Transactions on Science and Technology Vol. 8, No. 3-2, 172 - 177, 2021

Sensory Evaluation and Nutrient Composition of Noodles Enriched with Wood Ear Mushroom (*Auricularia polytricha*) Powder

Dg Nur Shafanadirah Ag Sulaiman, Muhd Kamil Zakaria, Ramlah George, Patricia Matanjun#

Faculty of Food Science and Nutrition, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, MALAYSIA.
#Corresponding author. E-Mail: patsy@ums.edu.my; Tel: +6088-329042; Fax: +6088-320259.

ABSTRACT Edible mushrooms are highly nutritious and have been regarded as a functional ingredient to improve the nutritional value of consumer food product including noodles. The objective of this study is to explore the feasibility of incorporating different levels of wood ear mushrooms (*Auricularia polytricha*) powder into noodles formulations and to assess the sensory properties and nutritional value of the final formulation. Six formulations of noodles containing different percentages of wood ear mushroom (WEM) powder, 0% (F1), 5% (F2), 10% (F3), 15% (F4), 20% (F5), and 25% (F6) were prepared. Sensory evaluation was conducted to determine the best formulation of noodles enriched with mushroom. Nutrient composition consisted of proximate and mineral analyses were determined for the best formulation. The F2 was the best formulation based on the highest score in all five sensory attributes such as colour, aroma, taste, texture, and overall acceptance. The addition of 5% of WEM powder had significantly ($P<0.05$) increased the protein and ash content of the noodles. The mineral content of F2 with 5% WEM powder resulted in significantly ($P<0.05$) higher potassium, magnesium and iron content, significantly ($P<0.05$) lower zinc content while sodium and calcium content were insignificantly ($P>0.05$) different from control. In conclusion, WEM powder can be incorporated to improve the nutritional value of noodles and 5% additions of WEM powder sensory attributes were found to be acceptable.

KEYWORDS: *Auricularia polytricha*; wood ear mushroom; noodles; sensory evaluation; nutrient composition
Received 3 November 2020 **Revised** 23 November 2020 **Accepted** 21 December 2020 **Online** 2 November 2021

Original article

INTRODUCTION

Auricularia polytricha, also known as wood ear mushrooms, are among the most cultivated mushrooms alongside buttons (*Agaricus bisporus*), oyster (*Pleurotus ostreatus*) and shiitake (*Lentinula edodes*) mushrooms (Royse *et al.*, 2017). This edible mushroom has been used in many East Asian cuisines for its unique flavour and gel-like texture. *A. polytricha* was reported to contain flavonoids and phenolic acids that contributed to medical functions such as hypoglycaemic effect, antitumour activity and antioxidant activity effect (Packialakshmi *et al.*, 2017; Elkhateeb *et al.*, 2018; Ng & See, 2019). Increasing attention has been paid to the pharmacological functions of *A. polytricha* over the past several decades. Besides that, this mushroom is also highly nutritious containing a considerable amount of proteins and carbohydrates while low in fats. According to Rahman *et al.* (2020), the proximate value of one *Auricularia sp.* mushroom consists of 18.75% - 29.90% protein, 1.20% - 1.90% fat, 3.69% - 3.96% ash and 37.18% - 51.65% carbohydrate per 100 g on a dry weight basis. Because of its delicacy and health benefits, *A. polytricha* can be utilised as a functional ingredient to be incorporated into consumer food products.

Noodles are one of the staple foods in many Asian countries such as China, Korea, Vietnam, Thailand and Japan, and its worldwide consumption is on the rise. It is made of wheat flour, starch, water, salt, and other ingredients in a simple production line that can run at low cost which make this food product readily available in the market (Fu, 2008). Nowadays, a trend to improve the nutrient quality of noodles through fortification is growing (Gulia *et al.*, 2014). There are several examples of enriched noodles with other types of edible mushrooms such as oyster (Arora *et al.*, 2018; Parvin *et al*., 2020; Wahyono *et al*., 2017) and shiitake (Heo *et al*., 2014; Correia *et al*., 2017). However, no report related to *A. polytricha* enriched product was available. Therefore, the aim of this study is to determine the sensory evaluation and nutrient composition of noodles enriched with wood ear mushroom (WEM) powder.

METHODOLOGY

Sample Preparations

Wood ear mushrooms (WEM) were cultivated in Mesilau, Sabah, Malaysia and supplied by Rural Development Corporation, a state government agency under the Ministry of Agriculture. The WEM powder was prepared by drying the fresh mushroom at 50°C overnight using a drying cabinet (Thermoline Scientific, Australia). Dried WEM was ground and the powder was kept in an air-tight container for further use. Experimental noodles were prepared by substituting flour with WEM powder at different percentages of 0% (F1), 5% (F2), 10% (F3), 15% (F4), 20% (F5), and 25% (F6). The formulation includes a constant amount of salt, water, and sodium bicarbonate as shown in Table 1. The modifications of formulations were based on the baker's percentage method by calculating the ingredients weight according to the total weight of wheat flour used and this method was also used by Parvin *et al.* (2020). Dry ingredients were weighed and mixed accordingly. Water was added gradually into the dry ingredients while mixing until it formed a dough. The dough rested for 30 minutes before the sheeting process. The dough thickness was gradually reduced to 2-3 mm until a smooth surface was achieved before cutting them into an equally length strand. Next, the noodles were steamed for 8 minutes then dried in a drying cabinet at 40°C overnight. The dried noodles were kept in an air-tight container at ambient temperature until further usage.

Table 1. Formulations of noodles enriched with wood ear mushroom (WEM) powder.

Ingredients	F1	F2	F3	F4	F5	F6
Wheat flour (%)	100	95	90	85	80	75
WEM powder (%)	0	5	10	15	20	25
Salt (%)	2.5	2.5	2.5	2.5	2.5	2.5
Sodium bicarbonate (%)	1.2	1.2	1.2	1.2	1.2	1.2
Water (%)	38	38	38	38	38	38

Sensory Evaluation

The sensory evaluation was conducted by 50 panellists from the Faculty of Food Science and Nutrition, Universiti Malaysia Sabah. The standard sensory test uses 7-point hedonic scale (Meilgaard, 1999). The noodle (control) and noodles enriched with WEM were boiled for 5 minutes before it was served with bland soup. The experimental noodles were evaluated for five attributes, colour, aroma, taste, texture and overall acceptance by using the score based on 7-point hedonic scale (7 = liked very much, 6 = liked moderately, 5 = liked slightly, 4 = neither liked nor disliked, 3 = disliked slightly, 2 = disliked moderately, 1 = disliked extremely).

Proximate Analysis

The proximate analysis was conducted on F1 and best formulation of WEM enriched noodles selected from the sensory evaluation. Moisture, protein, fat, ash and crude fibre were analysed using AOAC (2010) methods. Moisture content was determined after overnight drying at 105°C in a universal oven (Binder, United States). Ash content was determined after the dried sample was incinerated in the furnace (Carbolite, United States) at temperature 550°C for 18 hours. Fat content was determined based on the Soxhlet method by using Soxhlet Avanti auto system, Soxtec™ 2050 (FOSS, Australia). Meanwhile, the Kjeldahl Method was used to determine the protein content of food samples by using an automated Kjeldahl machine, Kjeltec (Gerhardt, Germany) and conversion factor of 6.25 was used. Crude fibre was determined by using Fibertech (Gerhardt, Germany). Finally, the moisture, ash, protein, fat and crude fibre content was used to determine the available total carbohydrate content in the samples (James, 1996). All analysis was carried out in triplicate and data was presented as means ± standard deviations.

Mineral Analysis

Mineral analysis was conducted on F1 and best formulation of WEM enriched noodles. Major mineral elements such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and trace elements such as iron (Fe) and zinc (Zn) were determined based on AOAC (2003) method. Five grammes of 0% (control) and best formulation WEM enriched noodles were added with 10 mL of 65% nitric acid before it was heated until brown smoke undetectable. The solution was then filtered using grade 40 filter paper and diluted by 50x factor. The resulting solution was filtered using a 0.45 µm PTFE membrane filter. The analysis of mineral elements was carried out using the Inductive Coupled Plasma-Optical Emission Spectrometer (ICP-OES) instrument (Perkin Elmer, USA).

Statistical Analysis

Data obtained from sensory evaluation were analysed using Friedman test and Wilcoxon signed-rank test to determine the best formulation of enriched noodles with mushroom. Data obtained from proximate and mineral analysis were analysed using independent T-test. SPSS Version 24.0 was used to analyse the data (IBM, New York, USA).

RESULT AND DISCUSSION

Sensory Evaluation

The sensory evaluations of six different noodles are shown in Table 2. F2 had the highest scores for all sensory attributes when compared with other formulations except for F1 as the control. The score for colour, aroma, taste, texture and overall acceptance of the noodles was significantly ($P<0.05$) decreased with the increment of WEM powder. The results were compatible with the study by Arora *et al.* (2018) and Wahyono *et al.* (2017). According to Parvin *et al.* (2020), the texture of cooked noodles is the best characteristics to determine the consumer acceptance of the product. The result showed there was no significant difference ($P>0.05$) between F2 and F1 in most of the sensory attributes except for the aroma, indicating F2 can still be tolerated and equally acceptable as the F1. Hence, F2 was selected as the best formulation based on the sensory evaluation.

Proximate Analysis

This study also provides a comparative analysis on the proximate composition of F2 and F1 as shown in Table 3. The result shows that F2 had significantly ($P<0.05$) higher ash and protein content compared to F1. This result is in line with previously reported studies by Arora *et al.* (2018) and Wahyono *et al.* (2017). In contrast, in the present study, the crude fibre content of mushroom enriched noodles has increased insignificantly ($P>0.05$) when compared with F1 as the control. The crude fibre content of the enriched noodles in this study was expected to increase since edible mushrooms contain high amounts of dietary fibre (Cheung, 2013). However, the fibre content of the WEM enriched noodles may be modified by the cooking process as described in the study by Kalala *et al.* (2017). It is postulated that the cooking process might cause the insoluble dietary fibre to shift into soluble dietary fibre and caused them to leach out during cooking. Cooking the WEM enriched noodles in boiling water may provoke a decrease in total dietary fibre due to the lixiviation of soluble dietary fibre in water.

Mushrooms are generally known to be low in fat and therefore, it is not surprising that there was no significant (P>0.05) increased in fat content in the WEM enriched noodles. Several authors have described the nutritional contribution of fat from mushrooms are also limited but it still plays an important role in providing the flavour of edible mushrooms (Cheung, 2010; Kalac 2013). In this study, the carbohydrate and energy content of mushroom-enriched noodles were lower than control but not significantly (P>0.05) different. This result is in contrary to data obtained in previous study by Parvin *et al.* (2020) where the carbohydrate and energy content decreased significantly with the incorporation of mushroom powder.

Table 2. Sensory evaluation of noodles enriched with different percentage of wood ear mushroom (WEM) powder.

Attributes	F1	F2	F3	F4	F5	F6
Colour	5.28 ±1.05^{a}	5.58 ±1.27^{a}	4.46 ±1.32^{b}	3.46 ±1.01^{c}	3.24 ±1.11^{cd}	3.08 ±1.01^{e}
Aroma	5.28 ±1.17^{a}	4.80 ±1.24^{b}	4.78 ±1.23^{b}	3.74 ±1.41^{c}	4.10 ±1.24^{c}	3.82±1.57^{c}
Taste	5.28 ±1.08^{a}	4.96 ±1.29^{ab}	4.38 ±1.42^{b}	3.82 ±1.32^{c}	3.54 ±1.47^{cd}	3.24 ±1.64^{d}
Texture	5.46 ±1.05^{a}	5.24 ±1.07^{a}	4.48 ±1.07^{b}	3.66 ±1.00^{c}	3.40 ±1.35^{c}	2.98 ±1.26^{d}
Overall acceptance	**5.24 ±0.98^{a}**	**5.14 ±1.14^{a}**	**4.58 ±1.35^{b}**	**3.64 ±1.06^{cd}**	**3.50 ±1.19^{d}**	**3.14 ±1.29^{e}**

Values are mean of 50 panellists' ± standard deviation.
Values with different superscripts in a row are significantly different (P<0.05).

Table 3. Proximate analysis of F1 and F2 on dry weight basis.

Nutrients	F1	F2
Moisture (%)	8.15 ± 0.07^{a}	7.75 ± 0.07^{b}
Ash (%)	2.23 ± 0.02^{b}	2.87 ± 0.07^{a}
Protein (%)	11.20 ± 0.25^{b}	13.31 ± 0.09^{a}
Fat (%)	0.12 ± 0.0^{a}	0.39 ± 0.10^{a}
Crude fibre (%)	0.44 ± 0.11^{a}	0.79 ± 0.24^{a}
Carbohydrate (%)	77.98 ± 0.31^{a}	74.89 ± 0.34^{a}
Energy (kcal/100 g)	357.32 ± 0.60^{a}	356.31 ± 0.50^{a}

Values are means of triplicates ± standard deviation.
Values with different superscripts in a row are significantly different (P<0.05).

Mineral Analysis

The edible mushrooms are known to contain several macro elements (Kalac, 2013). Since the addition of WEM powder had significantly (P<0.05) increased the ash content, further analysis to determine the mineral element in both control and WEM enriched noodles were conducted (Table 4). The result shows the potassium, magnesium and iron of F2 significantly (P<0.05) increased while the zinc showed otherwise. *Auricularia sp*. is found to be rich in potassium, magnesium and iron (Kadnikova *et al*., 2015).

Table 4. Mineral analysis of F1 and F2 on dry weight basis.

Elements	F1	F2
Sodium (mg/100 g)	1348.59±30.56 [a]	1431.74±24.54[a]
Potassium (mg/100 g)	181.07±6.20[b]	227.27±3.79[a]
Calcium (mg/100 g)	54.9±3.40[a]	61.61±3.31[a]
Magnesium (mg/100 g)	31.85±1.63[b]	39.76±1.33[a]
Iron (mg/100 g)	97.94±2.24[b]	175.11±3.40[a]
Zinc (mg/100 g)	1.57±0.21[a]	1.13±0.10[b]

Values are means of triplicates ± standard deviation.
Values with different superscripts in a row are significantly different (P<0.05).

CONCLUSIONS

The noodle enriched with 5% (F2) wood ear mushrooms (WEM) powder had higher ash and protein content, and minerals such as potassium, magnesium and iron content compared to control noodles (F1). F2 was also well accepted with highest score for most sensory attributes such as colour, taste, texture and overall acceptance. Thus, WEM powder can be used as a functional ingredient to improve the nutritional value of the noodles.

ACKNOWLEDGEMENT

This study was funded by Universiti Malaysia Sabah *Skim Dana Nic* (SDN), Project code: SDN0065-2019.

REFERENCES

[1] AOAC. 2003. *Official Methods of Analysis of Association of Official Analytical Chemists* (17th Edition). Gaithersburg: Association of Official Analytical Chemist.

[2] AOAC. 2010. *Official Methods of Analysis of Association of Official Analytical Chemists* (18th Edition). Gaithersburg: Association of Official Analytical Chemist.

[3] Arora, B., Kamal, S. & Sharma, V. P. 2018. Nutritional and quality characteristics of instant noodles supplemented with oyster mushroom (*P. ostreatus*). *Journal of Food Processing and Preservation*, *42*(2), 13521.

[4] Cheung, P. C. 2013. Mini-review on edible mushrooms as source of dietary fibre: Preparation and health benefits. *Food Science and Human Wellness*, 2(3-4), 162-166.

[5] Correia, P. D. R., Esteves, S. A. & Guiné, R. P. F. 2017. Effect of mushroom powder in fresh pasta development. *Proceedings of the 11th Baltic Conference on Food Science and Technology" Food science and technology in a changing world" FOODBALT.* 27-28 April, 2017. Jelgava, Latvia.

[6] Elkhateeb, W. A., El-Hagrassi, A. M., Fayad, W., El-Manawaty, M. A., Zaghlol, G. M., Daba, G. M. & Ahmed, E. F. (2018). Cytotoxicity and hypoglycemic effect of the Japanese Jelly mushroom Auricularia auricula-judae. *Chemistry Research Journal*, *3*, 123-133.

[7] Fu, B. X. 2008. Asian noodles: history, classification, raw materials, and processing. *Food Research International*, 41(9), 888-902.

[8] Gulia, N., Dhaka, V. & Khatkar, B. S. 2014. Instant noodles: processing, quality, and nutritional aspects. *Critical Reviews in Food Science And Nutrition*, *54*(10), 1386-1399.

[9] Heo, S., Jeon, S. & Lee, S. 2014. Utilization of Lentinus edodes mushroom β-glucan to enhance the functional properties of gluten-free rice noodles. *LWT-Food Science and Technology*, 55(2), 627-631.

[10] James, C. 1996. *Analytical Chemistry of Foods.* London: Blackies Academic & Professional.

[11] Kadnikova, I. A., Costa, R., Kalenik, T. K., Guruleva, O. N. & Yanguo, S. 2015. Chemical composition and nutritional value of the mushroom Auricularia auricula-judae. *Journal of Food and Nutrition Research*, 3(8), 478-482.

[12] Kalac, P. 2013. A review of chemical composition and nutritional value of wild-growing and cultivated mushrooms. *Journal of the Science of Food and Agriculture*, 93(2), 209-218.

[13] Kalala, G., Kambashi, B., Everaert, N., Beckers, Y., Richel, A., Pachikian, B. & Bindelle, J. 2017. Characterization of fructans and dietary fibre profiles in raw and steamed vegetables. *International journal of food sciences and nutrition*, 69(6), 682-689.

[14] Meilgaard, M. C., Carr, B. T. & Civille, G. V. 1999. *Sensory evaluation techniques*. Boca Raton: CRC press.

[15] Ng, Z. X. & See, A. N. (2019). Effect of in vitro digestion on the total polyphenol and flavonoid, antioxidant activity and carbohydrate hydrolyzing enzymes inhibitory potential of selected functional plant-based foods. *Journal of Food Processing and Preservation*, 43(4), 13903.

[16] Packialakshmi, B., Sudha, G. & Charumathy, M. (2017). Studies on phytochemical compounds and antioxidant potential of Auricularia auricula-judae. *International Journal Pharmacy Science Research*, 8(8), 3508-15.

[17] Cheung, P. C. K. 2010. The nutritional and health benefits of mushrooms. *Nutrition Bulletin*, 35(4), 292-299.

[18] Parvin, R., Farzana, T., Mohajan, S., Rahman, H. & Rahman, S. S. 2020. Quality improvement of noodles with mushroom fortified and its comparison with local branded noodles. *NFS Journal*, 20, 37-42.

[19] Rahman, M. A., Al Masud, A., Lira, N. Y. & Shakil, S. 2020. Proximate Analysis, Phytochemical Screening and Antioxidant Activity of Different Strains of *Auricularia auricula-judae* (Ear Mushroom). *International Journal of Traditional and Complementary Medicine*, 5, 29.

[20] Royse, D. J., Baars, J. & Tan, Q. 2017. Current overview of mushroom production in the world. *In*: Zied, D. C. & Pardo-Giménez, A. (eds). *Edible and medicinal mushrooms: technology and applications*. West Sussex: Wiley-Blackwell.

[21] Wahyono, A., Novianti, Bakri, A & Kasutjianingati. 2017. Physicochemical and sensorial characteristics of noodle enriched with oyster mushroom (*P. ostreatus*) powder. *Journal of Physics: Conference Series,* 953(1), 12120.