Microbiological quality analysis of different types of popular dried food items


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Abstract

The study was carried out to investigate the microbiological quality of dried foods which are very popular among kids. Moreover, people from all age groups like it, although adults do not take it on a regular basis, the total consumed amount among the adults are not negligible. Chips, biscuits, muesli, salted peanuts all are dried foods, and all of these can undergo microbial contamination due to the remaining water activity, environmental condition, production processing faults, humidity, temperature etc. In the current study, twenty-four samples were analyzed for microbial quality analysis. Six samples from each category of dried food were subjected to study for the presence of mesophilic organisms, coliforms, molds and other specific food pathogens. Of the samples studied, almost all were found to be contaminated with the mesophilic bacteria (10^4-10^7 CFU/g) and fungus (10^5-10^7 CFU/g). Survival of *Vibrio* spp. was absent and *Salmonella* spp. was found in only one sample. *Escherichia coli*, *Pseudomonas* spp., *Staphylococcus* spp. and *Shigella* spp. were found in many of the samples indicating the poor quality of the dried food items. Overall, the present study revealed that potato chips were highly contaminated by bacteria and fungi. Consuming such contaminated chips may cause foodborne illness that is a great threat to our health.

1. Introduction

Dried foods like chips, biscuits, muesli or roasted nuts are very popular snack items all over the world which are available in every grocery shop, super shops as well as in the remote areas. These are enjoyed most during vacation, journey, picnic and even as school tiffin. The principal of production of potato chips are cooked and salted potatoes pieces mixed with different kinds of flavorings and ingredients including herbs, spices, cheeses, natural or artificial flavors and additives. A survey results published (Berry and Norman, 2014) that the world potato chip market collected total revenues of US$16.49 billion in 2005 that was 35.5% of the total market of snacks in that year ($46.1 billion) (Savory Snacks: Global Industry Guide, 2016). Nuts are a source of protein, fat and minerals. People who are more considerate about their health prefer nuts that junk snacks (Bhat and Vasanthi, 2003). Dried cereals are best suited for a modern busy life as they can be eaten directly with milk without further processing. Cereals are produced by mixing different cereal grains and processing them together (like roasting, grinding, swelling, shredding, flaking and so on). They are a good source of vitamins, minerals, zinc, phosphorus and calcium (Williams, 2014; Mbaeyi-Nwaoha et al., 2016). Another popular dry food is biscuit which mostly contains carbohydrate, and some protein, gluten and fat content (Shewry et al., 2002; Adobowale et al., 2012).

Potato Chips are not only tasty and easily available snack, but also inexpensive. The major fact is the impact of chips on our body is not sound. Due to high oil contents, it is harmful to the peoples suffering from chronic heart diseases and obesity (Consensus Action on Salt and Health, 2004; Prajapati et al., 2003).

There are international standards for the microbiological limit of foods and beverages. These standards can be modified slightly by locally. Almost every country has its own regulations and monitoring body to check the quality of the food, exclusively the ready to eat foods due to its high alarm for human health hazard. As a ready to eat foods, chips, biscuits, salted nuts and muesli have a risk for microbial contamination on its production, packaging, transportation or storage (Fraizer and Westhoff, 1995; Eze et al., 2011; Oladipo et al., 2019). *Escherichia coli* O157: H7, *Salmonella* spp.,

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Shigella spp., Bacillus spp., Mycobacterium spp., Brucella spp., Listeria monocytogenes, Yersinia enterocolitis, Pseudomonas spp.; Clostridium perfringens, Klebsiella spp., Vibrio spp., Campylobacter jejuni and Staphylococcus aureus have been reported to be the common food spoilage bacteria (Fraizer and Westhoff, 1995; Beuchat et al., 1996; Torquato et al., 2004; Jay et al., 2005; Nordmann et al., 2009; Rahman and Noor, 2012; Acharjee et al., 2013; Hassan et al., 2013; Noor et al., 2014; Oladipo et al., 2019). Furthermore, it contains toxic and carcinogetic byproducts which are not found in the uncooked foods (Exon, 2006).

Potato Chips contaminated by microorganisms (bacteria, yeasts, viruses, and protozoa) can cause health-related issues (Jaykus, 2000; Drury, 2012). Contaminated nuts with fungus and associated toxin can cause liver damage, cancer, abortion etc. (Abbas et al., 2005; Drury, 2012).

The objective of the current study was to identify the existence and amount of bacteria (Escherichia coli, Klebsiella spp., Pseudomonas spp., Staphylococcus spp., Shigella spp., Salmonella spp., Aeromonas spp., Vibrio spp.) and fungi in different types of dried foods (potato chips, muesli, biscuits, salted peanuts) to determine their overall quality for assessing the public health risks.

2. Materials and methods

2.1 Study area, sampling

A total of twenty-four samples of chips, biscuits, muesli and salted peanut (six sample per category of food) with valid manufacturing and expiry dates were collected from April 2017 to May 2017. These samples were collected from different retailer store in Dhaka city, Bangladesh and then transported to the laboratory to determine the microbiological quality of the respective chips.

2.2 Sample processing

For each dried food samples, 10 g were weighed and homogenized with 90 mL normal saline and serial dilutions were prepared up to $10^{-4}$ and the dilution was used for plating purpose according to the standard protocols (Cappuccino and Natalie, 1983; Cappuccino and Sherman, 1996).

2.2.1 Enumeration of total viable count (TVC) and total fungal count (TFC)

For the quantification of total viable count (TVC) and total fungal count (TFC), 0.1 mL of the $10^{-3}$ and $10^{-4}$ dilutions were spread onto the Nutrient agar (NA) and Sabouraud’s dextrose agar (SDA) (Oxoid Ltd., Basingstoke, Hampshire, England) plates, respectively, by means of spread plate technique. Plates were incubated at 37°C for 24 hrs and 25°C for 48 hrs for total viable bacteria and fungi, respectively (Atlas et al., 1995; Cappuccino and Sherman, 1996; Downes and Ito, 2001; Deak, 2003).

2.2.2 Enrichment of samples

An aliquot (1 mL) of the homogenized sample was transferred into 9mL of selenite cysteine broth (SCB) and alkaline peptone water (APW) (Oxoid Ltd., Basingstoke, Hampshire, England) for the enrichment of Salmonella, Shigella, and Vibrio spp., Aeromonas spp. respectively and incubated at 37°C for 4-6 hours. Samples were then diluted up to $10^{-3}$ and 0.1mL of samples from each of the $10^{-2}$ and $10^{-3}$ dilutions were spread onto Salmonella-Shigella (SS) agar and thiosulfate citrate bile salt sucrose (TCBS) agar (Oxoid Ltd., Basingstoke, Hampshire, England) for the isolation of Salmonella spp., Shigella spp., and Vibrio spp., Aeromonas spp. respectively. Plates were incubated at 37°C and the appearance of typical colonies (if any) was noticed within for 24-48 hrs (Samia et al., 2014).

2.2.3 Isolation and enumeration of Staphylococcus spp. and Pseudomonas spp.

From the $10^{-3}$ and $10^{-4}$ dilution of each suspension, 0.1 mL of sample was spread onto Mannitol salt agar (MSA) and Pseudomonas agar (PA) media for the enumeration of Staphylococcus spp. and Pseudomonas spp. consecutively. All the plates were incubated at 37°C for 24 hrs (Samia et al., 2014).

2.2.4 Isolation and enumeration of Escherichia coli, Klebsiella spp.

From the $10^{-3}$ and $10^{-4}$ dilutions of each suspension, 0.1 mL of sample was spread onto MacConkey agar media for the enumeration of E. coli and Klebsiella spp. All the plates were incubated at 37°C for 24 hrs (Samia et al., 2014).

3. Results

3.1 Microbiological analysis of chips

From Table 1, we can see that Total viable count (TVC) higher than Total fungal count (TFC) for sample C1,C2,C5,C6 and in the case of sample C3, C4 TFC are higher than TVC. The highest count of TVC ($2.8 \times 10^7$ CFU/g) and TFC ($1.1 \times 10^8$CFU/g) was found in sample C2 and the lowest count of TVC ($3.0 \times 10^6$CFU/g) and TFC ($6.0 \times 10^4$CFU/g) was found in sample C1. In our study, we also tried to detect the existence of some specific bacteria in potato chips. We found Salmonella spp. ($7 \times 10^5$CFU/g) only in sample C3. Pseudomonas
spp. (ranging from $2.5 \times 10^4$ CFU/g to $2.8 \times 10^5$ CFU/g), Staphylococcus spp. (ranging from $4 \times 10^3$ to $5.2 \times 10^5$ CFU/g), Shigella spp. (ranging from $1.0 \times 10^4$ CFU/g to $7 \times 10^4$ CFU/g) was found in all the samples which means that all the samples were produced in such a condition which made the quality unsatisfactory for consumption. E. coli was found only in 3 samples (sample C1, C3, C4).

3.2 Microbiological analysis of biscuits

Table 2 shows the overall microbiological quality of biscuits. The highest total bacterial count and total fungal count was found in sample B5. Salmonella spp. and Vibrio spp. were absent. Aeromonas spp. ($1.0 \times 10^5$ CFU/g) was found only in sample B5. E. coli, Klebsiella spp. and Shigella spp. was found in 2 samples each. Staphylococcus spp. (ranging from $4.0 \times 10^3$ CFU/g to $2.6 \times 10^4$ CFU/g) and Pseudomonas spp. (ranging from $2.5 \times 10^3$ CFU/g to $1.4 \times 10^5$ CFU/g) were found in all samples.

3.3 Microbiological analysis of muesli

From Table 3 (muesli) we can observe that TVC was higher than TFC for all samples. The highest count of TVC ($2.7 \times 10^6$ CFU/g) and TFC ($1.1 \times 10^6$ CFU/g) was found in sample M2 and the lowest count of TVC ($3.0 \times 10^5$ CFU/g) and TFC ($1.9 \times 10^5$ CFU/g) was found in sample M6. Salmonella spp. and Vibrio spp. were totally absent. Pseudomonas spp. (ranging from $1.7 \times 10^5$ CFU/g to $2.5 \times 10^5$ CFU/g), Staphylococcus spp. (ranging from $2.0 \times 10^3$ to $2.9 \times 10^5$ CFU/g), Shigella spp. (ranging from $1.0 \times 10^3$ CFU/g to $2.4 \times 10^4$ CFU/g) were also found in all the samples. Klebsiella spp. was present only in sample M4 whereas E. coli was found in sample M3 and sample M6.

3.4 Microbiological analysis of salted peanut

Table 4 (salted peanut) depicts the highest count of TVC ($2.2 \times 10^4$ CFU/g) in sample P3 and TFC ($1.1 \times 10^6$ CFU/g) in sample P2. The lowest count of TVC ($2.0 \times 10^5$ CFU/g) was found in sample P2 and TFC ($6.0 \times 10^5$ CFU/g) was found in sample P1. Salmonella spp. and Vibrio spp. was absent like all other dry foods under this study. Aeromonas spp. was found only in sample P2 and P6. E. coli, Klebsiella spp. and Shigella spp. was found to be present in 50% samples (3 out of 6). The highest number of Staphylococcus spp. and Pseudomonas spp. was found in sample P1.

4. Discussion

All the samples have a noticeable amount of TFC and TVC that lies on the unsatisfactory levels. According to East African Standard 747, 2010, if the count for chips (per gram) for TVC is $>10^4$ and TFC is $>10^3$ then it is unacceptable. The presence of Staphylococcus spp., Shigella spp., and Vibrio spp. is not satisfactory to be present as they are potent food spoilers and can cause disease in human upon consumption. Their presence must be controlled to keep consumers safe. Salmonella spp. and E. coli must also be absent in chips (Harris et al., 2002; East African Standard 747, 2010).

If any bacteria from the fecal group (in our study E. coli, Klebsiella spp.) is present it means that the quality of the food is not safe to eat. The presence of any amount of fecal bacterium is not acceptable according to the safety guideline of ready dried foods.

In this study, most of the samples showed the presence of E. coli and Klebsiella spp. Other pathogenic bacteria (Pseudomonas spp. and Salmonella spp.) were present in a lower amount (Guan and Holley, 2003).

The presence of such bacteria in dried food items can come during the production process and also after storage if the packaging material is not intact or the storage condition is not good for storing food items. During the production process, many steps are carried out and in many of these steps, there are possible chances of contamination to occur (Figure 1). Mechanical areas in processing line like hopper with feeder, grader, peeler, feed conveyor, slicer, flavor applicator etc. are the areas where attention should be maximized to prevent such unwanted contamination.

Biscuits can be spoiled by different ways like physical, chemical and microbial spoilage. Microbial spoilage often depends on some factors like storage temperature, humidity, storage hygiene, packaging material, the moisture content in the storage area etc. (Ooaraikul, 1991). Peanuts often get contaminated with aflatoxin while storing in conditions with high atmospheric temperature, high humidity, low light and long-term storage (Ostadrahimi et al., 2014).

Dried foods are quite popular fast food item around the world and often we ignore the quality as it is a dry food item. But there are possibilities to become contaminated during production and processing of these foods. Several food poisoning bacteria and fungi can be present if proper good manufacturing practice is not maintained and the people (especially children and other young adults among who such food items are very much popular) consuming such contaminated chips can face serious health issues. Attention should be kept on dry food items like chips to process in such a way to prevent any contamination.
Table 1. Microbiological analysis of chips (CFU/g)

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Table 2. Microbiological analysis of biscuits (CFU/g)

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Table 3. Microbiological analysis of muesli (CFU/g)

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Table 4. Microbiological analysis of salted peanut (CFU/g)

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4. Conclusion

Foodborne illness can result in death of people from all age range with a higher ratio for children. Our result indicated that dried foods are contaminated by bacteria and fungi. If people consume such contaminated these contaminated foods, they will suffer from various foodborne diseases. Therefore, routine microbiological analysis of different dried foods is necessary to protect public health. The Government should also take necessary steps to monitor the food quality on a regular basis and enforce the law against those who will fail to produce safety foods.

Conflict of Interest
The authors have no potential conflict of interest.

Acknowledgement
Authors would like to thank Stamford University Bangladesh for the financial and technical supports.

References

Figure 1. Chips production line. (Green parts are safe and red parts are the areas where contamination can occur)


