

Transmission of pathogens within the commonly consumed vegetables: Bangladesh perspective

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Fresh vegetables and fruits are prime source of fiber, vitamins and minerals in our daily diet. Nevertheless, raw vegetables act as a vector for transmitting pathogenic microbes and the majority of diseases are spread by the fecal-oral route at different point of harvesting, post harvesting, during transportation and storage conditions. Contaminated water, carrier materials, and unhygienic handlers are the crucial gateway for disease causing microbes in fresh vegetables. Recently *Listeria* spp., *E. coli*, and *Salmonella* spp. associated outbreak evident in mixed vegetables salad and other vegetable samples also showed pathogenic proliferation to some extent. Children are the major risk group and according to World Health Organization, their mortality rate is high due to food borne infections. In Bangladesh, the situation is more alarming in terms of pathogenic proliferation in raw vegetables. A lot of researches have been conducted in recent years on fresh vegetables and a wide range of vegetables are found to harbor pathogenic microorganisms inclusive of drug resistant bacteria which may affect the measures to combat harmful pathogens. Additionally, phytotoxic, natural contaminants and pesticides are also found to reside in raw vegetables which may be life threatening for both human and animal health as these particles magnify when we repeatedly consume them. The current review focus on the possible intervention of potential contaminants in the vegetable items and possible public health risks associated with their consumption along with a general guideline to combat contamination of fresh vegetables.

Key words: Vegetables; Microbial contamination; Transmission; Pathogens

BACKGROUND: NUTRITION & INFECTION RISK

A healthy human diet requires a considerable intake of vegetables due to the obvious benefits it can possess; many developed countries have advocated the daily consumption of substantial amounts of fruits and vegetables as a necessity for maintaining good health (1-3). Vegetables are known to be the most important basis of nutrients, dietary fiber, vitamins and minerals (4). A side from the health benefits, ironically, the increased consumption of fruits and vegetables has contributed to lowering the risk of various chronic diseases including enteric diseases, cardiovascular diseases and even of the onset of cancer (5-10).

VEGETABLES AND FOOD SAFETY

Contamination with both microorganisms such as *Listeria monocytogenes*, *Salmonella enterica*, and

Escherichia coli O157:H7 and chemicals are a long term concern in food safety resulting in disease outbreaks (4, 11-14). Vegetables, particularly raw vegetables, have previously been identified as a vehicle for the transmission of various bacterial, viral and parasitic pathogens (3). Contamination with microorganisms can occur during harvesting, post-harvest, handling or distribution leading to an increase in the incidence of foodborne illnesses due to fruits and vegetables (3, 4, 8, 15, 16). Salad vegetables have long been held responsible for traveler's diarrhea, affecting those who travel to developing countries (17).

Fruits and vegetables along with the agricultural soils may often harbor natural contaminants like mycotoxins (18). Plants may produce toxins (like the Cry proteins, produced by the soil bacterium *Bacillus thuringiensis*), which are retained within the vegetables for the further uptake by insects (19). Other major plant generated toxins may include phytohaemagglutinin, for red Kidney beans, solanines, for tomato and potato, and for oxalates (spinach and rhubarb) (20-22). Although washing can be applied to remove these contaminant, in order to further ensure the complete removal of the toxins, the regulatory

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bodies like the Center for Disease Control and Prevention (CDC), US Food and Drug Administration (FDA), World Health Organization (WHO) and Center for Science in the Public Interest (CSPI) need to instill the relevant monitoring programs which may include the dietary studies focused to maintain safe and tolerable levels of the natural contaminants (14, 23, 24).

PATHOGENIC BACTERIA ASSOCIATED WITH VEGETABLES AND THE FATALITY

The prevalence of the endophytic cultivable bacterial community like *Salmonella* spp., *Escherichia coli*, *Bacillus cereus*, *Campylobacter* spp., *Yersinia enterocolitica*, *Listeria monocytogenes*, *Clostridium botulinum*, yeasts, molds, some viruses and parasites in the salad vegetables like carrots, cucumbers, tomatoes or onions are not unlikely (22, 25-27). The incidents of Listeriosis, the *E. coli* 0157 outbreak, and the *Salmonella* outbreak upon consumption of mixed salad vegetables unfortunately seem to be common (23). As mentioned in the earlier reports, besides the potential health offers from the fresh vegetables, the point of safety and the quality of vegetables is of clinical significance due to an array of disease outbreaks (23). The role of the opportunistic pathogens in vegetables contamination conferring the disease outbreak is also well known (26). The World Health Organization (WHO) has long before recognized foodborne illnesses as a major contributor of death, particularly in children (28). Along with WHO, the U.S. Food and Drug Administration (FDA), the U.S Department of Agriculture (USDA), and the Center for Disease Control and Prevention (CDC) suggested that the Good Agricultural practices (GAP) program in combination with the Hazard Analysis and Critical Control Point (HACCP) program would be the most effective means of ensuring food safety of produce at all stages (29).

PREVALENCE OF DRUG -RESISTANT PATHOGENS WITHIN THE VEGETABLES AND THE ASSOCIATED HEALTH IMPACT

Besides the clinical samples, an array of foods and environmental sources may disseminate the huge number of microorganisms that are deliberately resistant to one or more antimicrobial drugs targeted for medicinal usage or in the agriculture (30, 31). Indeed, the problems of anti-microbial resistance is already established globally problem including the cases of multi-drug resistance and the extensively drug resistance (31-33). Eventually, such rise in the drug resistance has greatly limited the spectrum of antibiotics available for the use as treatment of medical complications by the healthcare professionals which in

turn, often results in the usage of multiple drugs with high potency that are more expensive and may trigger the physiological side effects as well (34-37). It also affects the supportive care that the patient may receive and often increase the risk of death. As noticed from our previous research, the issue of drug resistance or the multi- drug resistance has been found to be very much conjoint within the pathogenic isolates from the vegetables (15, 29). As can be inferred from the previous researches, the widespread and indiscriminate use of antibiotics including the addition of antibiotics to livestock feed has led to the development of serious problems of resistance and hence limits the usefulness of antibiotics to eliminate bacterial infections (38). Dissemination of the antibiotic resistance genes (*sulII*, *tetG*, *tetC*, *tetA*, and *terM*) may be triggered even by planting in the manure-amended soils (38).

MICROBIOLOGICAL STUDY OF VEGETABLES IN BANGLADESH

Proliferation of microorganisms are very much likely (1) to edge the shelf life of vegetables; and (2) to spread and transmit diseases in humans and animals (15, 39). Several of our research reported huge contaminating bacteria (including the drug-resistant ones) among a range of vegetables (carrot, lettuce, cucumber, tomato, chilli, onion, capsicum and coriander) collected from different sources (8, 27, 39). This is to be added that together with our microbiological investigations focusing on the quality of vegetables, we have also introduced the concept and application of microbiological challenge tests (MCT) which goes a long way to unravel how the inoculum size, types of vegetables, and the other physicochemical factors may influence the growth and survival of bacterial pathogens within vegetables commonly consumed (15, 40, 41).

As stated earlier, the microbiological load of vegetables has continued to be an interesting research topic in both Bangladesh and abroad as it has proven itself as the cause of various outbreaks of food borne illnesses (42). Food and water has always been a common vehicle of transmission for infectious diseases, and recent research has identified them as the most important vehicles for the transmission of cholera (44). Although, parasites responsible for food borne diseases are not given that much importance in developing countries, due to the possibility of contamination of vegetables in the field, unhygienic practices or from the use of contaminated wash water (43). Studies conducted by Ali et. al. (43) have been able to identify around 2×10^4 to 2×10^7 cfu/g in raw vegetables in Dhaka city, among which *paratyphi A*, *Salmonella* and *Enterobacter* were most common. Nawas et al. (44) found counts of *Vibrio* spp. in salad vegetables from the restaurants of Chittagong ranging from 1.86×10^4

to 7.28×10^5 cfu/g. There were more than 1100 coliforms found in salad samples, among them *Salmonella* spp., *Vibriospp.* and *Proteus* spp. were more commonly identified (44). Other studies in Chittagong have identified viable bacterial colonies ranging from 2.5×10^3 to 3×10^6 cfu/g (42).

CONCLUSION

The rise in consumption and export of fruits and vegetables has contributed to the spread and rise of food-borne diseases. Several studies have been able to identify large numbers of bacteria and fungus in raw fruits and vegetables. A surpass perception on fruits and vegetables, microbiological invasion of those fresh foods together with the associated environmental triggers, the processing and handling factors of the food items, and the other factors facilitating the microbiological contamination may allocate the remedies to fight against the risk of contamination of these commonly consumed food items. Measures should be taken control the spread of these pathogens, which include removal of pathogen and introduction of key food safety skills among those who handle foods. A united approach to combating the spread of food-borne disease will have a lasting positive impact on consumer safety.

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