Mal J Nutr 23(1): 129 - 138, 2017

Formulation of a Protein and Fibre Enriched Soy-Mushroom Health Drink Powder Compared to Locally Available Health Drink Powders

Tasnim Farzana*, Suman Mohajan, Md. Nur Hossain & Monzur Morshed Ahmed

Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh

ABSTRACT

Introduction: Protein malnutrition is a major concern in Bangladesh where there is a high dependence on cereal-based diets. Use of protein-calorie sources of plants like soybean and mushroom as a dietary supplement may provide a solution. This study was designed to formulate a high protein and fibre enriched soy-mushroom health drink powder, and to compare its nutritional contents with locally available health drink powders. **Methods:** Soy-mushroom health drink powder was developed mainly from soy flour, mushroom, germinated wheat flour, malt extract and milk powder. Three locally available health drink powders were randomly selected. Proximate and microbiological analyses and sensory evaluation were undertaken by standard methods. Data were analysed using Statistical Package for the Social Sciences (SPSS). **Results**: The moisture, ash, protein, fat, fibre, carbohydrate and energy contents of the developed soy-mushroom health drink powder ranged from 3.04-3.96%, 3.23-7.4%, 8.98-21.37%, 1.10-10.13%, 0.04%-1.50%, 59.93-81.58% and 363.54-416.40 kcal/100g, respectively. The soy-mushroom product had the highest content of protein, fibre, energy and the lowest content of carbohydrate compared to the other health drink powders. Based on sensory analysis, the soy-mushroom product showed high acceptability. Microbiological assessment showed the shelf life of this product to be one year. **Conclusion**: The soy-mushroom health drink powder was nutritionally superior to locally available health drink powders and could serve as a nutritional supplement.

Key words: Fibre, food supplementation, health drink powder, mushroom, protein, soy flour

INTRODUCTION

Protein malnutrition is a widely recognised health problem and it is a problem in Bangladesh as well because of the cereal-based dietary pattern of the population (Haque *et al*., 2014; Kurshed *et al*., 2010). Moreover, at the current time, another prevalent challenge for the Bangladeshi population, especially for pregnant and lactating women, manual labourers, pre-schoolchildren and adolescent girls, is the requirement for high nutrient foods and the need to make them available in an acceptable form. Under the prevailing circumstances, all possible sources of protein will have to be exploited. In this regard, plant sources could be a good candidate because plant foods are a vital

*Correspondence: Tasnim Farzana; Email: *triptiot@yahoo.com*

source of protein; almost 70% of food proteins and more than 80% of food energy requirements are supplied by the plants (Kumar *et al.,* 2013). The use of protein-calorie sources of plants, like soybean and mushroom, as a supplement to the regular diet may be a possible solution to overcome the malnutrition problem of our country.

Soybean (*Glycine max*), a species of legume, is an excellent source of good quality protein (43.2%) with minimal saturated fat, 31.3% carbohydrates (Kundu *et al*., 2011) and adequate amounts of minerals and vitamins. Soybean contains about 18% oil with the predominant type being linoleic acid and accounting for approximately 50% of total fat (Van, 2009), whereas most of the oilseeds contain 40-50% oil. On the basis of amino acids profile, soybean is superior to other plant proteins because it contains most of the essential amino acids except methionine (Mazumder & Begum 2016; Krishnan 2005), which is abundant in cereals. These beneficial properties make soybean an excellent ingredient for supplementary foods like biscuit, bread, pasta, and other cereal products (Hegstad, 2008).

Mushroom is a nutrient-dense versatile food which shares some of the benefits of both fruits and vegetables, and has been used as a food supplement since ancient times (Kakon, Choudhury & Saha, 2012). It is considered to be a complete, safe food, suitable for all age groups. Mushroom is rich in protein, minerals, vitamins, fibres and contains an abundance of essential amino acids (Kurtzman, 2005). It is a unique plant food as it is very low in carbohydrates and fat, making it ideal for diabetic patients (De Silva *et al*., 2012). Therefore, mushrooms can be a good supplement to cereals (Regula & Michalowska, 2010). It is often used in various sausages, health drinks, soups, cake and bakery products.

Currently, as in the case of increasing consumption of various bakery and beverages foods, consumption of health drinks is also increasing in Bangladesh. These health drinks are not only popular among adults but also among children. These are widely consumed as taste enhancers to encourage drinking of milk among growing children. So, health drinks could be a good target for fortification because nutrient contents of the currently locally available health drinks are not up to mark. Moreover their protein and fibre contents are not sufficient to alleviate the protein energy malnutrition problem of our country. If we enrich our health drinks by introducing soybean and mushroom as fortifying agents and make it available to the people, the problem of protein energy malnutrition in our country may be alleviated.

In view of this consideration, the present work has been designed to formulate a high protein and fibre enriched soy-mushroom health drink powder and to compare its nutritional facts with three locally available health drink powders to gain a better insight into this concern.

METHODS

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

Sample collection

Three samples of locally available health drink powders were randomly selected. These were imported from foreign countries.

Preparation of raw materials

Soybean was collected from the Bangladesh Agricultural Research Institute. Oyster mushroom (*Pleurotuso streatus*) was collected from the National Mushroom Development and Extension Center, Savar, Bangladesh. Other ingredients were

Table 1. Formulation of the soy-mushroom health drink powder

Ingredients	*Amount (%)*
Wheat flour	20
Soy flour	20
Malt extract	25
Corn starch	5
Mushroom	5
Milk powder	30
Sodium benzoate	0.02
Salt (NaCl)	1.5

obtained from the local market. Soybean seeds and mushrooms were processed according to the procedure described by Farzana & Mohajan (2015).

Germination of wheat

Wheat (*Triticum aestivum*) were soaked in water overnight, then washed with sterile distilled water, spread out in a sterile tray and covered with a sterile black cloth. The trays were maintained at room temperature with optimum humidity. The germinated wheat was then dried in oven at 60°C. The dried germinated wheat was milled into flour. The flours were screened through a 0.25 mm sieve and stored at 4°C in a refrigerator to prevent spoilage and microbial growth.

Mashing: the conversion of grain powder starch into malt sugars

All of the grain powders (soy flour, germinated wheat flour, corn starch, malt extract) were mixed with water and kept in an oven at around 65-67°C, in the presence of abundant water for mashing to occur. At this temperature, the dormant enzymes become active and complete the conversion of starch into sugars, a process that starts after 10 min and finishes within a few hours. A slow-rising temperature favours this conversion into simple sugars.

Preparation and formulation of soy-mushroom health drink powder

On completion of mashing, milk powder and mushroom were added and brought up to a gentle boil for about 20 min or up to 30 min with constant stirring to prevent the mash from searing. The resultant dense sludge-like portion was dried in an oven and milled into powder. Then salt, flavours, and preservatives were added and mixed well in a blender. The prepared soy mushroom health drink powder was then sealed in a packet and used for sensory evaluation. The preparation and formulation of the product is shown in Figure 1 and Table 1.

Sensory analysis

The sensory attributes including flavour, taste, texture, consistency, colour, mouth feel, and overall acceptability were evaluated using the 9-point hedonic scale scorecard (Lim, 2011) by 10 trained panellists selected from the staff members of IFST of the BCSIR. Each attribute was scored based on its intensity on a 9-point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely) for colour, flavour, texture and taste.

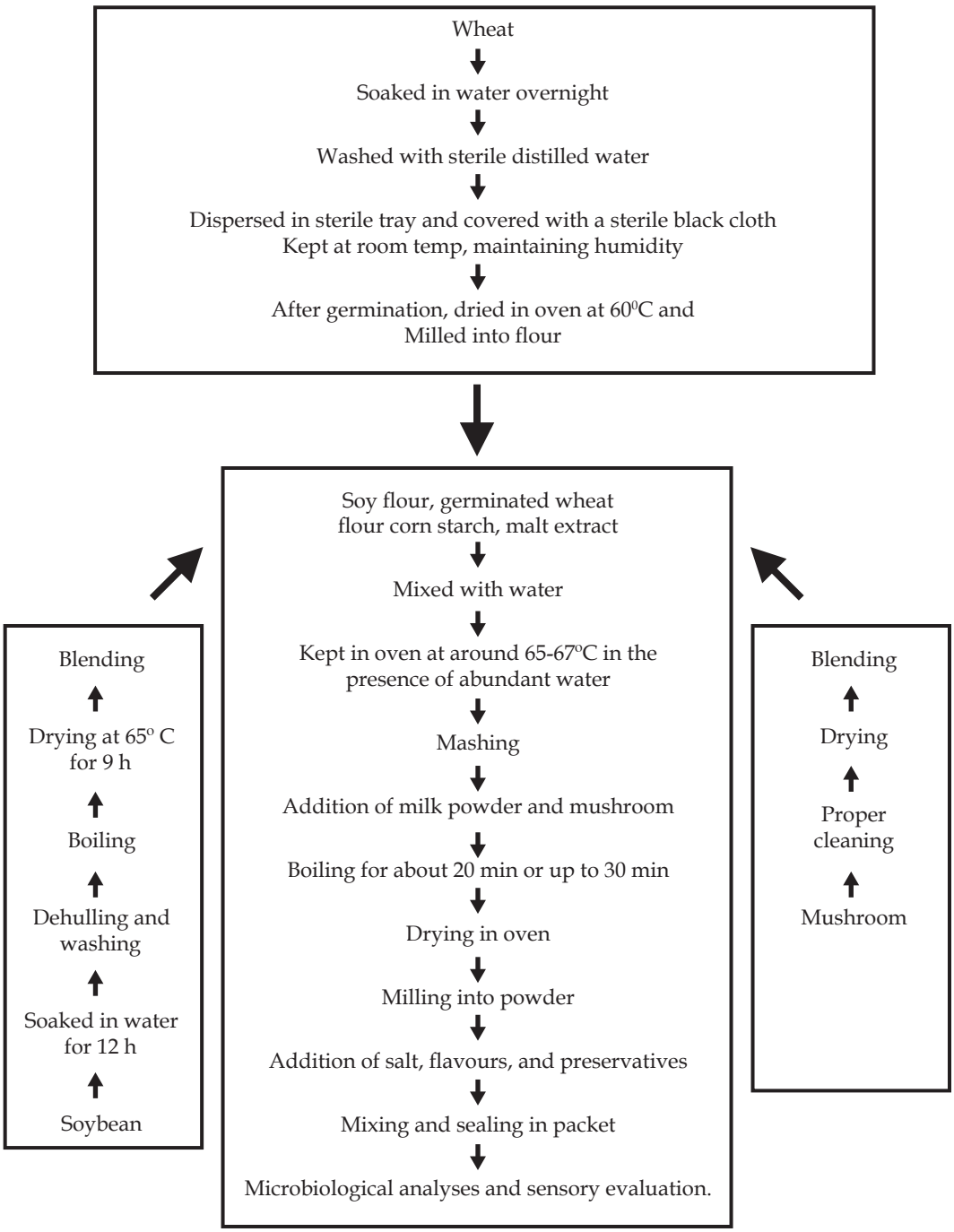

Figure 1. Flow chart for the preparation of soy-mushroom enriched health drink powder

Proximate analyses of soy-mushroom health drink powder and locally available health drink powder

The proximate composition (i.e., moisture, ash, protein, fat, fibre) of the soya-mushroom health drink powder and locally available similar products was estimated according to the standard analytical methods (AOAC, 2005). The carbohydrate content was determined by calculated difference method and energy value was determined by multiplying the proportion of protein, fat and carbohydrate by their respective physiological energy values and taking the sum of the products (Farzana & Mohajan, 2015)

Microbial analyses of soy-mushroom health drink powder

Microbial analysis especially Total Viable Count, coliforms and *E. coli,* yeast and moulds of soy-mushroom health drinks powder were carried out according to the procedure of Bacteriological Analytical Manual (Maturin & Peeler, 2001; Tournas *et al*., 2001; Feng *et al*., 2013).

Statistical analysis

Data analyses were carried out using Statistical Package for the Social Sciences (SPSS version 15.0 SPSS Inc. Chicago, Illinois, and U.S.A). Values were expressed as percentage and mean ± SD. The significance/non-significance of results was determined using one way ANOVA and Duncan test.

RESULTS AND DISCUSSION

Chemical composition of soy flour, mushroom powder, soy–mushroom health drink powder and locally available health drink powder

The moisture, protein, fat, ash, fibre and total carbohydrate of dehulled soy flour were found to be 1.4%, 49.3%, 24.9%, 2.8%, 3.0% and 18.6% respectively in dry weight (Table 2). The values for fat and protein contents were slightly higher than the values obtained by Kundu *et al*. (2011) on a dry weight basis. In the case of oyster mushroom (*Pleurotuso streatus*) powder, the moisture, protein, fat, ash, fibre and total carbohydrate were 4.0%, 31.8%, 2.5%, 7.0%, 12.5% and 42.2% respectively on a dry weight basis(Table 2). These results are almost similar to the findings of Michael, Bultosa & Pant (2011).

Chemical composition of the developed soy-mushroom health drink powder compared to other locally available health drink powders are described below (on a dry basis).

Moisture and ash content

In the present study, it was found that moisture content ranged from 3.04 to 3.96%. Highest moisture content was found in sample 1 (3.96%) while the moisture content of our developed soy-mushroom health drink powder was found to be 3.84%. The ash content of the three samples ranged from 3.23 to 7.4% and for our developed health drink powder, it was 3.23% (Table 2).

Protein content

The protein content ranged from 8.98 to 21.37%. The highest protein content (21.37%) was found for our developed soy-mushroom health drink powder and the difference in mean as compared to others was also significant (p<0.05)(Table 2). From this study, it has been found that locally available health drink powders have low protein content. Moreover, the protein content of our soy-mushroom health drink powder was higher than that of the soy-malt beverages developed by Oluwole *et al.* (2012). This increase in protein content could be due to the incorporation of soy flour and mushroom in the health drink as soy bean is a protein rich legume and a brilliant complement to lysine-limited cereal protein. That is why soy flour is often used as an economical protein supplement in biscuit, health drink, bread, pasta, and other cereal products.

Table 2. Proximate analysis of soy flour, mushroom powder, soy–mushroom health drink powder and locally available health drink powders

Test parameters	*Soy flour*	*Oyster mushroom powder*	*Soy–mushroom health drink powder*	*Sample 1*	*Sample 2*	*Sample 3*
Moisture (%)	1.4 ± 0.04	4.0 ± 0.03	3.84 ± 0.05ab	3.96 ± 0.06a	3.78 ± 0.08b	3.04 ± 0.07c
Ash (%)	2.8 ± 0.02	7.0 ± 0.03	3.23 ± 0.03d	4.25 ± 0.02c	4.33 ± 0.04b	7.4 ± 0.03a
Protein (%)	49.3 ± 0.05	31.8 ± 0.04	21.37 ± 0.05a	11.01 ± 0.05b	8.98 ± 0.07d	9.62 ± 0.06c
Fat (%)	24.9 ± 0.06	2.5 ± 0.07	10.13 ± 0.04a	1.45 ± 0.03b	1.29 ± 0.05c	1.10 ± 0.06d
Fibre (%)	3.0 ± 0.04	12.5 ± 0.04	1.50 ± 0.04a	0.08 ± 0.03b	0.04 ± 0.01b	0.06 ± 0.03b
Carbohydrate (%)	18.6 ± 0.21	42.2 ± 0.21	59.93 ± 0.21d	79.25 ± 0.13b	81.58 ± 0.17a	78.78 ± 0.25c
Energy (Kcal/100g)	495.7 ± 0.1	318.5 ± 0.05	416.4 ± 0.23a	374.09 ± 0.05b	373.85 ± 0.05b	363.54 ± 0.24c

Values are means of triplicates ± standard deviation. Values with the same superscripts in a row are not significantly different ($P > 0.05$).

The use of mushroom in our developed health drink powder is supported by its excellent source of high-quality protein (20–40% on a dry weight basis), vitamins (vitamin B- complex), and minerals (Walde *et al.*, 2006; Kurtzman, 2005). This result confirms that mushrooms can be used as a nutritional source in the development of various products. Products developed from soy flour and mushroom have a greater potential in overcoming protein-calorie malnutrition in the world (Akubor & Ukwuru, 2005).

Fat content

In the present study, the fat content ranged from 1.10% to 10.13%. The highest fat content (10.13%) was found in our soy-mushroom health drink powder (Table 2). This is supported by a previous study on soy-malt beverages by Oluwole *et al.* (2012). The highest fat content found in our developed health drink powder could be due to the presence of soy flour in the drink. Globally soy flour is considered as the number one edible oil source (18% of oil) (Van, 2009), most of which are unsaturated in nature (61% of polyunsaturated fatty acids and only 15% of saturated fatty acids, without trans-fatty acids). The two polyunsaturated fats, linoleic and linolenic, which are essential fatty acids that are not produced in the body, support the absorption of vital nutrients required for human health (Ivanov, Levic & Sredanovic, 2010). In addition to soy flour, whole milk powder rather than skim milk powder was incorporated into the production of the health drink powder. This could be another reason for higher fat value in our soy mushroom health drink powder.

Fibre content

The fibre content ranged from 0.04% to 1.50%. The highest fibre content (1.50%) was recorded in our developed soy-mushroom health drink powder (Table 2).The difference in mean as compared to others is also significant (p<0.05). The incorporation of soy flour and mushroom in our developed health drink powder might be its enhanced fibre content, supported by a study of Ndife,Abdulraheem & Zakari (2011). According to well-documented studies, it is now accepted that dietary fibre plays a significant role in the prevention of several diseases such as cardiovascular diseases, diverticulosis, constipation, irritable colon cancer, and diabetes (Slavin, 2005; Elleuch *et al.*, 2011). So, this soya-mushroom health drink powder may be helpful in preventing these cases.

Carbohydrate content

In the present study, carbohydrate content ranged from 59.93 to 81.58%. The lowest carbohydrate content was observed in our developed soy-mushroom health drink powder (59.93%) and the difference in mean was also significant (p<0.05) (Table 2). This may be due to the presence of soy flour and mushroom as ingredients which have a low carbohydrate content (31.3% for soy flour and 42.2% for mushroom) (Kundu *et al.*, 2011; Michael *et al.*, 2011).

Energy value

Food energy is the amount of caloric value available from food through oxidation. The calorie content in the study was found to be 363.54 to 416.40 kcal per 100g (Table 2). The highest caloric value was observed in our developed soy-mushroom health drink powder (416.40 kcal per 100g). The difference was also significant (p<0.05) compared to other locally available health drinks.

Sensory evaluation soy-mushroom health drink

In the present study, with regard to flavour, taste, texture, consistency, colour, mouth feel, and overall acceptability, sensory scores of our developed health drink powder were found to be the best (9.0) compared to locally available health drinks powders (Table 3).

Table 3. Sensory attributes of soy-mushroom health drink powder.

Sample	*Sensory attributes*						
	Colour	*Taste*	*Texture*	*Consistency*	*Mouth feel*	*Flavour*	*Overall acceptability*
Soy–mushroom health drink powder	9 ± 0.03[a]	9 ± 0.02[a]	9 ± 0.03[a]	9 ± 0.03[a]	9 ± 0.01[a]	9 ± 0.02[a]	9 ± 0.02[a]
Sanple1	8.5 ± 0.01[b]	8.4 ± 0.02[c]	8.5 ± 0.01[b]	8.6 ± 0.02[b]	8.7 ± 0.03[b]	8.6 ± 0.03[b]	8.5 ± 0.03[b]
Sample 2	8.2 ± 0.03[d]	8.3 ± 0.01[d]	8.4 ± 0.03[c]	8.3 ± 0.04[d]	8.5 ± 0.01[d]	8.6 ± 0.01[b]	8.4 ± 0.03[c]
Sample 3	8.3 ± 0.02[c]	8.6 ± 0.03[b]	8.3 ± 0.02[d]	8.5 ± 0.04[c]	8.6 ± 0.02[c]	8.5 ± 0.02[c]	8.41 ± 0.04[c]

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

Table 4. Microbiological analyses of soy-mushroom health drink powder

Sl No	*Test parameters*	*Shelf Life (Month)*						
		0	*3*	*6*	*9*	*12*	*15*	*18*
01	Total viable count, cfu/gm	<10**	<10**	<10**	1.9×102	9.0×103	3.6×106	TNTC*
02	Total yeast & moulds Count, cfu/gm	<10**	<10**	<10**	<10**	<10**	5.0×102	7.5×105
03	Total coliforms, MPN/gm	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***
04	E.coli, MPN/gm	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***	<0.3***

*TNTC= too numerous to count
** <10 indicates absence of test organisms in one gram of sample
***As per MPN chart, the most probable number <0.3 indicates absence of test organism in one gram. MPN means most probable number.

Microbiological Analyses

In our study the product microbial load was assessed and up to 12 months, the total viable count and total yeast and mould count were within the acceptable limits whereas no coliform or *E. coli* was found during the entire storage period (Food Standards Australia New Zealand, 2001). After 12 months, the total microbial load gradually increased and the product became unacceptable (Table 4).

CONCLUSION

Considering biochemical analyses, it can be concluded that the protein, fibre and caloric value of our developed soy-mushroom health drink powder was found to be superior compared to locally available health drink powders. On the basis of oraganoleptic evaluation, this developed product was also acceptable in sensory quality. From a microbiological point of view, this product was also within acceptable limits. In a nutshell, introducing soy flour and mushroom into the health drink preparation not only increased its nutritional quality but also increased sensory attributes. This developed product may serve to meet day-to-day nutritional requirements as a supplement.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Bangladesh Council of Scientific and Industrial Research for funding the Research and Development work.

Conflict of interest

No conflict of interest

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