

Study on supplementation of 'ogi' with oyster mushroom flour (*Pleurotus ostreatus*)

Abstract

'Ogi' is a traditional staple food in Nigeria consumed by millions of people. However, it is low in protein contents and hence there is a need to improve its nutritional quality of protein rich foods such as mushroom. In this study, oyster mushroom was blended with 'ogi' to form a composite and its effect was investigated on the nutritional improvement in the samples. The composite 'ogi' samples were analysed for proximate composition, physico-chemical properties and sensory evaluation. The results of the proximate composition were as follows: moisture (9.08-10.02)%, protein (8.90-13.29)%, fat (4.73- 5.03)%, ash (1.56-1.90)%, crude fibre (3.13-3.90)% and carbohydrate content (66.64-72.51)%. The results of physico-chemical properties were as stated; swelling power (19.25-19.45)%, solubility (21.49-22.90)%, water absorption capacity (40.07-42.25)%, bulk density (0.51-0.57) g/ml. The sensory results were: aroma (1.50-5.75), colour (3.50-4.00), taste (2.25-4.50), texture (2.75-4.25), sourness (2.75-4.25) and overall acceptability (2.50-3.50). The result of the research showed that up to 20% inclusion mushroom flour could be used to increase the protein content of 'ogi' and still be acceptable sensorially. It was concluded that oyster mushroom could be used to improve the nutritional quality of 'ogi' in terms of protein and fibre especially in developing countries where protein-energy malnutrition is prevalent.

Keywords: ogi, oyster mushroom, proximate, functional and sensory evaluation

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Abbreviations: ANOVA, analysis of variance; DMRT, Duncan multiple range tests; NADBA, national development biotechnology agency; AOAC, association of official analytical chemists

Introduction

Fermented cereal gruel popularly called 'Ogi' in Yoruba dialect is a staple food in Nigeria. It is estimated that about 150 million people consume it in West Africa despite its nutritional deficit.¹ It is easy to prepare and serves as infant weaning food, breakfast for school pupils and convenient food for the aged adults. 'Ogi' can be prepared in various ways such as hot liquid smooth gel called 'eko' in 'Yoruba' which can be consumed with sugar, honey, and ground- nut and bean cake. It can also be boiled into thick paste which when it is cool becomes solid called 'eko agidi'. This can then be consumed with soup or bean cake ('moinmoin' or 'akara'). Major raw materials for 'ogi' preparation are maize, sorghum or millet. The raw materials used determine the colour of 'ogi' produced. The production processes involve cleaning, steeping in warm water for 2-5 days to softening the kernels and fermentation process; the fermented maize is wet milled, sieved with muslin cloth and allowed to settle. The process of settling down of 'ogi' particles leads to substantive second fermentation process. The longer the 'ogi' is left in water, the sourer it becomes, and it can be preserved in this form for more than six months provided the supernatant water of the slurry are changed every three day. Other methods of preservation are by drying and packaged as flour.

Pleurotus species otherwise known as oyster mushrooms are fungi with distinct fleshy fruiting bodies. It is often found on dead trees and has been reported to have got an excellent flavor and taste when cooked to form delicacies.² It is reported to have high quantities of proteins, carbohydrates, minerals (calcium, phosphorus,

iron) vitamins (thiamin, riboflavin and niacin) as well as low fat.^{3,4} Despite its abundant availability, oyster mushroom has been grossly underutilized in Nigeria because its nutritional values have not been explored.

The nutritional composition of 'ogi' is mainly starch and it is low in protein, vitamins and minerals. This is because during sieving, most water soluble vitamins and some minerals have leached into the water leaving the slurry deficient in essential nutrients. As a result of this, attempts have been made by researchers to increase its nutritional content by supplementation with protein/vitamins rich foods; for instance, Enujiughu⁵ supplemented 'ogi' with African oil bean seed. Olorode et al.,⁶ supplemented it with *Moringa oleifera* leaf powder; Otunola et al.,⁷ reported the supplementation of 'ogi' with pawpaw. Adejuyitan et al.,⁸ supplemented 'ogi' with baobab fruit powder, Aremu et al.,⁹ supplemented 'ogi' with scarlet runner beans (*Phaseolus coccineus* L.) flours. Ajanaku & Oluwole¹⁰ carried out a study on sorghum-'ogi' weaning food mixed with crayfish (*Paraneopros planifrons*). However, supplementation of 'ogi' with oyster mushroom has not been well reported in the literature. Therefore, the objective of this study was to evaluate the effects of oyster mushroom supplementation on the nutritional properties of 'ogi' powder.

Materials and methods

Materials

Maize (*Zea mays*) was obtained from Wazo market, Ogbomoso and the oyster mushroom was obtained from the National Development Biotechnology Agency (NADBA), Ogbomoso, Oyo State, Nigeria.

Methods

'Ogi' processing

A modification of the method described by Akingbala et al.,¹¹ was used for 'ogi' preparation. The flow chart for the process is shown in Figure 1. The obtained maize grains were sorted and winnowed. 2kg of the maize grains were weighed into a bowl, washed and rinsed several times. The rinsed grains were soaked in hot water (60°C) for 72hrs to ferment. After fermentation, the grains were thoroughly washed and rinsed in water before grinding to paste using local disc attrition mill. The paste was sieved with muslin cloth in a basin of water and allowed to settle for about an hour to form smooth slurry. The supernatant was decanted and the slurry of 'ogi' was collected. This slurry was pressed into cake and dried at 50°C in an oven to obtain dried cake. The cake was milled into flour, sieved and packaged for further analysis.

Preparation of mushroom (*p. ostreatus*) flour

2kg of fresh and clean oyster mushroom were weighed and chopped into small pieces with knife. Then, the chopped mushrooms were spread in trays and dried at 50°C until the slight brown colour was obtained. The dried oyster mushroom was grounded into powder for 3-5minutes using blender (750 Watt Sapphire model) and stored in air-tight container for further usage.

Sample preparation of 'Ogi'-mushroom blends

The 'ogi' flours were measured into different weights: 100g, 90g, 85g and 80g. The mushroom flours also were measured into weights: 10g, 15g, and 20g. The samples were then mixed into proportions of 100:0, 90:10, 85:15 and 80:20 for 'ogi'-mushroom, respectively. Each combination represents samples A, B, C, and D respectively. The flow chart production is as shown in Figure 1

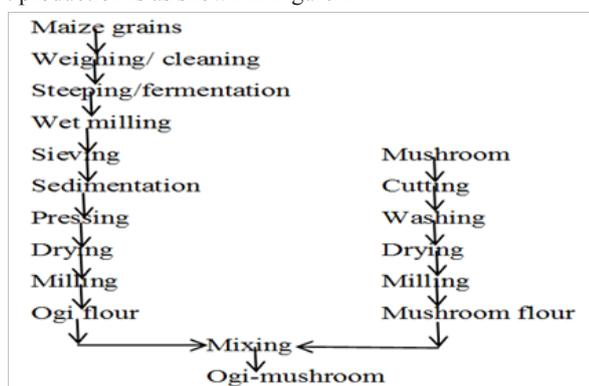


Figure 1 Flow chart of 'ogi'-mushroom flour Source:Akingbala et al.,¹¹ modified.

Chemical analyses

a) Proximate analysis

The proximate (moisture, protein, fat, ash, crude fibre and carbohydrate) analysis of 'ogi'-mushroom blends and pap were determined using (AOAC 2005) method¹²

b) Functional analysis 'ogi'-mushroom blends

Water absorption capacity, bulk density, swelling power and solubility 'ogi'-mushroom blends were determined using AOAC (2005) method¹²

c) Sensory analysis of pap

Fifty member semi-trained panelists were used to evaluate the 'eko' sample. The 'ogi'-mushroom flour was mixed properly with water to form thick slurry and heated to gelatinization using boiling water and sugar to form pap. It was served hot on randomly coded plates. The pap were rated based on aroma, colour, taste, texture, sourness and overall acceptability on a 9 point hedonic scale, where 1 represented "like extremely" and 9 represented "dislike extremely".

Statistical analysis

The statistical analysis of each sample was performed using the statistical package for social scientists (SPSS 20.0 versions). The data generated from these investigations were analyzed using analysis of variance (ANOVA) and the test significance was carried out using Duncan Multiple range tests (DMRT).

Results and discussion

The proximate composition of 'ogi'-mushroom flour mixes is as presented in Table 1. Statistical analysis showed significant differences in the proximate components among the samples at ($p < 0.05$). The moisture levels ranged from 9.08% to 10.02%. Sample A had the least moisture content of 9.08% which was better than sample B, C, and D for storage. Sample D had the highest moisture content indicating it was prone to microbial attack in the terms of storage. Also, the values of moisture content in this study were higher than the one obtained in the substitution of 'ogi' with *Moringa oleifera* leaf powder extract reported by Olorode et al.⁶ It can be deduced that increase in the addition of mushroom content favored the increase in moisture content of the blend; this may be partly due to the increased moisture content of the mushroom which affected the mixes. The protein content varied significantly from each other ($p < 0.05$), it ranged between 8.90 to 13.29% with Sample A and D had the least and highest values respectively. The increase in the protein content was due to the addition of various levels of mushroom flour to the 'ogi'. This suggests that mushroom could improve the nutritional status of 'ogi' flour. The protein content obtained was lower than the one obtained by Enujiugha⁵ in the supplementation of 'ogi' with African oil bean seed flour of which the protein reached up to 33.25% at a ratio of 60:40. The value also lower than the one obtained by Theodore et al.,¹³ in the supplementation of 'ogi' with Bambara nut flour which reached up to 16.4% at a ratio of 80:20. The fat content of the flour ranged from 4.73 to 5.03% and exhibited no significant difference between sample B and C ($p > 0.05$) but sample A and D were significantly different ($P < 0.05$). These values were higher than the values of fermented composite blends of cereals and soybeans that were reported by Onilude et al.,¹⁴ which ranged from 18.4 to 28.8%. Fat serves as energy store in the body. It can be broken down in the body to release glycerol and free fatty acids. The results showed that oyster mushroom is not good sources of fats. The results of the ash content ranged from 1.56% to 1.90% with sample A and D had the lowest and highest values, respectively.

The samples were significantly different from each other ($p < 0.05$). This result showed the ash contents value of the samples in this work were higher when compared to the values reported by Onilude et al.,¹⁴ which ranged from 0.4-0.8%. This result indicated that the samples could be good sources of nutritionally essential minerals and trace elements if further examined. Crude fibre of the samples ranged from 3.13% to 3.90% with sample A had the lowest value of

3.13% while sample D had the highest value of 3.90%. They were significantly different from each other ($p < 0.05$). The values obtained were comparable with those obtained by Adejuyitan et al.,⁸ which ranged from 2.2 to 2.4% when supplemented 'ogi' with baobab leaf powder. Reports have shown that increase in fibre consumption might contribute to the reduction in the incidence of certain diseases such as diabetes, coronary heart disease, colon cancer and various digestive disorders.¹⁵ The values of the carbohydrate content however showed a reverse trend. It decreased from 72.51% to 66.64% as the values of oyster mushroom increased from 10 to 20% in the 'ogi' - mushroom flour. Sample A had the highest carbohydrate content while sample D had the lowest carbohydrate content. The samples were significantly different from each other ($p < 0.05$). These values compared favourably with the one obtained by Akinrinola et al.,¹⁶ with values ranged from 70.77 to 89.60% who supplemented 'ogi' with okra seeds.

Table 1 Proximate composition of yellow maize-mushroom flour mixes

Nutrients	A	B	C	D
Moisture	9.08±0.15 ^a	9.83±0.14 ^b	9.94±0.10 ^{bc}	10.42±0.11 ^c
Protein	8.9±0.15 ^a	9.03±0.13 ^{ab}	9.89±0.18 ^b	13.29±0.18 ^c
Fat	4.73±0.15 ^a	4.84±0.13 ^{ab}	4.98±0.21 ^{ab}	5.03±0.20 ^b
Ash	1.56±0.18 ^a	1.75±0.12 ^b	1.83±0.13 ^{bc}	1.90±0.17 ^c
Fiber	3.13±0.18 ^c	3.24±0.14 ^{ab}	3.50±0.15 ^a	3.90±0.14 ^b
Carbohydrate	72.51±2.01 ^d	71.47±2.15 ^c	69.86±3.11 ^b	69.64±3.15 ^a

Values with different superscripts within a column are significantly different at $p < 0.05$.

Key: A, 100% 'Ogi' flour; B, 90% 'Ogi' flour and 10% mushroom flour; C, 85% 'Ogi' flour and 15% mushroom flour; D, 80% 'Ogi'.

Functional properties of 'Ogi'-Mushroom Flour Mixes

The results of swelling capacity ranged from 19.25 to 19.49g water/g sample as seen in Table 2. There was decrease in the swelling power as the values of mushroom increased. Sample A and D had the highest and lowest values, respectively. Sample A and B were not significantly different ($p > 0.05$) and likewise sample C and D. This implied that the mushroom flour in itself alone had low swelling capacity which in turn had insignificant effect on the composite samples. The value in this work was in agreement with earlier findings of Adejuyitan et al.,⁸ but higher than the values obtained by Olorode et al.⁶ Swelling capacity and solubility index provide evidence of the magnitude of interaction between starch chains within the amorphous and crystalline domains and also evidence of association bonding within the granules of maize starches.¹⁷

The result obtained for solubility index ranged from (21.49-22.90%) with sample A and D having lowest and highest values, respectively, as seen in Table 2. Samples C and D had no significant difference from each other ($p < 0.05$) but sample A and B were significantly different ($p < 0.05$). The high value for solubility in sample D may be attributed to its higher protein content. This is in agreement with the result of Omueti et al.,¹⁸ on the solubility of complementary diets developed from soybean, groundnut and crayfish, whereby increase in solubility was recorded at increased level of high protein products which indicated that the high protein content was an advantage to the solubility. Furthermore, the values compared favorably with the

result obtained by Olorode et al.⁶ Solubility is an index of protein functionality such as denaturation and its potential applications Omueti et al.,¹⁸ The highest and lowest water absorption values were 42.25% and 40.07% observed in sample A and D respectively, as shown in Table 2. Samples A and B were not significantly different from each other ($p < 0.05$) but sample C and D were significantly different from each other ($p < 0.05$). This value compared favourably with the result obtained by Theodore & Olorode et al.^{6,13} The results from the water absorption capacity showed that, the higher the percentage of mushroom flour added, the lower the water absorption capacity. Water absorption capacity denotes the maximum amount that a food material can take up and retain under formulation condition. The bulk density of the samples ranged from 0.51g/ml to 0.57g/ml. Samples A, B and C were not differed significantly from each other but differed from sample D ($p < 0.05$). These values compared favorably with the results obtained by Olorode et al.⁶ Non-supplemented 'ogi' (sample A) had lowest bulk density when compared with the composite ones as seen in Table 2. High bulky density was as a result of high viscosity; therefore, the bulk density increased as the supplement increased in the samples.¹⁹ The bulk density is generally affected by the particle size and the true density of the matter in flour.²⁰

Table 2 Functional properties of 'Ogi'-mushroom composite flour

Samples	Swelling capacity (g water/ g sample)	Solubility (%)	Water absorption capacity (%)	Bulk density (g/ml)
A	19.49±0.21 ^b	21.49±0.85 ^a	42.25±0.64 ^c	0.51±0.06 ^a
B	19.40±0.42 ^b	21.82±0.15 ^b	42.00±0.92 ^c	0.52±0.12 ^a
C	19.31±0.28 ^a	22.83±0.35 ^c	41.20±0.11 ^b	0.53±0.04 ^a
D	19.25±0.28 ^a	22.90±0.35 ^c	40.07±0.22 ^a	0.57±0.04 ^b

**Values with different superscripts within a column are significantly different at $p < 0.05$.

A, 100% 'Ogi' flour; B, 90% 'Ogi' flour and 10% mushroom flour; C, 85% 'Ogi' flour and 15% mushroom flour; D, 80% 'Ogi' flour and 20% mushroom flour.

Sensory evaluation of pap

The sensory evaluation of 'ogi'-mushroom pap is as shown in Table 3. Sample A differed significantly from samples B, C and D in terms of aroma and was most preferred while sample D was the least preferred. This was because the aroma of the fortified sample was slightly different from the usual aroma of 'ogi' known to the consumers. There were no significant differences among samples C and D in terms of the colour but sample A was most preferred. The same trend was not seen in terms of taste as Sample C was rated highest followed by Sample B. This could be as result of the distinctive taste of mushroom in the pap. However, the samples showed no significant difference from one another. Although, there were no significant differences between samples A and B in terms of texture, yet Sample A was rated best followed by sample B. This was because, mushrooms are fibrous in nature; as the amount of mushroom increased in the samples, it affected the texture of the overall samples of 'ogi'-mushroom samples. In terms of sourness, sample A was liked very much, sample B and C were liked moderately but sample D was

the least preferred. This is as a result of the inclusion of mushroom which reduced the sour taste in the pap. The distinguish characteristics of the pap is the sour taste which always attract most consumers. However, samples A and B were not significantly different from each other but differed from samples C and D. The overall acceptability of 'ogi'-mushroom pap showed that samples A was most preferred followed by sample B, C and D. In summary, the acceptability of the 'ogi' samples in terms of aroma, colour, taste, texture, sourness and overall acceptability were not affected when supplemented with up to 15-20% mushroom flour.

Table 3 Sensory evaluation of 'ogi'-mushroom pap

Properties	A	B	C	D
Aroma	2.25±0.16 ^a	3.50±0.30 ^b	3.75±0.52 ^b	4.50±0.28 ^c
Colour	1.50±0.58 ^a	2.75±0.26 ^b	5.25±0.63 ^c	5.75±0.20 ^c
Taste	4.00±0.45 ^a	3.75±0.99 ^a	3.50±0.38 ^a	4.00±0.94 ^a
Texture	2.75±0.22 ^a	3.00±0.82 ^a	4.00±0.06 ^b	4.25±0.41 ^b
Sourness	2.75±0.16 ^a	3.50±0.58 ^a	4.00±0.82 ^b	4.25±0.89 ^b
Overall acceptability	2.50±0.71 ^a	2.87±0.82 ^a	3.00±0.50 ^a	3.50±0.89 ^a

Values with different superscripts within a column are significantly different at $p < 0.05$.

Key: A, 100% 'Ogi' flour; B, 90% 'Ogi' flour and 10% mushroom flour; C, 85% 'Ogi' flour and 15% mushroom flour; D, 80% 'Ogi' flour and 20% mushroom flour.

Results of the proximate analysis of 'Eko'

Table 4 shows the moisture content of the pap ('eko') which ranged from 18.72 to 15.11%. The inclusion of mushroom reduced the moisture content significantly. This observation was contrary to the trend observed for composite flour in Table 1. This is because, starch structure were altered and behaved differently at a gelatinization stage. The values of protein increased significantly at $p < 0.05$ as mushroom proportion increased in the pap. These values were greater than the values reported by Adebola et al.,²¹ who reported the values protein content of 'eko'. This implies that percentage protein increase in ogi could be enhanced by the inclusion of mushroom. The percentage of fat content followed a decreasing trend from sample A to D. Sample A and B were not significant difference at $p < 0.05$ but different from samples C and D. This suggested that oyster mushroom is a not a good source of fat, hence it could be used as a fat-reducing agent. Ash and fibre content of the pap values are as shown in Table 4, the values increased as the mushroom content increased with significant difference at $p < 0.05$. The carbohydrate content of the pap reduced as the mushroom content increased in the pap. The processing of 'ogi' into 'eko' has generally affected the proximate composition of the sample leading to reduction in the values of fat, ash and fibre when compared with the ogi flour in Table 1. This trend was also observed by Oyarekua, Adejumo & Adebola et al.²¹⁻²³

Table 4 Proximate composition of 'eko' samples

Nutrients	A	B	C	D
Moisture	18.72±0.15 ^a	16.73±0.14 ^b	15.25±0.10 ^c	15.11±0.11 ^c
Protein	2.90±0.15 ^a	5.03±0.13 ^b	7.89±0.18 ^c	9.29±0.18 ^d
Fat	0.93±0.05 ^a	0.84±0.03 ^a	0.68±0.02 ^b	0.39 ±0.02 ^c
Ash	0.26±0.08 ^a	0.37±0.02 ^b	0.41±0.03 ^b	0.91±0.01 ^c
Fiber	0.18±0.00 ^a	0.41±0.01 ^b	0.60±0.01 ^c	0.80±0.01 ^d
Carbohydrate	77.01±2.01 ^a	76.62±2.15 ^a	75.17±3.11 ^{ab}	73.50±3.15 ^b

Values with different superscripts within a column are significantly different at $p < 0.05$

Key: A, 100% 'Ogi' flour; B, 90% 'Ogi' flour and 10% mushroom flour; C, 85% 'Ogi' flour and 15% mushroom flour; D, 80% 'Ogi' flour and 20% mushroom flour.

Conclusion

The use of yellow maize and mushroom flour mixes in 'ogi' formulation yielded a product with improved functional characteristics and high nutritive value. The study showed that supplementation with oyster mushroom could improve the protein content, mineral content and some selected functional characteristics. The research showed that mushroom flour can actually be used to mix "ogi" up to 20% inclusion of mushroom and still be acceptable.

Recommendation for further studies

The authors observed the limitation of this work and recommended the following for further studies on the work.

- Optimization studies for the formulation of 'ogi'-mushroom blends should be investigated,
- Shelf life and packaging studies for the product should further be examined,
- Microbial studies on the product should be investigated further

Acknowledgments

None.

Conflict of interest

Author declares no conflict of interest.

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