Middle-East Journal of Scientific Research 25 (7): 1607-1610, 2017
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2017.1607.1610

Experimental Studies on the Nutritional and Bio-Sensory Properties of Mushroom Fortified Ogi

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Abstract: The feasibility of enriching ogi with mushrooms grown domestically was evaluated from fermented rice husk substrate, dried, milled into flour, blended with maize flour at the ratio of 5%, 10%, 15% and 20% and co-fermented for 72 hours. The maize mushroom ogi produced were evaluated for proximate composition, bio-sensory and nutritional properties. The nutritional qualities include NPU, BV, PER TD and weight gain respectively. Results showed that mushroom inclusion improved protein, ash and Fibre contents of the ogi while carbohydrates, fat and moisture content were reduced with increase in level of inclusion. Bio-sensory evaluation showed that ogi at 20% level of inclusion was preferred to the 100% maize ogi in terms of overall acceptability although the product lost the traditional sour taste of ogi at above 10% inclusion. Inclusion of mushroom even at low level (5%) increased NPU and BV of test ogi significantly.

Key words: Experimental · Nutritional · Sensory · Mushroom · Ogi

INTRODUCTION

Ogi is a fermented gruel made from the fermentation of corn. It is also prepared from sorghum and millet in the Northern part of Nigeria. Ogi is a staple food for infants and pre-school children who largely depend on it. Ogi from maize has been found to be deficient in lysine and tryptophan [1] and infants weaned solely on ogi is reported to suffer from protein energy malnutrition [2]. This is because considerable nutrient losses in the macro nutrient, vitamins and mineral are inevitable since much of the protein in cereal grains is located in the testa and germ, which are usually sifted off during steeping, milling and sieving [3]. The enrichment of ogi from maize with other high protein legumes and vegetable becomes essential [3] in order to balance the amino acid profile of the product. However, mushroom contains all the essential amino acid and has been reported to be present in an easily digestible form better than many legume sources [4]. The co-fermentation of maize and mushroom would provide a nutritionally improved food because of the improved protein quality which helps to effectively complement the maize ogi protein. The present study was therefore aimed at evaluating the effect of mushroom on the nutritional and sensory properties of ogi.

MATERIALS AND METHODS

White maize grain (*zea mays*) were bought from Abakaliki main market. The fruit bodies were harvested fresh from fermented ricehusk substrate cultivated in the Food Science and Technology Laboratory Ebonyi State University. Corn starch was purchased from a retail outlet in Enugu, Enugu State, Casein was bought from a chemical store in Nsukka, Enugu State, while vitamin and mineral premixes were bought from Bio-organics Nigeria Plc, Lagos.

Preparation of Ogi: The maize grain were sorted and conditioned by sprinkling water and allowing it softened for about 2 hours, it was milled using an attrition mill to obtain fine maize flour. The maize flour was mixed with the dry milled mushroom at the ratio of 95:5, 90:10, 85:15 and 80:20 (maize: mushroom). This was placed into a 1000ml conical flask moistened with tap water enough for the flour to ferment for 72 hours. Thereafter, it was sieved and allowed to stand for 20 minutes and the ogi was recovered, oven-dried at 50^{o}c for 8 hours, pulverized obtain flour, which was stored in an air-tight container for further analysis.

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Proximate Composition of Flours: Carbohydrates, Protein, fat, ash and fibre were determined according to standard methods

Sensory Evaluation: Panels of twenty semi-trained students of Food Science and Technology, Ebonyi State University who were familiar with ogi gruel were used to evaluate the taste, flavor, mouth feel, appearance and general acceptability of the ogi samples. A nine point Hedonic scale where 1 represents "dislike extremely" and 9 "like extremely" was used to assess the scores.

Diet Formulation: A total of four diets were formulated to provide 10% level of protein, while other ingredients such as vegetable oil, vitamins, minerals and cornstarch were added to balance the diets (Table 3). The diets were properly mixed, pelletized and stored in polyethylene bags and kept in air-tight containers until ready for use.

Animal Feeding Experiment: Thirty male weanling rats of the wistar strain with average initial weight of 50-75g were used for the study. The animals were randomly grouped into five rats each and housed in individual cages designed to separately collect faeces and urine. The animals were allowed to receive drinking water and were feed ad libitum. One group was fed with a protein-free diet, the second with casein diet and the other groups with the experimental diets. Feeds intake was measured twice weekly and body weight weekly for 21 days [6]. Those animals were used to assess the apparent digestibility, biological value and net protein utilization of the diets based on casein. Urine was collected in sample bottles, preserved in O.IN HCL to prevent loss of ammonia and stored in a refrigerator until analyzed for urinary nitrogen. Faeces were pooled individually dried at 85^{o}c for 4 hours, weighed before being ground into fine powder and stored for faecal nitrogen determination. The concentration of nitrogen in the diet, faeces and urine was estimated by the Kjeldahl method.

Data Analysis: A one-way analysis of variance (ANOVA) was used while means were separated by the Dunean's multiple range test using the (SPSS) 16.0 versions (SPSS Inc; Chicago, IL, USA).

RESULTS AND DISCUSSIONS

Proximate Composition of Ogi: The proximate composition of mushroom indicate that it contains 23.25% protein, 7.70% fibre, 6.30% ash and 55.33% carbohydrate (Table 1).The proximate composition of ogi produced is presented in Table 1. The protein content ranged from 9.73% to 16.23%. Significant differences existed among all the ogi samples including the control (100% maize ogi) ($p<0.05$). The protein content increased with increased inclusion of mushroom. [7], reported that soyabeans enhanced the protein content of ogi, but the increase in the protein content resulting from mushroom inclusion compared favourably with the 20.7% reported for soya bean. The ash and fibre content of enriched ogi were observed to increase by 56.2% and 72.1% respectively. [8] reported that potassium as most abundant in the upper part of the fruit body. This result is of great advantage since increased fibre consumption may contribute to a reduction in the incidence of certain life threatening disease [9]. [10] reported that calcium and potassium were abundant in mushrooms. The reduction in the ash content observed in the samples may be as a result of the hydrophilic nature of proteins which results in lowering of the free water content of the ogi. [11] reported a moisture content value of 9.09% for sorghum soya ogi while sorghum ogi alone had 9.62% moisture. The drop in the carbohydrate content of ogi enriched with mushroom could be as a result of the higher protein content of the gruel. [12, 13, 14] reported a decline in the carbohydrate content of sorghum ogi mixed with crayfish by 69.2%. Inclusion of mushroom resulted in a drop of fat content of ogi. The drop in the fat content of the mushroom-ogi is a good attribute which suggests possible greater storage stability.

Sensory Evaluation: The sensory scores of the mushroom enriched ogi are shown in Table 2. The results shows that there was a significant difference ($P<0.05$) in the colour, taste, flavor and general acceptability of the ogi samples. The inclusion of mushroom during fermentation as employed in this study may have reduced the population of the lactic acid bacteria responsible for the sour nature of traditional ogi gruels. However, mushrooms are characterized with a unique taste which apparently interacted with the acidic ogi taste, hence altering the natural ogi taste to produce a more mild taste which varies with mushroom inclusion. The general comment showed that at 15% and 20% mushroom inclusion, the ogi samples lost their natural ogi taste and aroma, but the samples were good and yielded products with better overall sensory characteristics than the control.

Nutritional Evaluation: The result of the nutritional evaluation of the test diets is presented in Table 3. There was no significant difference in the food intake of the rats

fed the formulated diets (P<0.05) in relation to those fed with casein-based diets. Although, it was observed that the rate of food intake was not synonymous with the weight gain of the rat. Since food intake can be influenced by palatability, it could suggest that the rats found all diets to be palatable. The results also revealed that all rats gained weight and there were no significant differences in gained weights of rats fed with test diets and casein-based diets (P<0.05). This implies that the ogi enriched with mushroom have the potential for promoting growth. [13] reported that low urinary and faecal nitrogen indicates high protein quality of fed diets. It was observed that, except for the control sample with 100% maize, no significant differences existed between the test and casein-based diets (p<0.05) for values of urinary nitrogen which were all low.

Biological Value (BV) and Net Protein Utilization: Protein utilization (NPU), 100% denotes the highest quality protein. It was observed that, except for diet formulated with 100% ogi, no significant differences existed between the test and casein-based diets (p<0.05). The values obtained for BV and NPU ranged from 45.47 to 85.76% and 56.06 to 87.91%, respectively. The Protein Advisory Group (PAG, 1971) recommended BV of 75% for children and NPU value of more than 70%. This suggest, that the ogi sample with mushroom met the required minimum recommendation, thus are of high protein quality.

Digestibility: Apparent digestible for all the diets ranged from 81.14 to 97.64%. The ogi sample with 100% maize had the least AD of 81.14%, which was significantly different from that of 97.64% AD in casein-based diets (p<0.05). High digestibility does not always mean high protein quality.

In conclusion, this study reveals that the enrichment of maize ogi with mushroom results in increase in the protein, ash and fibre content of the product while fat and moisture content were reduced. Sensory rating of ogi showed that at above 10% mushroom inclusion the colour and flavor of the enriched ogi had a high preference although that traditional taste of the ogi may be altered. The protein quality evaluation of enriched diets fed to rats showed that the protein was easily digestible. The BV, NPU, PER values were above the minimal recommended values which suggest that the enriched ogi is of good protein quality.

Table 1: Proximate composition of ogi enriched with mushroom grown on fermented rice husk substrate.

Samples	Protein	Fat	Ash	M.C	Fibre	CHO
100 % Maize	6.03^{e}	2.74^{ab}	2.42^{d}	7.70^{a}	0.7^{c}	80.41^{a}
95% Maize/5 % FB	9.73^{d}	2.31^{ab}	4.55^{c}	6.31^{b}	1.4^{b}	75.70^{b}
90% Maize/10 % FB	11.41^{c}	2.44^{ab}	4.85^{b}	5.62^{c}	1.7^{b}	73.94^{c}
85% Maize/15 % FB	14.13^{b}	2.53^{ab}	5.40^{a}	5.41^{cd}	2.41^{a}	70.12^{d}
80% Maize 20 % FB	16.23^{a}	2.62^{ab}	5.52^{a}	5.22^{cd}	2.51^{a}	68.13^{e}

Means with different superscripts in the same column are significantly different (p<0.05).,FB = Fruit bodies.

Table 2: Sensory Characteristics of ogi enriched with mushroom

Samples	Appearance	Taste	Mouth feel	Flavor	General Acceptability
95M/5FB	6.65^{b}	8.20^{a}	7.85^{a}	7.45^{a}	8.00^{a}
90M/10FB	8.15^{a}	7.90^{b}	7.80^{a}	7.65^{a}	7.40^{a}
85M/15FB	7.75^{a}	7.85^{b}	7.75^{a}	6.05^{b}	7.05^{a}
80M/20FB	5.25^{c}	7.85^{b}	7.40^{a}	5.95^{b}	6.55^{b}
100M	6.85^{b}	8.10^{a}	8.25^{a}	4.90^{c}	5.35^{c}
LSD	1.9	1.2		0.5	1.3

Means with different superscripts in the same column are significantly different (p<0.05).

FB- Fruit bodies

M-Maize

Table 3: Maintenance body weight, food intake and nitrogen balance of rats fed with maize ogi and ogi enriched with mushrooms.

Parameter	95%M: 5%FB	90%M: 10%FB	85%M: 15%FB	80%M: 20%FB	100%MMAIZE	Casein A
Food intake (g)	201.3^{b}	179.14^{b}	201.4^{b}	195.7^{b}	203.3^{ab}	208.9^{ab}
Weight gain (g)	20.33^{bc}	25.63^{a}	23.43^{ab}	23.33^{ab}	24.57^{a}	21.07^{b}
Nitrogen intake (g)	0.86^{b}	1.06^{a}	1.07^{a}	1.04^{a}	0.65^{c}	1.11^{a}
Faecal Nitrogen (g)	0.05^{c}	0.04^{def}	0.03^{Fg}	0.03^{Fg}	0.12^{a}	0.01^{F}
Urinary Nitrogen (g)	0.17^{ab}	0.16^{ab}	0.22^{a}	0.16^{ab}	0.23^{a}	0.13^{b}
Apparent digestibility	94.11^{bc}	96.18^{ab}	97.44^{a}	97.12^{ab}	81.14^{e}	97.64^{a}
NPU	73.74^{bc}	80.44^{ab}	76.81^{abc}	81.31^{ab}	45.47^{F}	85.76^{a}
PER	3.79^{bc}	4.29^{bc}	3.49^{bc}	3.58^{bc}	6.04^{a}	3.03^{c}
Biological Value	78.44^{ab}	83.83^{ab}	78.93^{ab}	83.82^{ab}	56.06^{F}	87.91^{a}
Digested Nitrogen	0.81^{c}	1.02^{b}	1.04^{ab}	1.01^{b}	0.53^{d}	1.10^{a}
Nitrogen Balance	0.63^{c}	0.86^{b}	0.82^{b}	0.85^{b}	0.29^{d}	0.97^{a}

M - Maize

FB -Fruit bodies

PER-Protein efficiency ratio

NPU-Net Protein utilization

ACKNOWLEDGMENT

We express our heartfelt gratitude to the contributions made by the staff of FST Dept of Ebonyi State University. Professor Okoli Eric we thank you for your assistance and support to the success of this work.

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