

# Vegetable Microbiology: Concern for Human Health



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## Opinion

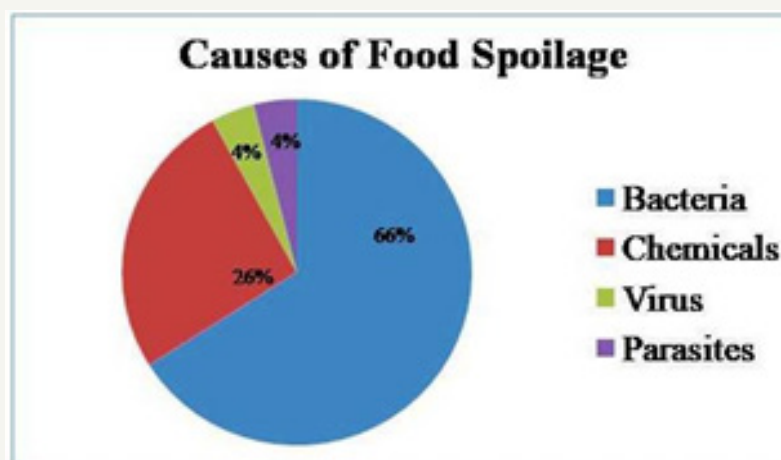


Figure 1: Causes of Food Spoilage.

In the health conscious society of 21st century, vegetables form an integral part of human diet. They provide us essential vitamins and minerals, dietary fiber, phytochemicals, and also help in reducing the risk of dangerous diseases [1]. World Health Organization (WHO), European Food Safety Authority (EFSA), Food & Agricultural Organization (FAO) and French Agency for Food Safety (AFSSA) recommended the intake of atleast five servings of vegetables and fruits per day [2]. In general, freshly consumed vegetables are considered to be more vital than the cooked ones. However, they are usually accompanied with many food borne diseases, thus poses safety threats [3]. Ready to Eat (RTE) vegetables, generally grown near the metropolitan cities are cultivated in unhygienic environments [4], irrigated with poor quality water [5], and fertilized using organic and inorganic amendments [6,7]. This all leads to microbial contamination and spread of infectious diseases like diarrhoea, Salmonellosis and Shigellosis etc. in humans. Bacteria are reported to be the major villain (Figure 1) among the causes of food borne illness [8]. Bacteria associated or isolated from different raw vegetables have been documented in article entitled "Recent Trends in Microbiological Safety of fruits and vegetables" by [9].

Extended list of microbial outbreaks that occurred through contaminated vegetables has been provided by [10] in their

excellent review on "Microbial contamination and behavior of enteropathogens in phyllosphere". Further, there are reports of microbial contamination of fresh vegetables above recommended thresholds in comparison to International standards, in different parts of the world [3-11]. Country wise list of RTE vegetables containing bacterial pathogens along with remedial measures have been listed by [12]. Comprehensive information on "Vegetable Microbiology" right from the sources of contamination to its consequences on human health is available in above mentioned literature [3-12].

After thorough study of available literature, author realized the importance of dissemination of knowledge pertaining to the subject, he named "Vegetable Microbiology". First of all, initiation of awareness programmes is the need of hour. The chain of programme must begin from farmers then to the sales person and finally towards the consumers. Special attention needs to be directed toward the source of contamination and its treatment [13,14]. This could be possible at farm level. Then next treatment i.e. thorough washing of vegetables with running water or with sanitizers or any other type of innovative treatments might be done at market level. Finally, awareness among consumers is also a major concern, particularly, among those who consume vegetables from their home gardens. Unknowingly, they are consuming microbial

strains along with fresh produce which results in the spread of infectious diseases. To minimize such risks of contamination, Good Agricultural Practices (GAP) and Good Manufacturing Practices

(GMP) must be followed at all points from the field to the fork [12] (Table 1).

**Table 1:** Vegetables reported with microbial contamination and their possible prevention.

Crop	Microbial Contamination	Methods for Prevention	Reference
Lettuce	Faecal <i>coliform</i>	Vinegar based washing	Woldetsadik et al. [5]
	<i>Helminth</i> parasitic infections.	Physical washing with running water	Woldetsadik et al. [5]
	<i>Escherichia coli</i> O157:H7		Buck et al. [9]
Ready to Eat (RTE) Vegetable Salads	<i>Escherichia coli</i>	Identifying and eliminating possible sources of contamination.	Mir et al. [3]
	<i>Listeria monocytogenes</i>	Modified Atmospheric storage and refrigeration to enhance shelf-life	Campos et al. [13]
	<i>Salmonella</i>		Pothakos et al. [14]
Carrot	Enterotoxigenic <i>E. coli</i>	<b>General Recommendations discussed</b>  1. Washing and Rinsing 2. Use of disinfectants and sanitizers 3. Chemical seed treatments for sprout seed including chlorine compounds (e.g., calcium and sodium hypochlorite), ethanol, etc. 4. Thermotherapy (Exposing seeds to temperatures of 57 to 60 °C for short periods (e.g., 10min)). 5. Use of Ionizing radiation 6. Seed Testing	Buck et al. [9]
Cauliflower	<i>Aeromonas</i>		
	<i>Salmonella</i>		
Cabbage	<i>Clostridium botulinum</i>		
	<i>Salmonella</i>		
Tomato	<i>Listeria monocytogenes</i>		
	<i>Salmonella</i>		
Cucumber	<i>Bacillus cereus</i>		
	<i>Listeria monocytogenes</i>		
Spinach	<i>Salmonella</i>		

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