Recent Indian Studies on Food Toxins

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The toxins that may be contained in the foods that we consume can be considered to fall into two broad categories. There are toxins that are present in some foods in their natural state, e.g. Lathyrus sativus; there are others which are extraneous contaminants of food. These latter could be either toxin-producing micro-organisms or chemicals. Foods containing such toxins are health hazards.

There have been numerous outbreaks in the country, of large-scale acute or chronic diseases in humans and farm animals caused by food toxins[1,2]. Examples of major disease outbreaks caused by food toxins in our country during the last 25 years are: lathyrism, epidemic dropsy, venoocclusive disease[32], enteroergotism, aflatoxicosis, paralytic shell fish poisoning and bacterial food poisoning. The reported outbreaks during the last two decades may be a gross underestimate of the actual number of food poisoning episodes in the country.

During the present decade, several studies on food toxins had been carried out in India. These are important from the point of public health and national economy. The major research effort in the country during the current decade (1980-89) had been in the area of mycotoxins, the toxic metabolites produced by fungi, in contrast to the earlier periods during which major attention had been focused on naturally occurring toxins in foods[4]. In this communication, we refer to some recent outbreaks.

Recent Disease Outbreaks In Humans

1. Deoxynivalenol trichothecene mycotoxicosis in Kashmir valley: The widely reported outbreak of food-borne disease in humans in the Kashmir valley during the latter half of 1987, was identified as a distinct disease caused by consumption of mould-damaged wheat products. Epidemiological studies carried out in the community following on this outbreak, indicated that it was non-contagious, seasonal, and was related to consumption of contaminated wheat.

During the epidemic, the refined wheat flour that was available in the market was nonglutinous in nature and was popularly referred to as 'chewing gum' atta. The predominant symptoms of the disease were mild to moderate abdominal pain, a feeling of fullness of abdomen within 15 minutes to one hour of consuming the food, irritation of the throat and diarrhoe.

Samples of wheat, wheat products like refined or ordinary wheat flour (*maida* and *atta*), consumption of which was associated with the disease symptoms, were analysed in the laboratory. *Fusarium* moulds were isolated from almost all the samples. In addition, the presence of mould was confirmed by detection of ergosterol, a chemical component of mould. Trichothecene mycotoxins like deoxynivalenol were detected in nearly a fourth of the food samples; and acetyldeoxynivalenol in a few samples. The extracted toxins when fed to pups produced vomiting in all the animals. Thus epidemiological, clinical, analytical and toxicological evidences indicated that the food-borne disease was caused by the trichothecene mycotoxin, deoxynivalenol.

Deoxynivalenol was originally discovered in Japan and the U.S.A. during the early 1970s and was initially named vomitoxin because it elicited a vomiting response in farm animals like swine. In certain years high levels of deoxynivalenol in wheat were also observed in the U.S.A., Canada and Japan, synchronising with outbreaks of diseases in swine.

The sequence of events leading to the Kashmir outbreak as could be inferred from our epidemiological studies seemed to be as follows. During the 1987 wheat-harvesting season in the North-Western plains of Punjab, there were unseasonal rains and large quantities of wheat were damaged by rain. Such damaged wheat was purchased at a discount and mixed with good wheat to the extent of 50 percent and milled by millers of Srinagar for distribution to the nanwais, the local bakers. Consumption of local bread made from such contaminated wheat was clearly responsible for the disease outbreak which disappeared as soon as the supply of contaminated wheat was stopped[8].

A study of wheat, sorghum and animal feeds from different parts of India indicated that while over 200 normal samples of wheat and sorghum collected in unaffected regions were free from deoxynivalenol, 24 of the 48 samples of rain-affected wheat and its products were found to be positive for deoxynivalenol and other trichothecene mycotoxins. However, among the over 300 isolates of the fungus *Fusarium* from these commodities fortunately only nine isolates were found to be capable of producing deoxynivalenol under laboratory conditions.

2. Phycotoxins: fish poisoning in Bombay: Phycotoxins are toxic metabolites of the algae found in marine and fresh water environments. Algal blooms take place in certain areas during certain periods specially following ecological disturbances and concentration of polluted matter. Typical outbreaks such as paralytic shell fish poisoning had been reported in the past mostly from temperate waters. During the present decade, at least two outbreaks have been reported from India.

In one of the outbreaks at Kalpakkam in Tamil Nadu in 1981, children were reported to have died due to consumption of shell fish containing the toxins. The symptoms included gastrointestinal disturbances, tingling sensation in lips, tongue and fingertips, blurred vision and sensation of floating in the air. Another outbreak was reported from the Fisheries College, Mangalore in Kumble estuary in the West Coast, following the consumption of clams[13].

During December 1987, a food-borne disease presumably due to consumption of fish was also reported from four slums in the suburbs of Bombay. People of different age groups and both sexes, who consumed the fish caught in a particular pond were affected. The symptoms included pain in the abdomen, vomiting and diarrhoea, weakness and alternating sensation of heat and cold. The extracts from the fish *mystus seenghala* from the pond were found to be toxic to mice and phytotoxins were identified as the aetiological factor. The pond from which the fish were caught was in an ecologically disturbed state due to its reclamation and flow of industrial effluents and had thick algal blooms, specially of Oscillatoria sp[9].

Biological Effects of Aflatoxins

During the last three decades, considering

able work has been carried out on the biological effects of aflatoxins in normal as well as malnourished animals and their carcinogenicity in primates was proved for the first time[12,32]. During the last decade, work was extended mainly to investigate the biological effects of aflatoxins in farm animals. These studies carried out in the Veterinary Institutes of the Agricultural Universities at Mannuthy (Kerala), Tirupathi, Bangalore and Madras, had indicated that animals like crossbred Jersey cows, buffaloes, goats, pigs, as well as chicks were affected. Even at low levels, aflatoxins were found to decrease growth rate, produce fatty and haemorrhagic liver and cause several other changes including depression of immunological functions[3,17,19]. It was interesting to note that some of these harmful effects could be counteracted and the aflatoxin toxicity minimised by administration of thymine and folic acid[10].

Deoxynivalenol (DON): Short term studies in primates conducted at the National Institute of Nutrition by feeding DON at different levels, indicated that a minimum dose of 300 μg/kg body weight was needed to produce vomiting. On feeding a sub-emetic dose of 250 μg/kg body weight for a period of 35 days, a gradual decline in the body weight was observed. Haematological changes such as increase of leucocytes in the males were observed. Serum enzymes showed an increase in *LDH* values for females and decrease in *GOT* values for both males and females.

Risk assessment: In view of the well known biological effects of mycotoxins, fixing tolerance levels for mycotoxins in food has assumed practical importance in order to protect the health of consumers. Tolerance limit of 30 ppb aflatoxin in all foods has been fixed in India while the limits of 0-50 ppb has been fixed at the international level depending on the country and commodity. In a meeting held in 1988, the Codex Alimentarius Commission of the U.N. System suggested the stringent regulatory level of 5 ppb. Unfortunately, these levels are being suggested on arbitrary grounds like minimum detectable limits, economic and commercial interest of the country or biological effects in experimental animals.

A truly scientific criterion for suggesting safe limits must be based on a risk assessment study. Such an attempt was made at the National Institute of Nutrition recently for deoxynivalenol, one of the mycotoxins, as a possible model for other mycotoxins. The study was aimed at determining the actual level of deoxynivalenol responsible for the disease outbreak in humans based on the actual food consumption data obtained through a diet survey. The data so obtained were further corroborated by similar data calculated on the basis of natural outbreaks of DON mycotoxicosis in animals as well as results of experimental studies in pups and primates conducted at the National Institute of Nutrition, and on studies in other animals reported in recent literature. On the basis of this investigation, a tolerance level of 34 μg of DON in one kg of wheat/wheat products was suggested. This limit is more stringent than the limits of 1,000 μg/kg of DON in wheat suggested in Canada, somewhat similar to the limit suggested in the U.S.S.R., and more liberal than 5 μg/kg of DON fixed in Rumania.

Simple methods of detection: Internationally acceptable methods of detection and quantitation of environmental contaminants like aflatoxins are now available. However, most of these methods need an elaborate laboratory set-up. In order to ensure the observance of tolerance limits, it is essential that appropriate feasible methods within the competence of state-level food laboratories are developed.

A simple rapid, reliable method for detection of aflatoxins in food and feeds by Pressure Minicolumn (PMC) has been developed. The technique employs commonly available glass syringes which are tightly packed with certain adsorbents like silica gel, florisil and sodium sulphate. The presence of aflatoxins is observed as a compact bluish fluorescent band under long range UV light. Chemical confirmatory tests in the same column can also be performed. The technique has been found to be useful for aflatoxins in a variety of agricultural commodities as well as in oil cakes and poultry feed[22,24]. Similar technique has also been evolved for deoxynivalenol, sterigmatocystin and sanguinarine, an alkaloid used for detecting adulteration of edible oils with argemone oil[20,26].

Moulds are the principal microorganisms which spoil agricultural commodities. The determination of ergosterol, a component of the fungal cell wall, is a useful measure of fungal invasion. A rapid, highly sensitive and specific method for the determination of ergosterol in food grain contaminated with fungi has been evolved. The method involves simple iodination of ergosterol resulting in the formation of a highly fluorescent product which is determined fluorodensitometrically. The method is expected to find wide application for screening of food grains contaminated with fungi[23].

Economic Consequences

Case studies of the economic impact of a food-borne disease outbreak have been conducted at NIN, Hyderabad, and the cost of a food-borne disease outbreak to the family and the community was computed.

A study carried out in a poultry farm at the outskirts of Hyderabad during an outbreak of aflatoxicosis showed that over a three week period following exposure to aflatoxin in the diet, the egg production in the 11,000 layer poultry farm was down from an initial 90 percent level to 60 percent level. Soon after the withdrawal of the incriminating diet, the egg production started picking up but never reached the original level. During this period the economic cost in terms of reduced egg output, medication, non-utilisation of the contaminated feed, cost of feed analysis, etc., were calculated to be over Rs. 45,000. This amount is equal to about 10 percent of the initial cost of the establishment of the farm[6,25].

The EEC countries have enacted stringent regulations regarding aflatoxins in animal feeds. Although samples of all the agricultural commodities before export at the port of export are subjected to analysis of aflatoxins and if found to contain aflatoxins in excess of the stipulated levels are never exported, the importing countries discouraged imports from India, or when found to contain slightest traces of aflatoxin, buy them at a discount of even as high as 40 percent. Over a 10-year period the export of oilseed extractions of groundnut have declined from 550 metric tonnes to 265 metric tonnes resulting in the loss of foreign exchange. The export of groundnut kernels has declined from 130 metric tonnes (per annum) valued at Rs. 652 million during 1977-78 to a mere 20 metric tonnes in 1985-86[5].

Prevention and control: The strategies for prevention and control of

mycotoxins include: use of good agricultural practices to reduce or eliminate pre and post-harvest contamination by fungi and insects, use of proper water management and soil amendments, development of improved post-harvest practices like drying the produce to safe moisture level, improvement of storage structures at village level, markets and warehouses, application of chemicals to minimise fungal contamination, use of good transportation practices at various activities and enactment and implementation of legislature concerning mycotoxins.

During the late 1960s, the National Institute of Nutrition had pioneered studies on genetic approach of evolving varieties of groundnut which are resistant to aflatoxin formation[21]. These studies have been later extended and promising varieties of groundnut, maize, soyabean and sunflower which support least amount of aflatoxin have been identified[18]. However, due to locational and seasonal variations in aflatoxin production in these varieties, the most ideal varieties are yet to be identified. Despite this, the approach has been found to be basically sound and research efforts are still being continued in different parts of the world to locate the most appropriate varieties which will be least vulnerable to aflatoxins[16].

The prevention of formation of aflatoxin in groundnuts and maize of naturally occurring chemicals extracted from plants has received attention at the National Institute of Nutrition, Hyderabad, BARC, Bombay and the University of Bhagalpur. The plants that have been found to have chemicals which inhibit aflatoxin under laboratory conditions include onion[28], spices like turmeric and black pepper[14], and castor[29]. Certain phenolic compounds like tannic acid, O-vanillin and ferulic acid and substances like piperine and pepper oil have also been found to be active in minimising aflatoxins[11,15]. Under the aegis of the Joint ICAR-ICMR Panel on Mycotoxins, efforts are currently underway to explore the possibilities of extending these laboratory-based studies to the field level.

The approach of detoxification through industrial chemicals or sunlight advocated by the CFTRI, Mysore, had been further followed. Recent studies suggested that urea and sunlight can detoxify aflatoxin in groundnut flour and cake[27].

Concluding comments: The majority of the victims of food contamination arising from the consumption of spoiled and poorly stored foods are the poor, who are already undernourished because of limited access to food. It is at least to be expected that such food as the poor have access to is wholesome. The hazard to health posed by prevailing undernutrition in the poor should not be allowed to be further aggravated by food contamination.

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NUTRITION NEWS

The XXII Annual Meeting of the Nutrition Society of India will be held on November 10 and 11, 1989 at Trivandrum in Kerala. The scientific programme will include the following:

Special Lectures

- Energy metabolism in Indians by Dr. P.S. Shetty, Professor of Physiology, St. Johns Medical College, Bangalore.
- Chronic Calcific Pancreatitis (Pancreatic diabetes) – by Dr. V. Balakrishnan, Director & Professor of Gastroenterology, Medical College, Trivandrum.

Gopalan Oration by Prof. J.V.G.A. Durnin.

Symposium

- Women – Health and Nutrition
- Iodine in Human Nutrition

Young Scientists Awards.

Awards for best papers in *Community Nutrition* and *Experimental Nutrition* will be presented for scientists below 40 years of age.

Details may be obtained from Joint Secretary, Nutrition Society of India, National Institute of Nutrition, Hyderabad 500 007, Andhra Pradesh.

ICMR Awards

Dr. Kamala Krishnaswamy, Deputy Director, National Institute of Nutrition, Hyderabad, was awarded the Dr. Kamala Menon Medical Research Award of the Indian Council of Medical Research for her outstanding work on 'drug metabolism and disposition in human malnutrition'.

Dr. (Mrs.) P. Bhaskaram, Assistant Director, National Institute of Nutrition, Hyderabad, was awarded the Prof. B.K. Aikat Oration Award of the Indian Council of Medical Research for her comprehensive studies on measles. Her work was on 'nutritional status, biochemical parameters, morbidity, and immune response among children before the development of measles, during the illness, and in the post-measles period'.

Dr. S.G. Srikantia

Dr. S.G. Srikantia, former Director, National Institute of Nutrition, passed away early in the morning of the 6th of May. And India lost a highly talented, respected and versatile scientist. An outstanding scholar, a gifted teacher, a competent researcher and a loyal and trusted colleague, Srikantia was above all, a remarkable human being. A gentleman to the core, gentle, soft-spoken, kind and compassionate, he could be firm and unbending, when it came to upholding scientific standards or defending truth and justice. He was a person of rare personal and professional integrity, a man who shunned publicity and never sought honours.

Dr. Srikantia's solid contributions to nutrition research in India will remain indelibly etched into the history of nutrition research of his times. Through his personal example, he gave stature and credibility to nutrition research efforts in India. He represented in many ways the Golden Age of nutrition research in India – a period when nutrition research attracted to its fold the best biochemists, medical scientists and biologists in the country, and enjoyed great prestige and public support. Today, more than even before, with the increasing ascendancy of glamorous disciplines like molecular biology and biotechnology, when the very place of nutrition research in the hierarchy of biological sciences is being challenged, the nutrition scientists' fraternity in India needed for its inspiration and guidance a stalwart of the stature of Srikantia. His sudden demise at this juncture is indeed a greivous blow to nutrition science in India.

Dr. Srikantia was my close friend and colleague for over 37 years. I depended greatly on him and benefited much from his valuable advice and guidance and his abiding and steadfast loyalty, during all my years as Director, National Institute of Nutrition, and Director-General, Indian Council of Medical Research. In recent years, he has been a tower of support and strength to the Nutrition Foundation of India, and played a leading role in the formulation and implementation of many of its research projects and in the preparation of its scientific reports. Indeed Dr. Srikantia, in what perhaps was his very last letter, on the evening of the 5th of May, just a few hours before he retired for his fateful sleep, had offered me valuable comments and suggestions on a proposal for a major new study which we had earlier planned and discussed. The letter arrived several hours after the sad news!

The Nutrition Foundation of India, on behalf of its staff and all scientists collaborating in its several projects, pays its respectful homage and tribute to Dr. Srikantia and gratefully acknowledges the deep debt of gratitude it owes him. The Foundation's Special Publication 5, "Women and Nutrition in India", which is to be published shortly, is being dedicated to his memory.

C. Gopalan

FOUNDATION NEWS

Special Publication Series 5: 'Women and Nutrition in India'. This is a comprehensive and critical review of work done in the field of nutrition and related aspects concerning women, carried out in India over the last three decades – edited by C. Gopalan and Suminder Kaur.

Part I: Carries a critical review of available literature on the following aspects related to women and nutrition as listed below:

- General considerations – C. Gopalan
- Demographic aspects – K. Srinivasan
- Nutrient requirements of girls and women – B.S. Narasinga Rao
- Growth and development of girls and adult women – S.G. Srikantia
- Nutrition in pregnancy – Prema Ramachandran
- Lactation – Nutrition – Fertility interactions – Prema Ramachandran
- Nutritional disorders in girls and women – S.G. Srikantia
- Women and the health system – Saramma Mathai
- Socio-economic aspects – Meera Chatterjee.

Part II: Carries an extensive bibliography containing nearly a thousand references compiled by Suminder Kaur.

This book is expected to be a useful source material not only for students of nutrition science but also for planners and policy makers. The book is dedicated to the memory of Dr. S.G. Srikantia. The book is priced Rs.200 in India and $ 20 abroad (postage included).

Special Publications Series 2: 'Use of growth charts for promoting child nutrition — A review of global experience'— by C. Gopalan and Meera Chatterjee which had been out of print for some time, has now been reprinted on request. Limited number of copies are available at Rs.100 per copy in India and $ 10 abroad (postage included).

Scientific Report 10: 'Growth of affluent Indian girls during adolescence' has been published. Copies are available on request (unpriced).

Scientific Report 11: 'Studies on growth of affluent pre-school children – in seven different regions of India' is under publication.

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