

## **Effect of Climate Change on Food Safety and Quality: A Review**

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### **ABSTRACT**

*Climate change being a current global concern, has affected the food production systems and supply chain at varying magnitudes. Climate change can stimulate changes in the nature and occurrence of food safety hazards which can arise at various stages of the food chain, from initial production to consumption, and climate change may directly or indirectly affect their occurrence. Climate events play an important role in the presence of pathogens as warmer ambient temperature in combination with differences in eating behavior may contribute to the increased incidence of food borne diseases. Environmental factors also influence growth and development of fruits and vegetables.*

**Keywords:** *Climate change, Development, Growth, Safety hazards, Supply chain.*

### **I. INTRODUCTION**

Food production systems and supply chain have been effected by climate change at varying magnitudes [1]. Climate change not only affects crop production or food security [2], but has its impact on food safety, occurrence and prevalence of foodborne illness [3]. Climate related circumstances affect food safety through many pathways including: changed temperature and precipitation sequences, more intense extreme weather events, acidification and warming of oceans and changed pathways of complex contaminants. Pathogens, hazardous substances including chemicals of sewage, agricultural and industrial origin may contaminate soil, water, food, feed and agricultural land through extreme weather events such as floods and droughts arising more frequently as a result of climate change.

### **II. UNDERSTANDING IMPACT OF CLIMATE CHANGE**

Increasing radiative forcing of the earth as a result of greenhouse gas emission is expected to change temperature, precipitation, relative humidity and other factors related to climate change [4]. An average increase of 1.4 and 5.8 °C in air temperatures by the end of this century is expected according to the intergovernmental Panel [5]. In the near future, increasing air temperature may lead to more frequent extreme drought, flooding and intense heat waves [6]. Radiation leaving the Earth's surface is trapped by water vapour, CO<sub>2</sub> and small amounts of other gases resulting in greenhouse effect [5], infrared radiation being the major part of emanated energy from earth. Higher CO<sub>2</sub> levels indicate that more energy will be trapped in the atmosphere, leading to

global warming [7]. There has been approximately 35% increase in Carbon dioxide concentrations in the atmosphere since pre-industrial times to 2005 [8].

### **III. FOOD SAFETY IMPACTS OF CLIMATE CHANGE**

Growth, proliferation as well as transmission of pathogens are influenced by climate change [9]. Climate and weather events have an important part in the occurrence of pathogens as warmer temperature along with difference in eating behavior may lead to the foodborne part of higher incidence of enteric diseases [10]. Weeks of elevated ambient temperature may be preceded by higher enteric infections particularly salmonellosis and to a lesser extent campylobacteriosis [11]. Weather variables and pathogens on food in case of fresh produce have been statically related.

Viruses do not grow in foods and human gastroenteritis causing viruses have no relationship to ambient temperature [12]. Viral contamination of food occurs through three pathways: human sewage and faeces; infected food handlers; and animals for zoonotic viruses [13]. Therefore the most vulnerable foods are fresh fruits and vegetables, raw molluscan shellfish and ready-to-eat foods contaminated by handlers. Climate change may have influence on all these pathways.

#### **3.1 Mycotoxins and food safety**

Contaminated crop consumption is reason for human dietary exposure to mycotoxins. Products from animal consuming contaminated feed can lead to indirect exposure of humans to mycotoxins. Mycotoxins produce acute symptoms and death at higher doses but more significant to public health are low doses due to higher exposure level. Specific mycotoxins can be carcinogenic, cytotoxic, immunosuppressive, neurotoxic, estrogenic or having teratogenic activity, some more than one of these [14].

Toxigenic molds and their plant host interactions are affected by Temperature, humidity and precipitation. Specifically, unfavourable conditions to the host plant stimulate the fungi to proliferate more than under favourable conditions probably leading to higher mycotoxin production [15].

#### **3.2 Climate change and seafood safety**

Elevated/increased sea level, ocean acidification, warmer air and sea water temperatures are some of the effects of climate change. These changes have resulted in decreased biodiversity and ecosystem functions as well as reduced/impaired quality, quantity and food safety. The Intergovernmental Panel on Climate Change [16] estimated that by the end of 21st century: (a) concentration of CO<sub>2</sub> will be as high as 730-1020 ppm; (b) increase in mean surface temperature by 1.1-6.4 °C; (c) thermal warming, ice sheet and glacier melting will lead to sea-level rise of .18-.59 m; (d) .14-.35 units decrease in pH of seawater; (e) 50% decrease in atlantic ocean Meridional Overturning Circulation; (f) accelerated H<sub>2</sub>O cycle with higher precipitation in high latitudes and tropics, drier subtropics, and higher occurrence of extreme drought and floods. The variation of this magnitude in such short time has not occurred on earth in past several million years [17]. Anthropogenic climate changes will lead to several changes in the oceans and estuaries supporting fisheries. Changed timing and volume of fresh water entering the coaster oceans and ocean stratification increase are some of the major projections occurring as a consequence of warming of upper ocean and acceleration of water cycle [18].

### 3.3 Climate change and pathogens

Both global and local environments are affected by climate change as it has the capacity of increasing occurrence as well as spread of foodborne pathogens, either through emergence of new pathogens or through existing pathogen strains that are adaptive and having ability to spread and infect humans [19]. For example, sea surface temperature rise is strongly associated with increased disease occurrence related with vibrio species [20], change in salinity and pH, may cause pathogens to have different occurrence pattern and virulence through short or long-term adaptation [21].

### 3.4 Food safety hazards in dairy production associated with climate change

Susceptibility of animals to disease is directly or indirectly influenced by climate change. Living conditions of animals which are conducive to pathogens such as parasitic diseases (e.g. infestation/affection by nematodes and taenia), nutritional disorders, sunstroke or dehydration) are affected by climate change [22]. Every stage in the production chain is to be controlled to keep a check on safety hazards, particularly feed manufacturing and the farm conditions.

Increased incidents of animal disease as well as stress of cattle are related to global warming, both these directly affect production of milk. Higher temperatures as well as extreme weather events like drought and floods, may have direct effect on milk production and its quality as it directly relates to availability and quality of feed and water. In fact, occurrence of fungal mycotoxins on maize and wheat is associated with environmental conditions [23].

## **IV.EFFECT OF CLIMATE CHANGE ON POSTHARVEST QUALITY OF FRUITS AND VEGETABLES**

Capacity of air to absorb water vapour increases with elevated temperature, increasing the demand for water. Elevated evapotranspiration indices could lower or deplete soil water reservoir, inducing water stress in plants in dry season. Water stress not only decreases crop production but also hastens ripening of fruits [24]. Many aspects of global fruit and vegetable production are affected by change in concentration of Carbon dioxide (CO<sub>2</sub>), the most important greenhouse gas and ozone (O<sub>3</sub>) [25]. Environmental conditions effect fruit and vegetable growth and development [26]. High temperatures effect photosynthesis, respiration as well as levels of plant hormones, primary and secondary metabolites during development of fruits and vegetables. Germination of seeds can decrease or even be inhibited by elevated temperature, depending on species and stress level. Increase in temperature affects photosynthesis directly, causing alterations in sugars, organic acids, flavonoid content, firmness and antioxidant activity. Atmospheric carbon dioxide accumulation has lead to numerous postharvest quality changes in fruits and vegetables (common scab, tuber malformation, changes in reducing sugar content). In the scenario of changing climate farmers will need to find new ways to control pests. Pesticides, that are currently commonly used, could in fact be no longer appropriate to the new agricultural scenario.

## V. CONCLUSION

Understanding the impact of climate on mankind in the coming decades is of importance for human survival. There is an increasing concern of foodborne disease and seafood safety due to changing climate. It has an impact on occurrence and survival of pathogens in the dairy supply chain. Changes in climate affect temperature, carbon dioxide and ozone directly and growth and development of fruits and vegetables indirectly.

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