Review Article

Human health problems associated with current agricultural food production

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Scientific and technological developments in the agricultural sectors in the recent past has resulted in increased food production and at the same time led to certain public health concerns. Unseasonal rains at the time of harvest and improper post harvest technology often results in agricultural commodities being contaminated with certain fungi and results in the production of mycotoxins. Consumption of such commodities has resulted in human disease outbreaks. Naturally occurring toxins, inherently present in foods and either consumed as such or mixed up with grains, had been responsible for disease outbreaks. Other possible causes of health concern include the application of various agrochemicals such as pesticides and the use of antibiotics in aquaculture and veterinary practices. Foodborne pathogens entering the food chain during both traditional and organic agriculture pose a challenge to public health. Modern biotechnology, producing genetically modified foods, if not regulated appropriately could pose dangers to human health. Use of various integrated food management systems like the Hazard Analysis and critical control system approach for risk prevention, monitoring and control of food hazards are being emphasized with globalization to minimise the danger posed to human health from improper agricultural practices.

Key Words: food toxins, disease outbreaks, foodborne pathogens, agricultural production

INTRODUCTION

Health is the result of an interaction of factors at the individual, family, community, national and international levels. Several sectors or disciplines have the capability to act on a wide range of conditions determining health. These include agriculture, trade, food technology, and nutrition. Multisectoral actions in a coordinated manner would be a panacea to solve the problems.

Agriculture is essential for good health. There is a bidirectional link between agriculture and health, agriculture influences health and health influences agriculture. According to the Bangkok Charter for Health Promotion by the WHO which was enunciated in 2005, an integrated policy approach is essential if progress is to be made in addressing the determinants of health. In agriculture, the dual emergence of animal and human health concerns such as avian influenza and epidemics among agricultural communities as well as the human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) have heightened the need for integrated action with the health sector.[1]

Agriculture provides opportunities to improve as well as pose risks to health. The toll on human health that results form improper agricultural practices includes considerable economic losses such as the cost of mortality, productive capacity lost due to premature death and morbidity resulting from hospitalization and health care services, both public and private. Finally there is the intangible cost of pain, suffering, anxiety and reduction of the quality of life.[2]

A nation's food security depends on both an adequate food production in the country or food imports, and the creation of a system of entitlements that reliably enables each citizen to eat both on a regular basis and in emergencies without compromised food safety.

In this context, food safety assumes considerable significance. The objective of the current paper is to highlight the risk posed to human health arising from current agricultural food production practices.

Agricultural practices and mycotoxin health hazards

Aflatoxin contamination of food and disease outbreaks. Health hazards caused by the ingestion of foods contaminated with mycotoxins are one of the major outcomes of contaminated agricultural outputs, which are especially relevant for developing countries. Mycotoxins are secondary metabolites produced by fungi that may contaminate various cereals, millets, oilseeds, tree nuts, spices and other agricultural commodities.[3] Mycotoxins affect both human and animal health.

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Due to globalization and international trade, the impact of mycotoxin extends beyond local communities. Among mycotoxins, aflatoxins are most important.

They are a group of toxic secondary metabolites produced by *Aspergillus flavus and A.parasiticus* and found in maize, groundnut, cottonseed, black pepper, red chillies and milk. They can contaminate any stage of food production from pre harvest to storage whenever favourable conditions prevail. Factors that affect the production of aflatoxin include: climate, genotype, soil type, stress/ damage to crop, insect activity, unseasonal rains at harvest time, inadequate drying, and improper storage. A major outbreak of aflatoxic hepatitis occurred in India during 1974, subsequently in Kenya during 1981, 2004 and 2005 and in Malaysia in 1991. An outbreak due to aflatoxins occurred in Korea during the Second World War even before they were discovered in 1961. The disease that results manifests as severe, acute hepatotoxicity with a case fatality rate of 25%. [4]

Aflatoxin associated health effects pervade the developing world where the burden of disease is great. Over 5 billion people in developing countries are at risk of chronic exposure to aflatoxins through contaminated foods. Several studies in China have indicated that combined exposure to Hepatitis B Virus (HBV) and aflatoxins is associated with a much higher risk of hepatocellular carcinoma (HCC). Studies in Benin and Togo have shown an association between aflatoxin exposure and impaired growth in young children. In Ghana, higher levels of aflatoxin B1 albumin adduct in plasma were associated with lower percentages of certain leukocyte immunophenotypes. Studies in Gambian children found an association between serum albumin levels and reduced secretary immunoglobulin levels. EU countries control aflatoxins in food and animal feeds through stringent import restrictions.

Strategies for reducing aflatoxin exposure through agricultural and health interventions. Recently, a workgroup set up by the Centre for Disease Control, Atlanta, Georgia and the WHO suggested following agriculture interventions for the prevention or reduction of aflatoxin exposure at various stages of food production and preparation.[5]

These included, for pre harvest, time of planting, types of crops planted, genotype of seed planted, irrigation, insecticides and time of harvest. For post harvest drying and storage: hand sorting, drying on mats, sun drying, storing bags on pellets and the use of insecticides.

With regard to post harvest food preparation: hand sorting, winnowing, washing, crushing and dehulling, nixtamalization, acidification, chemoprotectant, and enteroabsorption

Public health strategies for the prevention or reduction of aflatoxin exposure include the formulation and implementation of awareness campaigns, analysis of food and biologic specimens, testing of aflatoxins in food and biological samples, the formulation and implementation of an early warning system designed to detect food contamination by making use of indicators from death of livestock or domestic animals and indicators from unseasonal rains during harvest season.

Deoxynivalenol contamination. Another mycotoxin of contemporary relevance is Deoxynivalenol produced in wheat, maize, and barley. It is found frequently in US, Canadian, European and Chinese wheat mostly associated with cool, wet growing and harvest seasons that favour the formation of scabs caused by *Fusarium graminearum.* Outbreaks had been reported from India, China and the USA. While the outbreaks in India and China occurred among the general population the outbreak in the USA had occurred in children in 17 schools in seven states who had consumed burritos as part of the school lunch programme. During that period, heavy contamination of deoxynivalenol was reported in wheat in several states in the USA. Deoxynivalenol toxicosis symptoms include nausea, vomiting and pain in the abdomen. No mortalities were reported. [6]

Ergot contamination and ergotism. Ergotism due to consumption of bread made of ergot rye had been ravaging Europe from the medieval years until recent times. However, after the advent of the green revolution, high yielding varieties of pearl millet in India and sorghum in the continents of America, Africa and Australia have been found to be susceptible to ergot. While ergot alkaloids in ergoty wheat and rye include the ergotamine group of alkaloids, those of pearl millet belong to the clavine group of alkaloids. These groups differ in chemical nature, biological effects in animals and clinical symptoms in humans.[3]

Fumonisin mycotoxins problems. Fumonisins have assumed as much toxicological significance as aflatoxins. Their presence have been observed most frequently in maize and sorghum. Consumption of mouldy sorghum contaminated with fumonisin resulted in human disease outbreak in India.[7] Symptoms included transient abdominal pain, barborygmy and diarrhoea. Consumption of fumonisin contaminated commodities has been associated with esophageal cancer incidence in human populations in China and various countries in Africa. It has also been hypothesized to cause neural tube defects such as anencephaly and spina bifida in southern Texas.

Presence of naturally occurring toxins in foods-the problem of lathyrism

Lathyrism is a crippling paralytic disease in humans, mostly found in India, Bangladesh, and Ethiopia. Earlier reports of the disease were also found in Spain and Germany and is attributed to the consumption of the legume *Lathyrus sativus* as a staple. In recent years due to changes in pattern of cultivation, newer varieties and decreased consumption, the incidence of lathyrism has somewhat reduced.

Problems with regard to the contamination of food crops with toxic weeds: Venoocclusive disease

An outbreak of venoocclusive disease occurred in India among populations who consumed millets, as staples, inadvertently contaminated with toxic seeds of the weed, *Crotalaria*. A similar outbreak was also reported in Afghanistan. The symptoms include pain in epigastrium and ascites leading to liver damage. *Crotalaria* often grows in

the same environment as millet and as a result its seeds often gets mixed with the food grain during harvesting. The toxic agent in the weeds belongs to the Pyrrolizidine alkaloids, which had caused the outbreak. During 0ctober 2003 in Solvenia, the consumption of imported buckwheat grain and flour contaminated with seeds of the poisonous plant *Datura stramonium* resulted in human illness. Agronomic practice of deweeding and post harvest methods of removing weed seeds by winnowing/sieving was suggested to minimize the problem.

Health concerns that relate to disease and pest control chemicals in agriculture

The increased usage of pesticides during agricultural operations leaves substantial pesticide residues in crops like vegetables and fruits. In some countries like India the pesticides are directly added to the grains during storage to ward off insects. Accidental consumption of seeds treated with pesticides had been responsible for several humans' deaths in different parts of the world.

The use of antimicrobials in livestock feeds represents a new food safety threat for human from agriculture. Antimicrobials such as tetracycline are added to the feeds and water of livestock, poultry and aquaculture to promote faster growth with less feed and to decrease disease driven losses. The emergence of antimicrobial resistant bacteria like *Salmonella typhimureum* and *Campylobacter* that lead to increased infections in hospitals is a problem in both the developed and developing countries.

Emerging problems with food borne bacterial and viral pathogens

Food borne bacterial pathogens continue to be a threat to human health. A massive botulism outbreak occurred in Thailand in 2006, when over 200 people were affected by symptoms such as gastroenteritis and paralysis ranging from bulbar palsies to quadraparesis. Affected patients required mechanical ventilation for respiratory depression and antitoxin. Home canned bamboo shoots were implicated. [8]

Outbreaks of human diseases associated with consumption of raw fruits and vegetables continues be a public health concern. The pathogens of concern are bacteria like: *Salmonella, Shigella, Escherichia coli, Campylobacter, Yersinia enterocolitica, Listeria onocytogenes, Staphylococcus aureus, Clostridium species, Bacillus cereus, and Vibrio* species, as well as viruses such as: Hepatitis A, Rotaviruses, Enteroviruses, Adenoviruses. Examples of parasites are: Giardia, *Entamoeba, Toxoplasma, Sarcocystis, Cryptosporium* and *Cyclospora.*

Health concerns of modern agriculture

Organic farming. Over the recent years, organic agriculture has gained popularity around the world and is considered as one of the best options for small farms. It is considered environmental friendly, less costly, yielding quicker returns on investments based on locally available resources and believed to yield a more natural and healthier food option. On the other hand the potential for contamination from various sources, especially bacterial and viral pathogens, exists. Thus the application of Good Agriculture Practices (GAP), Good Hygienic Practices (GHP) and the Hazard Analysis Critical Control Point system (HACCP) principles through the farm to table chain is emphasized to maintain the wholesomeness of organically grown food.

Recombinant DNA technology and genetically modified foods. Risk to human health from Genetically Modified (GM) foods is mainly related to toxicity, allergenicity and antibiotic resistance. The risk of toxicity may be directly related to the nature of the product whose synthesis is controlled by the transgene or the changes in metabolism and composition that result from the gene transfer. Most of the toxicity risks can be assessed using scientific methods. The introduction of newer proteins in transgenic crops from organisms, which have not been consumed in foods before, have the potential to become allergens. Health risk assessment of genetically modified organisms (GMOs) cultivated for food or feed is widely debated throughout the world, and very little data have been published on mid- or long-term toxicological studies with mammals. Two examples that heightened concerns for toxicity and the allergenicity potential of GM foods include the GM Maize event MON 863 and Bt toxin Cry 9C containing Starlink maize.

Transgenic maize MON863, approved by regulatory authorities in Europe in 2005, was recently re-analyzed independently. Data from a 90-day rat-feeding study, which formed the basis of European approval, indicated hepatorenal toxicity. It was concluded that longer experiments are essential in order to indicate the real nature and extent of the possible pathology and that with the existing data, it cannot be concluded that GM maize MON863 is a safe product.[9]

StarLink maize was genetically engineered by Aventis Crop Science to express an insecticidal Bt derived protein Cry9C. The US Environmental Protection Agency (EPA) had approved the registration of StarLink maize for restricted use as animal feed and not for human consumption, due to the presence of certain allergenic properties. The Centre for Disease Control in the USA found that 28 persons had experienced allergic reactions after the ingestion of taco shells made by Kraft foods that were found to have traces of Starlink maize. This resulted in a huge recall of the product from the market by the US Food and Drug Administration (FDA). This action resulted in the conduction of several studies to prove the safety of StarLink or otherwise, of the products. Sutton et al[10] proposed the Double Blind Placebo Controlled Food Challenge (DBPCFC) approach as the ultimate proof of the true allergenicity of Starlink or other transgenic proteins and found Starlink maize to be non allergenic. However Siruguri et al.[11] challenged the above study in view of the fact that raw Starlink maize was used in the study and not processed products. Sutton et al.[12] expressed the opinion that reliable methods of allergen predictability are not available and only "educated guesses concerning when and how a protein might be allergen" to be made. Double blind placebo controlled food challenges are the method of choice to prove allergenicity in individuals and thus is not the "ultimate proof". These two examples clearly indicate the possibility of health concerns arising from certain GM food events which were hastily approved or not

approved for human consumption and emphasize the need for further safety studies.

CONCLUSIONS

Public health concerns with regard to improper agriculture production systems are resulting in greater attempts to evolve effective food control systems in several countries of the world. Use of various integrated food management systems like the HACCP approach for the prevention, monitoring and control of food hazards are being emphasized by international organizations such as FAO/ WHO and the Codex Alimentarius Commission and are gaining increased acceptance worldwide. Unlike other quality control systems, the HACCP is a preventive system rather than end point testing.

The links between agriculture and health are increasingly recognized in the contemporary world and food safety is receiving increased attention. Improving food safety is an essential element of food security. Thus it is necessary that food safety forms an essential component of health based nutrition policies and nutrition education.

AUTHOR DISCLOSURES

Ramesh V Bhat, no conflicts of interest.

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