6.03±1.56^{b}

Average of 70 evaluations. The values denoted by different letters in the same column are significantly different ($P \leq 0.05$)

mushroom powder sample and biscuit formulations is proportional to the content level of the added Shiitake mushroom powder as illustrated in Table 7. As just mentioned, the data on TPC increased gradually following the raising addition of Shiitake mushroom flour levels. To be specific, biscuits D was the highest value which shared 1293.45 µg GAE/g. All three biscuit samples incorporated with Shiitake mushroom powder exhibited a significant level of TPC of the products compared to the control samples. The TPC (µg GAE/g) in the different varieties of the sample extracts were calculated using the standard curve for Folin with the equation y = 0.0404x + 0.005, R^2 = 0.995. In the supplemented Shiitake mushroom powder biscuits, TPC ranged between 667.39 and 1293 µg GAE/g, while the result of the control sample was 119.21 µg GAE/g. These concentrations were statistically different ($P < 0.05$) among the studied samples.

Sensory evaluation

Organoleptic tests of the biscuits depend on its first color, crispiness, taste, aroma. and overall acceptability of the sample. Figure 4 shows the comparison among the biscuits of their organoleptic quality factors and Table 8 presents whether the results are significantly different or not from the organoleptic acceptability of biscuits on 5 points Hedonic scale is given by 70 untrained panelists.

General impression for biscuits control, B, C was not significantly different sharing in the range between 6.64 and 7.20 in within the rate of like and moderately like. As displayed in Table 8, biscuits D was significantly lowest score allocating 6.03 for the impression, but it rated at slightly like this 15% Shiitake mushroom flour incorporated biscuits. Therefore, all three added Shiitake powder biscuits got moderately like from people, especially 5% Shiitake mushroom powder added is much more desirable than others. The 5%, 10%, and 15% addition of Shiitake mushroom flour are acceptable to consumers.

CONCLUSIONS

In this study, the incorporation potential of the wheat flour with shiitake mushroom powder in biscuits production to improve nutritional values and the development of new recipes to make good quality biscuits from shiitake mushroom was successfully and thoroughly investigated. The nutritional analysis of the wheat flour - Shiitake mushroom powder biscuits shown the more significant dominance of fiber, protein, and ash from 5 to 15% Shiitake mushroom flour enriched biscuits by selected supplements.

REFERENCES

1. Mattila P, Könkö K, Eurola M, Pihlava JM, Astola J, Vahteristo L, *et al.* Contents of vitamins, mineral elements, and some phenolic compounds in cultivated mushrooms. J Agric Food Chem 2001;49:2343-8.
2. Maria EV, Talía HP and Octavio PL. Edible Mushrooms: Improving Human Health and Promoting Quality Life. International Journal of Microbiology Volume 2015; Article

ID 376387.
3. Bilal AW, Bodha RH, Wani AH. Nutritional and medicinal importance of mushrooms. J Med Plants Res 2010;4:2598-604.
4. Barros L, Cruz T, Baptista P, Estevinho LM, Ferreira IC. Wild and commercial mushrooms as source of nutrients and nutraceuticals. Food Chem Toxicol 2008;46:2742-7.
5. Ka CS, Xia C and Jian-Yong W. Constituents actually responsible for the antioxidant activities of crude polysaccharides isolated from mushrooms. J Funct Foods 2014; 11:548-56.
6. Wasser S. Medicinal mushrooms as a source of antitumor and immunomodulating polysaccharides. Appl Microbiol Biotechnol 2002;60:258-27.
7. Jong SC, Birmingham JM. Medicinal and therapeutic value of the shiitake mushroom. Adv Appl Microbiol 1993;39:153-84.
8. Peter CL. Mushrooms as Functional Foods. Hoboken, New Jersey: John Wiley & Sons, Inc., Published Simultaneously in Canada; 2008.
9. Peter T. The forgotten mushrooms of ancient Peru. Oreslina, Switzerland: Global Mountain Action, Via al Corridore; 2012.
10. Adelakun OE, Lawal MA. Evaluation of wheat cassava and soymalt composite flour influence on biscuit quality. PAK. J Food Sci 2017;27:53-60.
11. Prodhan UK, *et al*. Development and quality evaluation of mushroom (*Pleurotus sajor caju*) enriched biscuits. Emirates J Food Agric 2015;27:542-7.
12. Gadallah MG, Ashoush IS. Value addition on nutritional and sensory properties of biscuit using desert truffle (*Terfezia claveryi*) powder. Food Nutr Sci 2016;7:1171-81.
13. Singh J, Sindhu SC, Sindhu A. Development and evaluation of value added pickle from dehydrated shiitake (*Lentinus edodes*) Mushroom. Int J Food Sci Nutr 2016;1:24-6.
14. Latimer G. Official Methods of Analysis of AOAC International. Gaithersburg, Md.: AOAC International; 2012.
15. Osborne DR, Voogt F. The Analysis of Nutrients in Foods. London: Academic Press; 1978.
16. Eleazu C, Ironua C. Physicochemical composition and antioxidant properties of a sweetpotato variety (*Ipomoea batatas* L) commercially sold in South Eastern Nigeria. Afr J Biotechnol 2013;12(7):720-7.
17. Gaithersborg S, editor. AOAC (Association of Official Analytical Chemists). Official Methods of Analysis. 15th ed. Washington DC, USA: AOAC Press; 2006. p. 78-90.
18. Nwosu JN. Production and Evaluation of biscuits from blends of Bambara Groundnut and Wheat Flour. Int J Food Nutr Sci 2013;2, 4-9.
19. Onabanjo OO, Dickson AI. Nutritional, functional and sensory properties of biscuit produced from wheat-sweet potato composite. J Food Technol Res 2014;1:111-21.
20. Adepeju AB, Gbadamosi SO, Adeniran AH and Omobuwajo TO. Functional and pasting characteristics of breadfruit (Artocarpus altilis) flours. Afr J Food Sci 2011; 5:529-35.
21. Yasumatsu K, Sawada K, Maritaka S, Toda J, Wada T, Ishi K. Whipping and emulsifying properties of soy bean products. Agric Biol Chem 1972;36:719-27.
22. Reis FS, Martins A, Barros L, Ferreira IC. Antioxidant properties and phenolic profile of the most widely appreciated cultivated mushrooms: A comparative study between *in vivo* and *in vitro* samples. Food Chem Toxicol 2012;50:1201-7.
23. Singleton VL, Rossi JR. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am J Enol Viticult 1965;16:144-58.
24. Srivastava Y, Semwal AD, Sharma GK, Bawa AS. Effect of virgin coconut meal (VCM) on the textural, thermal and physico chemical properties of biscuits. Food Nutr Sci 2010;2:38-44.
25. Monika T, Karuna S. Studies on nutritional, quality and sensory evaluation of value added baked products with button mushroom (*Agaricus bisporus*) powder. Int J Agric Sci 2018;14:173-9.
26. Clareto SS, Nelson DL, Pereira AJ. Influence of a protein concentrate used as a fat substitute on the quality of cheese bread. Braz Arch Biol Technol 2006;49:1019-25.
27. Meilgaard M, Civille V, Carr B. Sensory Evaluation Techniques. Boca Raton: CRC Press; 1991. p. 354.
28. Regula J, Suvulski M. Dried shiitake (*Lentinula edodes*) and Oyster (*Pleurotus ostreatus*) mushroom as a good source of nutrient. Acta Sci Pol Technol Aliment 2007;6:136-42.
29. Hung PV, Nhi NN. Nutritional composition and antioxidant capacity of several edible mushrooms grown in the Southern Vietnam. Int Food Res J 2012;19:611-5.
30. Jyoti S, Sindhu SC, Anil S. Development and nutritional evaluation of value added products from shiitake (*Lentinus edodus*) mushroom. Int J Food Sci Nutr 2016;1:24-6.
31. Crisan EV, Sands A. Nutritive value. In: Chang ST, Hayes WA, editors. The Biology and Cultivation of Edible Mushroom, New York, USA: Academic Press; 1978. p. 137-68.
32. Bano Z, Rajarathnam S. Pleurotus mushrooms. Part II. Chemical composition, nutritional value, post-harvest physiology, preservation, and role as human food. Crit Rev Food Sci Nutr 1988;27:87-158.
33. Baghel RK, Bisen PS, Sanodeva BS, Thakur GS, Prasad GB. Lentinus edodes: A macrofungus with pharmacological activities. Curr Med Chem 2010;17:2419-30.
34. Mizuno T. Shiitake, *Lentinus edodes*: Functional properties for medicinal and food purposes. Food Rev Int 1995;11:7-21.
35. Chandra S, Sigh S, Kumari D. Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. J Food Sci Technol 2015;52:3681-8.
36. Butt MS, Batool R. Nutritional and functional properties of some promising legumes proteins isolates. Pak J Nutr 2010;9:373-9.
37. Jacob J, Leelavathi K. Effect of fat-type on cookie dough and cookie quality. J Food Eng 2007;79:299-305.
38. Aremu MO, Olaofe O, Akintayo ET. Functional properties of some Nigerian varieties of legume seed flours and flour concentration effect on foaming and gelation properties. J Food Technol 2007;5:109-15.
39. Jitngarmkusol S, Hongsuwankul J, Tananuwong K. Chemical compositions, functional properties, and microstructure of defatted macadamia flours. Food Chem 2008;110:23-30.
40. Chauhan A, Saxena DC, Singh S. Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. Cogent Food Agric 2016;2:1125773.
41. Ihekoronye AI, Ngoddy PO. Integrated Food Science and Technology for the Tropics. London: Macmillan Publishers; 1985.
42. Wangensteen H, Samuelsen AB, Malterud KE. Antioxidant activity in extracts from coriander. Food Chem 2004;88:293-7.
43. Kähkönen MP, Hopia AI, Vuorela HJ, Rauha JP, Pihlaja K, Kujala TS, *et al*. Antioxidant activity of plant extracts containing phenolic compounds. J Agric Food Chem 1999;47:3954-62.
44. Zhang Z, Guoying LV, Huijuan P, Yongzhi WU, Leifa F. Effects of different drying methods and extraction condition on antioxidant properties of shiitake (*Lentinus edodes*). Food Sci

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