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Original Article

Assessment of Microbiological Quality of Fresh-cut, Processed and Preserved Mushrooms Available in and Around Dhaka City

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The results revealed that 40% of fresh mushrooms, 93% of processed and preserved mushroom samples including mushroom-based food products were safe for human consumption from bacteriological point of view. The highest bacterial load recorded was 8.7×10^8 cfu / gm in the samples collected from Sutrapur area of Dhaka city. The results also indicated that 27, 13, 13 and 7% of the fresh mushrooms were contaminated with coliform, fecal coliform, *E. coli* and *Salmonella* sp. respectively. Thus those mushroom samples were not up to the mark for consumption, considering safety and sanitation point of view. In case of processed mushrooms and mushroom-based food products the results showed that 20% of dried mushrooms were contaminated with both coliform and fecal coliform, 7% of powdered mushrooms were contaminated with only coliform and 13% of mushroom soup powder were contaminated with coliform, *E. coli* and *Salmonella* sp. In case of preserved mushrooms, it was found that 7% of the canned mushrooms had count <10 cfu/gm which was unacceptable as per specifications for the canned food. However, the results also revealed that coliform, fecal coliform, *E. coli* and even *Salmonella* sp. were not detected in preserved mushrooms examined.

Introduction

Mushrooms have gained popularity all over the world due to its pleasant aroma, taste and fleshy nature although the nutritional and medicinal values of mushrooms have long been recognized[1,2]. The world mushroom production was more than one million tones[4]. Due to its inherent food values, world mushroom production had reached three million tons[4]. Now, mushrooms are being cultivated in more than 100 countries of the world with an estimated total production of over 12 million tons[5]. In Bangladesh, interest in mushroom began in the late 1960's[6]. During the last three decades there have been perceptible changes in the scenario, particularly in respect of cultivation, production system with present production range 620-675 metric tons[7].

Now more than three tons mushroom are being imported by Bangladesh per year[8,9]. Mushrooms are now being available in fresh pack, processed pack, powdered form as well as caonned products in most upazilla level, towns shopping molls and mega shops of Dhaka city. Most recent these fresh mushrooms and mushroom based food items are invariably consumed by consumers of different age groups[10]. Food and drinks with proper nutritional value, hygienic in quality and appropriate in quantity is essential for good health and active life[11].

Materials and Method

The present study attempt to evaluate the microbiological quality of the fresh-cut oyster mushroom (*P. ostreatus*) dried mushrooms, dried and canned mushrooms. The experiment was conducted at Food microbiology section of IFST, BCSIR and Department of Botany, Jahangirnagar University, Savar, Dhaka in 2007.

Collection of Samples

Mushrooms including fresh-cut, dried, powdered, mushroomi (blanched mushroom fried with powdered pulse), tikiya (fried powdered mushroom with boneless smashed fish), mushroom soup powder and canned mushrooms were collected through randomized sampling from the local market and mega-shops of eleven different areas of Dhaka city including Savar thana. Oyster mushrooms were grown at the cropping room using standard IFST practice, and picked only first and second flash, then packed on the day of the experiment. Mushroom-based products derived from oyster mushrooms were considered as processed mushrooms. Fresh-cut mushrooms were 5 to 11cm in diameter. Imported canned mushrooms (*Agaricus* spp.) were collected as preserved foods. The sterile marked containers were used for sampling and transported under ambient temperature within 1-2 hours to the laboratory, and stored at 4^{o}C for 4-6 hours if necessary.

Culture media

Potato dextrose medium and Malt extract agar medium were used for isolation of contaminated moulds if any. All culture media were sterilized by autoclaving at 121^{0}C (Model-MC 30321, ALP, Japan) at 15 psi for 20 minutes and the glassware by using oven (Model-BS75, Memmert) at 180^{o}C for 1 hours.

Procedure

A recognized procedure (FAO EC, 1976) has been followed. All the cultures were incubated under aseptic conditions using

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Laminar Air Flow Cabinet (Model ER-17, Japan). The inoculated solid and liquid media were used for static growth conditions. The organisms were incubated at 32°C temperatures. For microscopic characterization of bacteria, compound microscope (Model NoEUROMEX-9305346) was used. Preservation and maintenance of different microbial cultures, heat labile chemicals or reagents etc were carried out at refrigerated temperature (Model NoK644U123, SIEMENS).

Total Bacterial Count (TBC) and Total Coliform Count (TC)

The total bacterial count was carried out by pour plate method and TC detection was done using MPN method. The number of colonies that appeared on the different plates was counted using digital colony counter and following formulae and expressed as log colony-forming unit per gram (log cfu/gm). In case of *E. coli* IMViC test was carried out for further confirmation.

Qualitative detection of Salmonella species

A 25gm solid sample was weighted aseptically into a sterile Lactose Broth (LB) medium and after incubation 16-20 hours pre-enriched in Selenite Broth (SB) medium and then inoculated on BSA (Bismuth Sulphite Agar) and TSI (Triple Sugar Iron Agar) media. In case of positive result, confirmation was done by urease test. The experiment had been performed as recommended by International Commission on Microbiological Specification for Foods[12, 13].

The features of collected samples are shown in Table 1.

Result and Discussion

The results of standard plate count (SPC) obtained from different fresh mushrooms, processed mushrooms and mushroom products are summarized in (Table 2).

Fresh mushrooms

In this study results showed that only 20% of fresh Oyster mushroom samples were in maximum desirable count (*m*), another 13% were in maximum acceptable (*M*) count and 7% maximum permissible number, yielding a count between *m* and *M*. More or less similar results were recorded by Splittstoesser[14]. Altogether 40% of fresh mushrooms were found as safe and consumable for humans from the bacteriological point of view. Maximum count was recorded in fresh mushrooms 8.7×10^8 cfu/gm, collected from Sutrapur area of Dhaka city. Food suspected to cause for foodborne poisoning give higher count ranging from 10^6 to 10^{10} per gram of food[15]. Remainder 60% fresh mushrooms were unfit for human consumption. From the safety and sanitation point of view, among the 60% of fresh mushrooms, 27, 13, 13 and 7% were contaminated with coliform, fecal coliform, *E. coli* and *Salmonella* spp., respectively (Figure 1). A similar observation was made by Beraha *et al.* [16] in case of fresh-cut mushrooms. The total viable counts of bacteria in processed food

Table 1: *General description of collected samples*

Sl. No.	Collected Sample's Unit	Name of Samples	Condition of Samples when Collected / Purchased			
			Type	Category	Package	Weight
1.	15	Oyster Mushrooms	Fresh	Vegetable	Polyethylene	100gm
2.	15	Oyster Mushrooms	Dried	Vegetable	Polyethylene	100gm
3.	15	Oyster Mushrooms	Powder	Vegetable	Aluminium Foil	50gm
4.	15	Mushroom Soup	Powder	Confectionary	Polyethylene	20gm
5.	15	Mushroomi	Cocked	Snacks	Paper box	100gm (±5gm)
6.	15	Tikkiya	Cocked	Snacks	Polyethylene	100gm (±5gm)
7.	15	Button Mushrooms	Canned	Vegetable	Can	425gm

Table 2: *Total viable count of fresh cut mushroom, processed mushroom and mushroom-based food products*

Name of the Samples Examined	Sample* size (n)	SPC Range cfu/gm		*m*	%	*C*	%	*M*	%	*M* >	%
		Lowest	Highest								
Oyster Mushroom	15	$0.04X10^2$	$8.7\ X10^8$	3	20	1	7	2	13	9	60
Oyster Mushroom (dried)	15	$0.96X10^2$	$5.2\ X10^8$	6	40	2	13	4	27	3	20
Oyster Mushroom (Powder)	15	$0.66X10^2$	$1.7\ X10^8$	10	66	1	7	3	20	1	7
Mushroom Soup (Powder)	15	$0.10X10^2$	$3.1\ X10^8$	8	53	1	7	4	27	2	13
Mushroomi (Fried)	15	$0.08X10^2$	$1.1\ X10^3$	15	100	0	0	0	0	0	0
Tikkiya (smashed)	15	$0.13X10^2$	$2.1\ X10^3$	14	93	0	0	1	7	0	0
Button Mushroom (Canned).	15	00	$0.04X10^2$	14	93	0	0	1	7	0	0

*Values are mean value of three replicate plates each of 10^{-1}, 10^{-2},10^{-3} dilutions. n = Number of samples examined; *m*=Maximum desirable count; *M*=Maximum acceptable count; *c* = Maximum allowable number of sample units, yielding a count between *m* and *M*. Sl No 01: Fresh Mushroom; Sl No. 02-06 : Processed Mushrooms; Sl No. 07: Preserved Mushroom.

were well below than fresh-cut mushrooms, which had clearly demonstrated that reduction in count of bacteria could be due to drying. Each processing steps and time or shelf life is directly related with associated microorganism[17]. The source of contamination of fresh-cut oyster mushrooms, in the present study, it is assumed that organisms might have come from water or at the pre-harvest stage. It had been found that the vegetables underwent successive stage of processing; the main source of organisms had come from the infectious diseases and the improper handling of employees[17].

Processed Mushrooms

As per standard plate count, it was also observed that 100% of mushroomi (cooked snack item) had counts within desirable limit, followed by 93% of tikkiya (mushroom-fish smashed), 66% of oyster mushroom powder, 53% of mushroom soup and 40% of dried mushrooms. Among the processed mushrooms, 7% of takkiya were in maximum acceptable count (*M*) where neither indicator organisms nor index organisms were found. Those finding influences the shelf-life of the product as mentioned by Beelman[18]. Though dried mushrooms, powdered mushrooms and mushroom soup powder were processed foods, all of these items had not been found within microbiologically acceptable limit. The SPC also showed that 20% of dried mushrooms, 7% of powdered mushrooms and 13% of mushroom soup powder had a count which exceeded acceptable limit. Burton[19] found that bacterial counts were consistently lower depending on processing and storage conditions. That was very similar with contaminations as recorded in the present study in mushrooms and mushroom-based food products. Figure 1 illustrated that dried mushrooms were contaminated with both coliform and fecal coliform whereas, powdered mushrooms were contaminated with only coliform. In case of mushroom soup powder, presence of coliform, *E. coli* and *Salmonella* sp. were recorded.

Preserved mushrooms

There is no production of canned mushrooms in Bangladesh till date, although imported canned button mushrooms are available. Results of SPC demonstrated that 93% of the canned button mushroom (*Agaricus bisporus*) samples were within desirable limit (*m*) and rest of 7% were not within acceptable limit (*M*), which was procured as preserved mushrooms from the local market. Though canned mushroom is highly processed food, contamination might occur because of some organisms which could enter into the cans at the start of cooling point through faulty seams, which generally result from can abuse, or some spores are not destroyed by heat, as has been pointed out by Schmitt[20]. So, special care should be undertaken for importing canned products. In the present investigation, the bacterial count of canned mushroom were <10 cfu/gm which was ultimately unacceptable range as per specified specifications for the canned food. No indicator organisms or index organisms were found; even any *Salmonella* sp was not present in such samples (Figure 1).

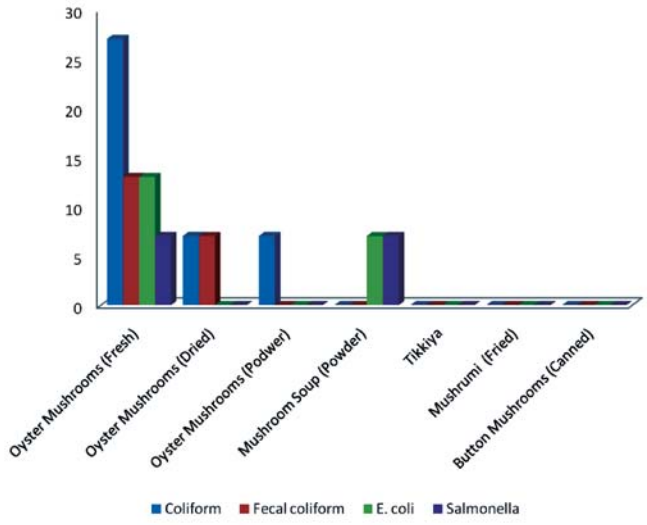

Fig 1: *Percentage of contaminated mushrooms and mushroom-based food products, contaminated with Coliform, Fecal coliform, E. coli and presence of Salmonella sp.*

Some research have been carried out on edible mushroom in Bangladesh, most of which on the cultivation, yield and production aspects. Studies regarding their processing, preservation and microbiological quality are either very scanty or nil. The presence of microorganisms in food is not necessarily an indicator of hazard to the consumers. In spite of the shortcomings, the presence of colifrom, fecal coliform as an indicator organism and *E. coli* as an index organism indicated for its poor hygienic and sanitation condition. Moreover, absence of *E. coli* is still widely used as an indication of safety of the food staff[21]. It was reported that coliforms were more efficient indicators of sanitation than enterococci prior to freezing, while enterococci were superior indicators after freezing and storage[22]. There are plenty of research papers on microbiological qualities of so many vegetables but regarding microbiological qualities of mushrooms are limited.

Evaluation of microbiological qualities of some snacks items are reviewed in some earlier studies[23,24]. Bacteriological quality of fast food and soft drinks in relation to safety and hygiene was assessed on the basis of SPC and they observed that maximum count are obtained form beef burger (6.4×10^9cfu/gm) followed by singara (5.8×10^9cfu/gm), beef roll (4.2×10^7) and chicken roll (5.2×10^5). Finding of these experiments were shown more or less similar in respect of bacterial loads with those of mushroom-based food products like tikkiya (fish mixed) and mushroomi. Canned button mushrooms were found as satisfactory which are comparable with the finding reported by Khatun *et al.*[25]. However, in this experiment, it was clearly evident that the harmful or pathogenic organisms were comparatively higher in fresh mushrooms than those of processed or preserved mushrooms. As we have seen that contamination of dried mushrooms are higher (20%) than those of powdered mushrooms

(7%) and mushroom Soup powder (13%). It indicates that the improper processing condition might have occurred due to various steps of food processing including collection of raw materials, handling, storage, transportation, distribution, packaging etc.

Conclusion

Spoilage of food is a special concern and from the economic point of view. Food and drinks with proper nutritional value, hygienic quality and appropriate in quantity is essential for good and active life. So, fresh mushrooms require minimal processing to consume. Conducting such type of experiments would enable us to decide as to what kind of processing methods should be adopted.

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References

1. Lucas EH, Rigler RL, Byrrum, RU and Stock OO. 1957. Tumor inhibitors in *Boletus edulis* and other holobasidiomycetes. *Antibiot Chemother*. 7: 1-4.
2. Suzuki S and Oshima S. 1976. Influence of shii-te-ke (*Lentina edodes*) on human serum cholesterol. *Mushroom Sci*. abstract (1), 463-T.
3. Gupta Y and Sharma SR. 1994. Mushroom spawns production. Technical Bulletin N.5. NCMR and T. Chambaghat, Solan- 173213, HP.India.
4. Anon 1997. A blow to Indian seafood exports, Indian Food Industry, 16(3), 15.
5. Suman BC and Sharma VP. 2007. Mushrooms cultivation in India, Daya Publishing House, Delhi.-110035, PP 18-22
6. Majid F Z and Khan Nowsher Ali. AZM. 1968. Studies on the *Agaricus* of Dacca, East Pakistan. *Scientific Researches*.**1**: 58-65.
7. Kamal AS Mostsfa, Khair A. Dawlatana, Hassan MT, Begum F and Rahim M. 2008. Evaluation of Aflatoxins and Pesticide residues in Fresh and different Processed mushrooms. Bangladesh *J Sci Ind Res*. (Acceptance letter No. BJSIR/P/36/2875/517; Dated 04.12.2008).
8. Anon 2006. National Board of Revenue (NBR); Ministry of Internal Resource Division. Government of the People's Republic of Bangladesh. Official Data, Dhaka, Vide memo no- 1 (2) CIS Cell/ NBR/ 2006/ 77; Dated 23/03/06.
9. Anon 2008. National Board of Revenue (NBR); Ministry of Internal Resource Division. Government of the People's Republic of Bangladesh. Official Data, Dhaka, Bangladesh.
10. Potter ME. 1978. Food born diseases concern, symposium on Engineering Microbiological concerns. Leather-head; Leather Head Food Research Association.
11. Valentine AA.1995. Compositional Studies on edible tropical species of mushrooms. *Food Chem.* **54:** 265-268.
12. ICMSF. 1974. Microorganisms in foods 2. Sampling for microbiological analysis: principles and specific applications, International Commission on Microbiological Specifications for Foods (ICMSF), Toronto, Canada, University of Toronto Press.
13. ICMSF. 1986. Microorganisms in foods 2. Sampling for microbiological analysis: principles and specific applications, 2nd edn. p 190. International Commission on Microbiological Specifications for Foods(ICMSF), Toronto, Canada, University of Toronto Press.
14. Splittstoesser DF, Queale DT, Bowers JL and Wilkinson M. 1980. Coliform content of frozen balanced vegetables pecked in United States. *J Food Safety*. **2:** 1-11.
16. Beraha L, Smith MA and Wright WR. 1961. Control of day of fruits and vegetables during marketing dev. *Industry Microbiol*. **2:** 73-77.
17. James M. Jay, 2005. Modern Food Microbiology, 4th edition, C.B.S publications and Distributors New Delhi. pp-79, **573**: India.
18. Beelman R. 1987. Factors influencing post-harvest quality and shelf life of mushrooms. *Mushrooms News*. **35**(7): 12-14.
19. Burton KS. 1989. The quality and storage life of *Agaricus bisporus* Mushroom Science xii (part 1) In: Proceedings of the twelfth International Congress on the science and cultivation of edible fungi, Braunschweig, Germany. pp. 287-293.
20. Schmitt HP. 1966. Commercial sterility in canned foods, its meaning and determination. *Assoc Food Drug US* Quart. Bull. **30:**141-151.
21. Narang SP. 2004. Food Microbiology - Methods of Enumeration; A P H Publishing Corporation, New Delhi.
22. Burton MC. 1949. Comparison of coliform and enterococcus organisms as indices of pollution in frozen foods. *Food Res*. **14**: 434 - 448.
23. Begum F, Banana UH, Sultana DA, E. Rati R and Varadary MC. 2004. Bacteriological Status of same Meat based Ready to Eat Foods served in Dhaka city. *Bang J Microbiol*. **21**(2): 62-64.
24. Ahamed J, Hossain ML, Malek MA and Begum F. 2008, Assessment of Bacteriological Quality of Fast Foods and Soft Drinks in Relation to Safety and Hygiene. *Bang J Microbiol*. **25:** 73-75.
25. Khatun K, Mahtab H, Khanam PA, Sayeed M.A and Khan K A. 2007. Oyster Mushroom reduced blood glucose, and cholesterol in diabetic subjects. *Mymensingh Med J*. **16** (1): 42-45.