Volume 1 • Issue 1 • 2019

Research Article

Archives of Nutrition and Public Health

Effect of Incorporation of Mushroom on the Quality Characteristics of Blended Wheat and Oats Flour

Tasnim Farzana[1]*, Tania Nowreen Orchy[1], Suman Mohajan[1], Nirod Chandra Sarkar[2] and Akhter Jahan Kakon[2]

[1]*Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh*

[2]*National Mushroom Development and Extension Centre, Sobhanbag, Savar, Dhaka, Bangladesh*

***Corresponding Author:** Tasnim Farzana, Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Dr. Qudrat-i- Khuda road, Dhanmondi, Dhaka, Bangladesh.

Received: February 19, 2019; **Published:** March 05, 2019

Abstract

The research study was conducted to evaluate the quality characteristics of mushroom-oats-enriched flour which could be used as a protein supplemented food. In this study, wheat flour was replaced with mushroom flour at different levels that is 5% (F_1), 7% (F_2), and 10% (F_3) and without mushroom flour was kept as control (Fo). Oats was added in both flours (15%). Flours were analyzed for chemical and sensory parameters. Protein content of the prepared flours were increased from 14.04% to 16.49% as compared to control along with a significant increase in ash (0.69–1.26%), sodium (773.51-1226.56 mg/100g), iron (6.97–15.85mg/100g), potassium (1213.02-3388.78 mg/00g), calcium (103.41-132.00 mg/100g), manganese (11.18-16.54 mg/100g). Results from chemical analyses and organoleptic evaluation indicate that good quality flour can be prepared by substituting wheat flour with 5% mushroom flour and addition of oatsflours. Also, the produced flour was compared with locally available wheat flours. The results showed that mushroom fortified flour contained higher ash, protein, fibre and Fe than locally available wheat flours. Protein Energy Malnutrition (PEM) of the Bangladeshi population can be reduced through the development of flours in this way.

Keywords: *Wheat flour; Mushroom; Oats; Protein, minerals; Fibre*

Abbreviations: IFST: Institute of Food science and Technology; BCSIR: Bangladesh Council of Scientific and Industrial Research; BHA: Butylated hydroxyanisole; BHT: Butylated hydroxytoluene; SPSS: Statistical Package for the Social Sciences; PEM: Protein Energy malnutrition

Introduction

Wheat flour is one of the most commonly used plant foods available.It is mainly used for production of roti, bread, biscuits and other bakery products. Use of wheat flour is also common in Bangladesh. We are consuming wheat flour in various ways in our day to day life from morning till night. Wheat flour is a good source of energy, carbohydrate, fibre and protein. It is also enriched with B-vitamins like B1, B2, B6, vitamin E and micronutrients like iron and zinc [1-2]. However these vitamins and nutrients remain concentrated in the outer layer of wheat grains. Eventually a significant portion is lost from wheat flour while milling and processing [3].

Thus fortification of wheat flour is a must for recovering these nutrients. It will also help in improving fibre and protein content. In developed countries it is a common phenomenon to fortify wheat flour with different nutrients, fibre and plant proteins for increasing the quality of wheat flours and also products developed from it.

Edible mushrooms are fungi that contain high quality protein (10-40%), carbohydrate (3-21%) and dietary fiber (3-35%) on dry weight basis depending on species [4]. Oyster mushroom (*Pleurotus ostreatus*) is a edible mushroom, cheapest and easiest to grow compared to all the cultivated edible mushrooms, is a great source of different types of nutrients such as protein, fibre carbohydrate. Mushroom proteins specially contain essential amino acids needed in human diet and are especially rich in lysine and leucine, which lacks in most cereal foods [5-6]. Apart from taste and flavour, the fruit body of oyster mushroom is considered as sources of minerals as well as antioxidants. Oyester mushroom contains antioxidant components such as ascorbic acid, β-carotene and α-tocopherol [7-10]. Several researches had proven that high amounts of antioxidants may prevent the oxidative stress caused by the presence of free radicals which lead to disorder in physiological effectiveness such as cell damage, generating of cancer cell and brain cell aging. Therefore, oyster mushroom is one of the second most cultivated mushrooms and cultivated all over world.

Oat is also a nutritious cereal popular around the world. Oat is characterized by a high content of lipids and a high protein content that can be a great exogenous source of amino acids [11-13]. Oat contains a smaller amount of carbohydrates, and a large content of dietary fibers (mainly glucans and pentosans) as compared to other cereals. Also, oat can be a good source of vitamins. Having a high content of soluble fibre (β-glucans), products made from oat have a positive effect on prevention of coronary heart disease, chronic disease conditions, such as diabetes, atherosclerosis and digestive diseases. Oat flour is also a good source of antioxidants which had effectiveness equal to that of commonly used commercial antioxidants such as BHA and BHT [14].

In this present study, Wheat flour is fortified with mushroom and oats flour and its nutrition, mineral contentwas determined.

Materials and Methods

The study was carried out in the laboratory of Quality Control Research Section of Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Bangladesh.

Raw materials

Oyster mushroom (*Pleurotus ostreatus*) was collected from the National Mushroom Development and Extension Center, Savar, Bangladesh. Oat flour and other ingredients were collected from the local market.

Preparation of raw materials

Mushrooms were dried in a hot air drier at 50°C for 6h and then ground into flour in a grinder. Finally the flour was sieved using 0.25 mm sieve.

Method of preparation of Mushroom flour

Wheat flour was replaced with mushroom flour in three different proportions 5, 7, and 10% and designed as F_1, F_2, and F_3, respectively, whereas F0 (without mushroom flour) was kept as control. The percentage of oat flour was kept constant (15%) in every sample (Table 1). Small amount of milk flavor was added for reducing the odor of mushroom and improving the taste.

Sl No.	Ingredients	F_0	F_1	F_2	F_3
1	Wheat flour	85	80	78	75
2	Oat flour	15	15	15	15
3	Mushroom flour	0	5	7	10
4	Milk Flavour	0.04	0.04	0.04	0.04

Table 1: *Sample table of formulation of mushroom fortified flour.*

Method of analysis

Proximate analysis

The proximate analysis of the mushroom fortified floursuch as (moisture, ash, protein, fat and fibre) was done according to the standard analytical methods [15]. The carbohydrate content was measured by calculated difference method [100-(moisture+ ash+ protein+ fat+ fibre)] and energy content was estimated by multiplying the amount of fat, protein and carbohydrate by their respective physiological energy values (9 kcal for fat, 4 kcal for protein and carbohydrate each) and taking the sum of the products [16].

Sensory analysis

The organoleptic test of the products was done by the 9-point hedonic scale scorecard, especially prepared for the purpose [17-18]. A 10-member trained panelist was selected from the staff members of the Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Bangladesh. Each attribute was scored based on its intensity scaled on a 9-point

hedonic scale (1 = disliked extremely, 2 = disliked very much, 3 = disliked moderately, 4 = disliked slightly, 5 = neither liked or disliked, 6 = liked slightly, 7 = like moderately, 8 = liked very much, 9 = liked very extremely) for color, flavor, texture, and taste.

Statistical analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS version 15.0 SPSS Inc. Chicago, Illinois, U.S.A). Values were expressed as percentage and mean ± SD. One way ANOVA was used for determining the significance of results. Means were separated using t-test.

Result and Discussion

Proximate compositions of mushroom flour and Oat flour (on dry basis)

In the present study, the moisture, ash, protein, fat, crude fibre, carbohydrate and energy of the mushroom flour were found 4.06%, 7.26%, 33.14%, 2.06%, 12.56%, 44.98%, 331 Kcal/100g respectively on dry weight basis. These results are almost similar with the study Farzana and Mohajan [19]. The proximate composition, i.e. moisture, ash, protein, fat, crude fibre, carbohydrate and energy content of the oat flour were found 8.01%, 1.95%, 16.28%, 3.54%, 2.45%, 75.78%, 400Kcal/100g respectively on dry weight basis. These results are almost similar to the findings of Youssef, M. K. E., et al. [20].

Proximate composition and mineral analysis of developed flour formulated with different levels of mushroom flour and oats flour (on dry basis)

Mushroom fortified flour with different levels of mushroom flour was prepared and their proximate and mineral analysis was carried out. These results were shown in the Table 2 (on dry basis).

Sl. No.	Parameter	F0	F1	F2	F3
1	Moisture	10.66±0.04a	10.44±0.05b	10.28±0.03c	10.13±0.02d
2	Ash	0.69±0.02d	1.01±0.01c	1.17±0.03b	1.26±0.01a
3	Protein	14.04±0.08d	14.72±0.12c	15.69±0.09b	16.49±0.16a
4	Fat	2.85±0.02a	2.24±0.03b	2.15±0.01c	2.02±0.05d
5	Fiber	1.00±0.01a	0.99±0.01ab	0.98±0.01bc	0.97±0.01c
6	Carbohydrate	81.39±0.17a	81.03±0.22a	80.01±0.16b	79.26±0.25c
7	Energy	407±2.00a	403±2.00b	402±1.00b	401±2.00b

Table 2: *Proximate analysis of mushroom fortified flour (on dry basis).*

Values are means of triplicates ± standard deviation. Values with the same superscript in a column are not significantly different (p >0.05).

In this study, the moisture were ranged from (10.66 to 10.13%), ash (0.69 to 1.26%), protein (14.04 to 16.49%), fat (2.85 to 2.02%), fiber (1.0 to 0.97%), carbohydrate (81.39 to 79.26%) and energy (407 to 401 kcal/100g). Ash, protein contents were linearly increased with the increasing percentage of mushroom flour (Table 2). These trends of increase are in agreement with the study of Genenu., et al. 2017 [21]. The highest ash and protein content was found for F_3 (1.26% and 16.49%) while least for control F_0 (0.69% and 14.04%).

The highest moisture content was found for control F_0 (10.66%) while least for F_3 (10.13%). The moisture content for other treatments F_1 and F_2 was found 10.44% and 10.28% respectively. The highest fat content was found for control F_0 (2.85%) while least for F_3 (2.02%). The fat content for other treatments F_1 and F_2 was found 2.24% and 2.15% respectively. The highest fibre content was found for control F0 (1.00%) while least for F_3 (0.97%). The fibre content for other treatments F_1 and F_2 was found 0.99% and 0.98% respectively. The highest carbohydrate content was found for control F_0 (81.39%) while least for F_3 (79.26%). The carbohydrate content for other treatments F_1 and F_2 was found 81.03% and 80.01% respectively. The highest energy content was found for treatment, control F_0 (407 Kcal) while least for F_3 (401 Kcal). The energy content for other treatments F_1 and F_2 was found 403 Kcal and 402 Kcal respectively.

The mineral contents (sodium ranged from 773.51 to 1226.54 mg/100g, potassium ranged from 1213.02 to 3388.78mg/100g, calcium ranged from 103.41 to 132.00 mg/100g, iron ranged from 6.97 to 15.85 mg/100g and manganese ranged from 11.18 to 16.54 mg/100g) were increased with the increasing content of mushroom flour (Table 3). Similar increasing trends were also observed in other studies Stella., *et al*. 2015 [22].

Sl. No.	Minerals	F0	F1	F2	F3
1	Sodium (Na)	773.51±0.26d	856.37±0.31c	1097.47±0.28b	1226.54±0.12a
2	Potassium (K)	1213.02±0.43d	3130.75±0.12c	3258.39±0.16b	3388.78±0.24a
3	Calcium (Ca)	103.41±0.08d	116.39±0.03c	123.04±0.06b	132.00±0.09a
4	Iron (Fe)	6.97±0.02d	7.73±0.04c	9.46±0.03b	15.85±0.08a
6	Manganese (Mn)	11.18±0.05d	15.24±0.02c	15.60±0.07b	16.54±0.03a

Table 3: *Minerals content of mushroom fortified flour.*

Values are means of triplicates ± standard deviation. Values with the same superscript in a column are not significantly different (p >0.05).

The highest sodium (Na) content was found for sample F_3 (1226.54 mg/100g) while least for control, F_0 (773.51 mg/100g). The sodium content for other treatments, F_1 and F_2 was found 856.37mg/100g and 1097.47mg/100g respectively. The highest potassium (K) content was found for sample F_3 (3388.78 mg/100g) while least for control, F_0 (1213.02 mg/100g). The potassium content for other treatments, F_1 and F_2 was found 3130.75mg/100g and 3258.39mg/100g respectively. The highest calcium (Ca) content was found for sample F_3 (132.00 mg/100g) while least for control, F0 (103.41mg/100g). The calcium content for other treatments, F_1 and F_2 was found 116.39mg/100g and 123.04mg/100g respectively. The highest iron (Fe) content was found for sample F3 (15.85 mg/100g) while least for control, F0 (6.97 mg/100g). The iron content for other treatments, F1 and F2 was found 7.73mg/100g and 9.46mg/100g respectively. The highest manganese (Mn) content was found sample F_3 (16.54 mg/100g) while least for control, F_0 (11.18 mg/100g). The manganese content for other treatments, F_1 and F_2 was found 15.24mg/100g and 15.60mg/100g respectively. Heavy metals such as Cu, Cd. Pd, Al, Pb, Cr were not found in the prepared samples. Thus by incorporation wheat flour with mushroom and oat flour has improved the nutritional quality of the flour.

Sensory analysis

In the present study, sensory scores of roti prepared with developed mushroom flour enriched with 5% (F_1), 7% (F_2), and 10% (F_3) mushroom flour keeping the oat flour percentage constant at 15%, showed that with regard to flavor, taste, texture, color, mouth feel and overall acceptability, the sensory characteristics of F_1 (5%) were found to be the best among F_0 (0% control), F_2(7%) and F_3(10%). (Table 4)

The score for color has decreased from 8.8 to 7.6 with the increase of mushroom flour. Taste of any product is considered as the primary concern when it comes to the possibility of successful acceptance in the local market. The taste score was highest for F_1 (5%) while F_0(0% control) and F_2 (7%) was also in acceptable range but F_3(10%) taste score was lower due to high mushroom flour content.

The texture of any product is related to the external appearance that is softness or hardness of the product. F_0 (0% control) and F_1 (5%) was found to score on the basis of texture and external appearance. But F_2 and F_3 scored lower than F_0 and F_1. Flavor of the product was highest for F_1(5%). Mouth feel was in acceptable limit for both F_0 and F_1. But with the increase of the percentage of mushroom flour the mouth-feel decreased. Overall acceptability includes many implications, which is an important parameter in organoleptic estimation. Treatment F_1 that is 5% mushroom flour had the highest mean value (8.2) for the overall acceptability. The overall acceptability for F_0 (0% control) has a mean score of 8.0 very close to F_1 (5%). Above this level, flour received a lower sensory score. Thus 5% mushroom flour has highest scores for all the sensory attributes evaluated.

Sl No	Sample Name	Colour	Texture	Flavour	Taste	Mouth feel	Overall acceptance
1	F0	8.8±0.03a	8.2±0.05a	7.6±0.06a	8.0±0.05b	8.2±0.04b	8.0±0.09b
2	F1	8.6±0.04b	8.0±0.06b	7.5±0.05b	8.4±0.08a	8.4±0.07a	8.2±0.06a
3	F2	8.0±0.07c	7.6±0.04c	7.2±0.03c	7.9±0.09c	8.1±0.08c	7.7±0.05c
4	F3	7.6±0.05d	7.2±0.08d	6.8±0.04d	7.0±0.07d	7.8±0.03d	7.1±0.04d

Table 4: *Sensory attributes of developed mushroom fortified flour.*

Values are means of triplicates ± standard deviation. Values with the same superscript in a column are not significantly different (p >0.05).

Comparison of proximate composition of newly developed mushroom fortified flour with locally available flours is as described below (on a dry basis)

Comparison of proximate analysis of developed mushroom fortified flour and locally available wheat flours are shown in table 5

Sl No.	Local Flour	Moisture	Ash	Protein	Fat	Fibre	Carbohydrate	Energy	Fe
1	F_1	10.44±0.02f	1.01±0.01a	14.72±0.12 a	2.24±0.01c	0.99±0.01a	81.03±0.17d	403±1.00d	7.73 ± 0.09a
2	S_1	11.89±0.03c	0.69±0.02b	12.54±0.14b	3.81±0.02a	0.15±0.01b	82.79±0.22c	416±1.00a	2.09 ± 0.11e
3	S_2	12.48±0.04a	0.46±0.03d	11.54±0.08c	2.34±0.02b	0.13±0.01b	85.51±0.60b	409±2.00b	3.42 ±0.07c
4	S_3	12.01±0.01b	0.53±0.01c	11.30±0.05d	1.72±0.04d	0.08±0.02b	86.36±0.13b	406±1.00c	1.76 ± 0.05f
5	S_4	11.59±0.05e	0.52±0.01c	10.64±0.17e	1.44±0.03e	0.07±0.24b	87.32±0.28a	405±2.00cd	3.03 ± 0.08d
6	S_5	11.80±0.01d	0.44±0.02d	10.75±0.08e	1.26±0.08f	0.08±0.01b	87.44±0.20a	404±2.00cd	3.40 ± 0.10c
7	S_6	11.85±0.06cd	0.47±0.03d	11.12±0.11d	1.19±0.04f	0.07±0.01b	87.14±0.23a	405±1.00cd	4.12 ± 0.05b

Table 5: *Comparison of nutritional composition of mushroom fortified flour (F1) and locally available flours (on dry basis).*

Values are means of triplicates ± standard deviation. Values with the same superscript in a column are not significantly different (p >0.05).

Moisture content

In this present study, moisture content of newly developed mushroom flour was found 10.44% where moisture content of local flour was ranged from 11.59% to 12.48%. The moisture content of the developed mushroom flour was a little lower than local wheat flour. This could be because of dried mushroom flour contains lower moisture which ultimately lower the moisture content. Moisture content is the most important factor to control microbial growth. The study of Muhammad., et al. describes that, moisture content less than 10% is suitable to maintain the quality of dried food materials [23].

Ash content

The ash content of the Mushroom flour was found 1.01% which is higher than other wheat flour available in local market. This may be due to presence of mushroom flour and oat flour content [24]. Higher mineral content will make this flour a better choice than other local wheat flours.

Protein content

The protein content was found 14.72% that is higher compared to locally available flours. This increase in protein content may be due to the presence of mushroom fortification [25-26]. Thus regular consumption of this flour will be helpful to overcome protein-calorie malnutrition of the people.

Fat content

In the present study, the fat content was found 2.24%. That was little higher than the fat content found in local flour. The fat content was a little due to the presence of mushroom flour [27].

Fibre content

The fibre content of the mushroom flour was found to be 0.99% where fibre content of local flours were ranged from 0.07-0.15%. This higher fibre content could be explained as mushroom flour contains higher amount of fibre [28]. Regular flour do not contain high amount of fibre as the fibre is removed during processing. So the addition of fibre using mushroom flour will be helpful in many ways. Dietary fibre contains many health benefits such as prevention of diabetes diverticulitis, cardiovascular diseases, constipation, irritable colon cancer etc. [29-30].

Carbohydrate and energy content

In the present study, carbohydrate and energy content was found 81.03% and 403kcal. Carbohydrate that was lower than the locally available flour. The lower carbohydrate content makes it suitable to consume for all ages of people. The energy value in the present study was found 403kcal per 100g which was slightly lower than other local flour. This may be due to the lower fat content.

Iron Content

The iron content was found 7.73mg/100g that is higher compared to locally available flours. This increase in iron content may be due to the presence of mushroom flour. Thus regular consumption of this flour will be helpful to overcome iron deficiency and it will help to improve hemoglobin deficiency of the people.

Conclusion

From the above studies, it can be stated that fortification of wheat flour with mushroom and oats flour has significant effects on the nutritional, physical and sensory attributes. Depending on the nutritional and sensory results, it can be concluded that flour fortified with 5% mushroom and 15% oats isacceptable in quality and it is nutritionally superior over locally available flours.The findings of the present study will be helpful for the people suffering from malnutrition and other degenerative diseases. Using this flour in bakery will also help to add some nutritional value to the finished products.

Conflict of interest

No conflict of interest

References

1. Shewry PR (2007). "Improving the protein content and composition of cereal grain". Journal of Cereal Science 46: 239–250.
2. Simmonds DH (1989). "Inherent Quality Factors in Wheat". In: Wheat and Wheat Quality in Australia,Melbourne. Australia Wheat Board 31-61.
3. Banu I., Georgeta S., Violeta, SI.,Luliana A. (2012). "Effect of the addition of wheat bran stream on dough rheology and bread quality". Food Technology 36.1: 39-42.
4. Breece W. (1990). "Nutritional and medicinal value of specially mushrooms". Journal of Food production 53: 883-894.
5. Sadler M. (2003). "Nutritional properties of edible fungi". British Nutrition Foundation Nutrition Bulletin 28: 305-308.
6. Chang ST. Buswell JA. (1996). "Mushroom nutriceuticals". World J.Microb.Biotechnol 12: 473-476.
7. Çağlarırmak N. (2007). "The nutrients of exotic mushrooms (Lentinulaedodes and Pleurotus species) and an estimated approach to the volatile compounds". Food Chem 105: 1188–1194.
8. Ferreira ICFR., Barros L., Abreu RMV. (2009). "Antioxidants in wild mushrooms".Curr. Med. Chem. 16.12: 1543–1560.
9. Jagadish LK., Krishnan VV., Shenbhagaraman R.,Kaviyarasan V. (2009). "Comparative study on the antioxidant, anticancer and antimicrobial property of Agaricusbisporusimbach before and after boiling". Afr. J. Biotechnol. 8: 654-661.
10. Unekwu HR., Audu JA., Makun MH., Evans, E. (2014). "Phytochemical screening and antioxidant activity of methanolic extract of selected wild edible Nigerian mushrooms". Asian Pac J Trop Dis 4.1: 153-157.
11. Butt MS., Tahir-Nadeem M., Khan MKI., Shabir R., Butt MS. (2008). "Oat: unique among the cereals". In European Journal of Nutrition 47.2: 68-79.
12. Dorota L., Halina G., Barbara M., Gabriela Z., Wiktor B. "Aminoacids composition of proteins in wheat and oat flours used in breads production". Journal of Microbiology, Biotechnology and Food Sciences 2.1 (2013): 1725-1733.
13. Gambuś H., Gibiński M., Pastuszka D., Mickowska B., Ziobro R., Witkowicz R. (2011). "The application of residual oats flour in bread production in order to improve its quality and biological value of protein". In ACTA ScientiarumPolonorum 10.3: 317-325.
14. Molteberg E., Vogt G., Nilsson A.,Florich, W. (1995). "Effects of Storage and Heat Processing on the Content and Composition of Free Fatty Acids in Oat". Cereal Chem 72: 88-93.
15. AOAC. Official methods of analysis of Association of Official Analytical Chemistry International.17th ed. Gaithersburg, MD: Association of Analytical Communities; 2000.

16. Farzana T., MohajanS., Hossain M. N., Ahmed, M. M. (2017). "Formulation of a protein and fibre enriched soy-mushroom health drink flour compared to locally available health drink flours". Malaysian Journal of Nutrition 23: 129–138.
17. Christenso P. "The effects of parental advisory labels on adulescent music preferences". J. Comm.42 (1992): 106-113.
18. Bushman BJ., StackA. (1996). "Forbidden fruit versus tainted fruit: Effect of warning labels on attraction to television violence". J. Exp. Psychol. Appl. 2: 207-226.
19. Farzana, T., Mohajan, S. (2015). "Effect of incorporation of soy flour to wheat flour on nutritional and sensory quality of biscuits fortified with mushroom". Food SciNutr 3.5: 363–369.
20. Youssef MKE.,NassarAG.,EL–Fishawy FA., Mostafa, MA. (2016). "Assessment of Proximate Chemical Composition and Nutritional Status of Wheat Biscuits Fortified with Oat Flour". Assiut J. Agric. Sci. 47.5: 83-94.
21. Genenu A., Adamu Z., Neela S. (2017). "Effect of mushroom flour on proximate composition and dough rheological properties of whole wheat flour bread, Annals". Food Science and Technology 18.3: 413-423.
22. Stella WN., Christina AO., Calvin O., Fredrick M. (2015). "Nutritional Composition, Physical Qualities and Sensory Evaluation of Wheat Bread Supplemented with Oyster Mushroom". American Journal of Food Technology 10.6: 279-288.
23. Muhammad N., Masood SB., Faqir MA., Kamran S., Rashid M. (2003). "Effect of Moisture on the Shelf Life of Wheat Flour". International Journal Of Agriculture & Biology 5.4: 458-459.
24. Wan Ros li WI., Nurhanan AR., Ais hah MS. (2012). "Effect of Partial Replacement of Wheat Flour with Oyster Mushroom (Pleurotussajor-caju) Flour on Nutritional Composition and Sensory Properties of Butter Biscuit".SainsMalaysiana 41.12: 1565–1570.
25. Kurtzman, RHJr. (2005). "A review of mushrooms: sources for modern western medicine". Mico. Ap. Int. 17: 21–33.
26. Walde SG., Velu V., Jyothirmayi T., Math RG."Effects of pre-treatments and drying methods on dehydration of mushroom".J Food Engr74 (2006): 108- 115.
27. Dikeman CL., Bauer LL.,Flickinger EA., Fahey GC. (2005). "Effects of stage of maturity and cooking on the chemical composition of select mushroom varieties". J. Agric. Food. Chem 53: 1130-1138.
28. Oyetayo FL., Akindahunsi AA., Oyetayo VO. (2007). "Chemical profile and amino acids composition of edible mushrooms". Pleurotussajor-caju.Nutr. Health 18.4: 383-389.
29. McRae Marc P., MSc, DC, FACN, DACBN. (2017). "Dietary Fiber Is Beneficial for The Prevention of Cardiovascular Disease: An Umbrella Review of MetaAnalyses". Journal of Chiropractic Medicine 16.4: 289–299
30. Elleuch M., Bedigian D., Roiseux O., Besbes S., Blecker C., Attia H. (2011). "Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications". Revue of Food Chemistry 124: 411–421.