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Development and evaluation of value added pickle from dehydrated shiitake (*Lentinus edodes)* Mushroom

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Abstract
The present study aimed at formulation of a pickled product, utilizing dehydrated Shiitake mushroom (*Lentinus edodes*). The mushrooms were solar dried with or without pretreatment with 5g/l citric acid. Pickle I was developed using untreated solar dried mushroom whereas citric acid treated solar dried mushroom was used for development of pickle II. The developed pickles were organoleptically acceptable to judges. Nutritional evaluation revealed that Pickle I had significantly higher ($p \leq 0.05$) protein content (9.41%) as compared to Pickle II (8.89 %). Polyphenol content was significantly ($p \leq 0.05$) lower (181.64 mg/100g) and *in vitro* protein digestibility (52.31 %) was significantly higher in pickle II. HCl extractability for iron, zinc, phosphorus and calcium were significantly ($p > 0.05$) higher (48.71, 98.94, 69.61, 53.48 %) in Pickle II. In conclusion, the developed pickles were acceptable to judges and had a good nutritional profile. Such developed products can add mushrooms to the plate of common man and be of commercial value for mushroom entrepreneurs.

Keywords: Citric acid, Nutritional Evaluation, Organoleptic acceptability, Pickle, Shiitake mushroom, Solar drying,

1. Introduction

Quality food, health and environment are the major concerns facing our country. Mushroom cultivation helps to address the issue of nutritional security and also provides solution for proper recycling of agro-wastes. In addition to good quality protein, no cholesterol, high fibre, low sodium, good quantity of vitamins and minerals, the mushrooms also have bioactive compounds like β-glucans, polysaccharide complexes that impart unique medicinal values like anti-cancer and anti-viral properties. With ever increasing demand for quality food, mushroom cultivation is emerging as an important activity in different parts of our country [1].

Fresh mushrooms cannot be stored for more than two to three days due to its perishable nature. This is a limiting factor for mushroom marketing. Quality deterioration starts just after harvesting. Therefore, producers are not able to hold it as fresh for more days to market. Processing into value added products is one option producer can adopt to save the product from spoilage as well as to earn more money. Dehydration technology and value-added products are the need of the hour for the mushroom growers not only to reduce the losses but also to enhance the income by value-addition to boost the consumption of mushroom [2].

Shiitake (*Lentinula edodes*) mushroom is the second most cultivated edible mushroom in the world, accounting for about 25% of worldwide production. These mushrooms are acknowledged as "the queen of mushrooms" and have great market potential both at home and abroad. It is one of the most popular mushrooms in the global market which is attributed not only to its nutritional value but also to possible potential for therapeutic applications. [3, 4]. Present paper communicates about the development and evaluation of value added pickle from dehydrated shiitake (*Lentinus edodes)* mushroom.

2. Material and Methods

2.1 Procurement and treatment

The present study was carried out in the Department of Foods and Nutrition, I.C. College of Home Science, CCS Haryana Agricultural University, Hisar. All the ingredients required for development of products were procured from open market in a single lot and stored in air tight food grade container. For the purpose of study, the Shiitake mushrooms were solar dried (with or without pretreatment with 5g/l citric acid). Pickle I was developed using untreated solar dried mushroom whereas citric acid treated solar dried mushroom was used for development of pickle II.

For development of pickle, the dehydrated mushrooms pieces were rehydrated by soaking for 2 minutes in warm water. These were blanched for 5 min in 0.05 per cent KMS solution. The blanched mushrooms were washed in cold water for 2-3 times and the excess water was drained off. Then the mushrooms were subjected to salt curing process, and kept overnight. The excess water oozed-out of mushroom was removed on the next day and spices & preservatives were mixed to the desired taste and quality of mushroom pickle (Table 1).

2.2 Sensory Evaluation

The developed pickles were organoleptic ally evaluated on a 9 point hedonic scale by a panel of ten semi trained judges.

2.3 Nutritional evaluation

The developed products were analysed for proximate composition [5], dietary fibre constituents [6], total carbohydrate (by addition method), total soluble sugars [7], reducing sugars [8], non –reducing sugars (by difference), starch [9] and *in vitro* protein digestibility [10]. Total iron, zinc, calcium and phosphorus in acid digested samples were determined by the

atomic absorption spectrophotometer according to the method of Lindsey and Norwell [11]. Mineral HCl extractability [12] and polyphenols [13] were also studied.

2.4 Statistical analysis

Suitable standard statistical methods were used for analysis of data. Statistical significance was set at (p <0.05).

3. Results & Discussion

3.1 Evaluation

The color, texture and taste for mushroom pickle-I were judged as 'liked very much' (7.50, 7.60 and 7.60 respectively) while appearance, aroma and overall acceptability (6.80, 7.10 and 7.47 respectively) were adjudged as 'liked moderately' (Table 2) as per 9 point hedonic scale. In case of pickle II, the scores were 7.10, 6.75, 7.20, 6.70, 6.85 and 7.02 respectively for color, appearance, aroma, texture, taste and overall acceptability. No significant difference (P≤0.05) was observed in scores of two pickles in terms of colour, appearance and aroma. However pickle I had significantly (P≤0.05) higher scores for texture, taste and overall acceptability.

Thus, the developed pickles were acceptable to the panel of judges. Similar work on product development and evaluation has been reported by various other authors. Wakchaure *et al*. [14] developed some novel value added products from the dried oyster mushrooms. They reported good quality of crunchy oyster mushroom biscuits, comparable with commercially available biscuits in terms of appearance and taste. Dunkwal *et al.* [15] also prepared mushroom products.

3.2 Nutritional evaluation

Pickle I and pickle II had moisture content of 67.53 per cent and 64.86 per cent respectively. Pickle I had crude protein, crude fat, total ash and crude fibre content of 9.41, 28.58, 0.91 and 9.13 per cent respectively while pickle II had 8.89, 28.38, 0.85 and 9.94 per cent respectively. The moisture and crude protein content of pickle II was significantly (P≤0.05) lower than that of pickle I (Table 3). Pickle II had total carbohydrate content 51.94, total soluble sugar 13.21, reducing sugar 1.30, non-reducing sugars 11.91 and starch 19.38 per cent. It had total fibre 13.59, soluble fibre 4.06 and insoluble fibre 9.53 g/100g (Table 3). There were no significant (P≤0.05) differences in the carbohydrate or dietary fibre composition of pickle I and pickle II. Pickle II had significantly (P≤0.05) lower polyphenol content (181.64 mg/100g) as compared to pickle I. At the same time the *in vitro* protein digestibility of pickle II (52.31%) was significantly (P≤0.05) higher than that of pickle I (50.21%).

Pickle II had total iron 10.85 mg/100g, zinc 98.76 mg/100, phosphorus 338.88 mg/100g and calcium content 24.44 mg/100g. No significant (P≤0.05) differences were observed in mineral profile of two pickles. However HCl extractability of iron (48.71%), zinc (98.94%), phosphorus (69.61%) and calcium (53.48 %) in pickle II were significantly (P≤0.05) higher as compared to those for pickle I (43.62, 89.01, 58.97 and 51.17% respectively) (Table 4).

Similar work on product development and evaluation has been reported by various other workers [16, 17, 18, 19].

3.3 Tables

Table 1: Ingredients for Shiitake mushroom pickle

Ingredients	Amount	Ingredients	Amount
Rehydrated mushroom pieces	250g	Carom seed	3g
Black mustard seed powder	8g	Nigella seed	2.5g
Turmeric powder	5g	Oil	60 ml
Red chilly powder	3g	Salt	15g
Cumin seed powder	1g	Acetic acid	5ml
Fennel seed powder	1.5g	Sodium benzoate	1g

Table 2: Sensory characteristics of Shiitake mushroom Pickles

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Pickle I	7.50±0.16	6.80±0.66	7.10±0.23	7.60±0.16	7.60±0.16	7.47±0.09
Pickle II	7.10±0.10	6.75±0.57	7.20±0.24	6.70±0.33	6.85±0.23	7.02±0.10
't' value	0.85^{NS}	1.15^{NS}	0.92^{NS}	0.78*	0.60*	0.33*

Values are mean ±SE of ten observations based on 9-point hedonic scale

Table 3: Chemical composition of Shiitake mushroom pickles

Component	Content		
	Pickle I	Pickle II	't' value
Proximate composition (%)			
Moisture	67.53±0.76	64.86±0.74	2.49*
Crude protein	9.41±0.29	8.89±0.10	2.88*
Crude Fat	28.58±1.57	28.38±0.22	4.41
Total Ash	0.91±9.45	0.85±8.36	2.49
Crude Fiber	9.13±0.25	9.94±2.69	3.13
Carbohydrate composition (%)			
Total Carbohydrate	51.97±6.56	51.94±4.45	0.001
Total Soluble sugars	14.30±0.34	13.21±0.58	1.60
Reducing sugar	1.10±6.35	1.30±0.10	1.60
Non-Reducing Sugars	13.23±0.38	11.91±0.50	2.06
Starch	21.34±2.76	19.38±1.04	1.12
Dietary fibre constituents(g/100g)			
Total fibre	15.09±0.71	13.59±0.17	2.03
Soluble fibre	4.37±0.34	4.06±6.83	0.86

Insoluble fibre	10.72±0.79	9.53±0.65	1.47
Antinutritional factor and *In vitro* protein digestibility			
Polyphenol (mg/100g)	185.68±2.74	181.64±3.01	0.99*
In vitro protein digestibility (%)	50.21±1.00	52.31±0.71	0.89*

Values are mean ± SE of three independent determinations Pickle I = Untreated mushroom, Pickle II = Treated mushroom

Table 4: Mineral composition and their HCl extractability in Shiitake mushroom pickles

Component	Content		
	Pickle I	Pickle II	't' value
Mineral content (mg/100g)			
Iron	10.39±0.18	10.85±0.47	0.88
Zinc	96.90±0.51	98.76±0.45	11.16
Phosphorus	335.88±1.73	338.88±9.49	4.76
Calcium	23.24±0.87	24.44±0.28	1.30
HCl extractability (%)			
Iron	43.62±1.93	48.71±0.48	2.55*
Zinc	89.01±0.40	98.94±0.51	10.16*
Phosphorus	58.97±1.17	69.61±0.31	8.76*
Calcium	51.17±0.56	53.48±0.81	0.32*

Values are mean ± SE of three independent determinations
Pickle I = Untreated mushroom, Pickle II = Treated mushroom

4. Conclusions

The developed pickles were acceptable to judges and had a good nutritional profile. Such developed products can add mushrooms to the plate of common man and be of commercial value for mushroom entrepreneurs.

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