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Possible Adverse Implications of Chemical Migration from Food Pack Materials in India

Senthil Kumar Kurunthachalam*

Department of Natural Sciences, Savannah State University, Savannah, GA 31404, USA

Abstract

India is fast developing large democratic country in South East Asia with more than 1.2 billion peoples with multitude of culture, language, lifestyle and food habits. The traditional culture in urban India started degrading with respect to life style and food habits (i.e., food preparation, inclusion of new food menu with effect to the modern and foreign culture). Intake of cocktail of chemicals and pathogens by general population is anticipated to increase in India. Considering those aforesaid facts, in this paper some major issues related to Indian modern food culture with special emphasis on chemical migration and food borne illness have been reviewed and highlighted.

Keywords: Indian food; Chemical migration; Plastics; Aluminum foil; Newspaper; Food coloring; Street food vendor; Food borne illness

Introduction

Food safety and toxicology is of great concern on the global terms due to unfair trade practices in quality and quantity. Food contamination refers the occurrence of toxic chemicals and microbial pathogens which could produce negative health implications to the humans. The impact of chemicals on consumer health is often apparent only after prolonged exposure at low levels. Chemical contaminants present in foods are often unaffected by temperature used for cooking. The scientific and public deliberates over the safety of chemical additives, contaminants, and adulterants, appearing in foodstuffs have been emphasized since long time. The common contaminants and food adulteration can be classified as intentional and non-intentional chemicals. The intentional category includes deliberately added chemicals like food additives and adulterant, the latter for the purpose of disguising inferior commodities and/or earning undue profits. The second group of non-intentional contaminants can come during production, processing, packaging and storage [1].

From India, intentional and non-intentional origin of food contamination can be defined as follows;

- Carrying home tea/coffee, hot curries which contains turmeric, alkaloids, spices, and oil fried dishes in plastic bags is very common in India.
- The deep fried or oven cooked meat (chicken, mutton and seafood), other vegetarian food been packed in aluminum foil with extreme hot conditions.
- Packing cooked food items directly in the used newspaper is most commonly seen practice. Besides, newspaper used as napkin in all parts of India.
- Due to rich culinary and diversity of food menu in India, usage of food coloring chemicals/dyes (e.g., azo-amines, coal tar and petroleum) not only in candy, ice-cream, pharmaceuticals, cosmetics but also several of coloring chemicals was added to different food ingredients such as turmeric, chilly, garam masala, ready to cook powders and also in Indian curries, tandoori chicken and kebabs in order to stimulate tasty buds of food hawkers.
- Canned foods contains environmental hormone Bisphenol-A (BPA). Usage of canned food increasing in India along with formation of BPA from the plastic bags during food to plastic reactions.
- New environmental chemicals such as Perfluorinated Organic Chemicals (PFCs) been coated in food wrapping materials and food cartons (e.g., wrapper paper and cartons for burgers, fried chicken etc.,) becoming a new source of chemical intake in to young Indian generation. Several of foreign food units (e.g., fast foods such as burgers, sandwich, rolls, noodles/spaghetti, Chinese food, Arabian food), invade India and the youngsters desire to eat foreign food rather than the Indian traditional food.
- In addition, additional chemicals such as pesticides and inorganic chemicals such as heavy metals already available in food and packing materials and their contribution to food contamination cannot be ruled out.
- Nevertheless, many of Indian foods (e.g., street food, Dhaba, restaurant as well as homemade food) contaminated with several species of bacteria and pathogens. Most tragic thing is next to street food, the railway food in India is point of major concern. Indian railway stations and bus terminals can be considered to be a hot spot region of human waste matter and multiple pathogenic bacteria, virus and fungi. The food vendors in railways stations and bus terminals used to cook food in the early hours and pack them in aluminum foil or plastic bags or with paper cartons and sell even after 10-12 hours after cooking.

The contamination of food is a major concern not only for developing countries but also for the entire world who adopt; selling

***Corresponding author:** Senthil Kumar Kurunthachalam, Department of Natural Sciences, Savannah State University, Savannah, GA 31404, USA, E-mail: kuruntha@gmail.com

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prepared and ready to eat food at places like street push carts, open street, bicycle, semi mobile (without any cover, especially near the sewage and garbage disposal area of crowded city), railway stations, bus terminals, school premises, Dhabas as well as fast street food vendors. In India it is estimated that about more than three million people are directly involved in street foods. Street food provides as a mean of livelihood for millions of people in the India with affordable price to the lower and middle income group [2]. It also serves as the only source food to millions of migrant workers in metropolitan cities. It has been often observed that these hawkers do not maintain proper hygienic conditions which lead to food poisoning to common consumers. Unless proper hygienic norms are adopted, the consumption of such foodstuffs from these hawkers may be a potential health hazard to the consumers.

Plastics

In India, concerns of the people suffering from gastric problem, renal/kidney problem, throat ailments, cancer in intestines, liver dysfunction and infertility rate is increasing at the alarming rate. The majority of these problems arise from those who eat hot foods carried in plastic bags [3,4]. More than hundreds of patients affected by polyvinyl chloride, polyethylene and polystyrene because of foods carried in plastic bags. Particularly, the patients had been consuming tea, coffee, milk, rice and curries carried in plastic bags. If a person eats food items carried in plastic bags for a long period, he or she is very likely to get serious health problems [5]. Because when hot food is packed in plastic, chemical exchange is maximized by high temperature. The most common food interactions are the migration of low molecular weight substances such as stabilizers, plasticizers, antioxidants and monomers from plastic packing materials. Particularly, plastic bags may cause chemical filtration of 3PA into the food which can cause cancer, heart diseases and reproductive problems [6]. In India usage of turmeric powder is enormous (in >90% of curries) and added in majority of cuisine. Corrosive nature of turmeric seems to react with the lighter plastics used for bags, making them sticky, slimy or have holes and therefore migration of chemicals to the food is likely. Similarly, most of the oils react and can break down the plastic, therefore it is advised to not to pack Indian food (especially liquid food such as tea/coffee, yogurt, spicy food like curries, kebabs and oil rick meat masala etc.,) in the plastic bags.

For example, drinking tea or any semi solid and liquid food packed in plastic cup makes peoples vulnerable to cancer because plastic can melt and release carcinogen agents into the food [3,4]. The reasons to avoid plastic when it comes to cooking and storing the food are for both environmental since plastic persist >1,000 to degrade and health reasons as it produce multitude of health problems. Another classical example that keeping food in freezer along with Ziploc bags and thawing them also influence chemical migration in to the food. Likewise, Styrofoam cup or otherwise basically it is plastic foam cup used in beverage industry such as coffee shops and restaurants. Hot coffee, tea with lemon of any form of acidic beverage can able to react with Styrofoam cup produce deep reaction and form even pits. For example, the hot water, lemon can react with Styrofoam or polystyrene and softened by lemon, an "acyclic terpene" that forms the principal constituent of lemon oil which considered to carcinogenic [7].

Aluminium foil

Aluminium foil can be used for storing foods in the refrigerator, avoid wrapping acidic foods in it. The acid from the food will gradually dissolve the surface of the aluminium foil causing small amounts of aluminium to migrate into the food. From one of the recent studies, leaching of aluminium from aluminum foil in different food solutions was studied. The results clearly indicate that the use of aluminium foil for cooking contributes to the daily intake of aluminium through the cooked foods. The amount of leaching was found to be high in acidic solutions, and even higher with the addition of spices [8]. The intake values from meat extract + tomato juice + citric acid + salt + spices cooked food were 537 mg/person. This value is also considered high and indicates a very high health risk to the consumers. The cause of this big increased leaching value is the presence of spices. In cooking process, people are used to add tomato paste, lemon juice, table salt, and other spices which cause more leaching of aluminium from the cook ware. Acidic nature of foods made up of vinegar, tomatoes, carrot, vegetables, fruits interact with the aluminium and erode the foil and trace amounts of aluminium can then migrate into the food and then aluminium salts such as white spots can form on these foods when their acidity reacts with the aluminium. Human bodies can excrete small amounts of aluminium very efficiently. An aluminium tolerable daily intake of 1 mg/kg body weight/day has been established by the World Health Organization (WHO) of the United Nation (UN) [9]. But unfortunately due to many reasons, most of us get exposed to and ingest more than what our bodies can handle [10]. Usage of aluminium vessel for cooking in India alone cause of major concern, in addition aluminium packed food and baking a chicken in oven with mixture of spices, vinegar, tomato paste becoming very common in India [11] and therefore study must be implemented to check the aluminium intake by general populations.

Newspaper

Recycled newspaper and board used in food packaging materials often causes migration of mineral oil into food at levels which are unacceptable according to present toxicological assessments [12]. Benzidine is a known carcinogen, and dyes derived from it are used in printing inks and paper. The dyes can leach chemicals when food packed and can metabolize into carcinogenic compounds [13]. A number of other ingredients and chemicals are also added to produce the newspaper ink [14]. These include dyes and pigments, which can be organic or inorganic in nature, as well as other additives such as paraffin or wax to help the newspaper ink dry faster. Mineral oils are commonly used in inks used in newspaper printing and if foods are packed in carton board prepared from recycled fibers then there may be the potential for them to migrate to the foods. Migration of selected ink components such as photo-initiators and plasticizers from printed food-packaging materials into foodstuffs also reported [14]. Even though inks and lacquers are applied to the outside of packaging materials, low molecular weight substances such as photo-initiators and plasticizers may permeate through the material and subsequently migrate to foods (refer http://www.food.gov.uk/multimedia/pdfs/proposedinksurvey.pdf). In recent years foods have been contaminated with Isopropylthioanthone (ITX) and Benzophenone which is used for newspaper printing. To ensure that any chemical migration does not pose a risk to consumer health the proposals with specific research on chemical migration from newspaper to food is warranted. Newspapers contained roughly 3,000 mg/kg mineral oil <n-C_{28}. These mineral oils fall into classes for which The Joint FAO/WHO Expert Committee on Food Additives (JECFA) established a tolerable daily intake of 0.01 mg/kg body weight. Using standard assumptions for calculating specific migration limits, a maximum tolerable concentration in food of 0.6 mg/kg is derived. This evaluation assumes highly refined white oils, whereas the oils found in recycled board are of technical quality and contain 15-25% aromatic compounds, predominantly with 1-3

aromatic rings [12]. Therefore further study is needed to understand intake of chemicals from newspaper or paper related stuffs,

Food dyes

We need color in food because all the senses contribute to the experience of eating. The impression food makes on us is a melange of sensations, and color and surface appearance are amongst the most important. Addition of a suitable color enhanced the appearance of fresh and process foods [15]. In some cuisines, color has played a more important part than others; for example saffron-colored rice and lurid red of tandoori chicken. Apart from natural color or turmeric (yellow), chilly (red), masala powders (red, pink and orange), food coloringis a chemical dye or pigment or substance that imparts color were added to Indian food or drink. For example, dye code like red #40, yellow #5 and yellow #6 alone make up 90% of the food dyes in the world market. Despite the food dyes usage in India started just three decades ago, use has gone up 5-fold to 20-fold in the past 10-15 years. Most artificial food colorings are a type of acid dye, and can be used to dye protein fibers and nylon with the addition of an acid. Food dyes are known to cause child hyperactivity and even attention deficit hyperactivity disorder (ADHD) [16,17]. Although past research showed no correlation between ADHD and food dyes [18] new studies reveals that synthetic preservatives and artificial coloring agents are considered to be an aggravating Attention Deficit Disorder (ADD) and ADHD symptoms in general populations [16,17]. Coloring agents also known to be potential hazards include annatto, cochineal and carmine (the products made from a beetle and petroleum). Artificial amines are included in food industry because biogenic amines are formed by the breakdown of proteins in foods. They can affect mental functioning, blood pressure, body temperature, and other physical functioning. Research suggests that about 70% of children with behavior problems are affected by salicylates, the artificial colors and preservatives. Artificial amines have also been associated with migraines and headaches, as well as other symptoms of food intolerance, including irritable bowel symptoms, eczema and depression. Food colorings linked to hyperactivity, asthma, and even cancer, has been detected in Indian chicken tikka masala. Random tests ordered by Trading Standards officers in Surrey suggest 57% of Indian restaurants in UK use "illegal and potentially dangerous" levels of dyes to give the sauce its distinctive orange-red hue [18]. Not only in tikka masala but also in latest Indian culinary such as tandoori chicken, chicken sagwala, chicken/mutton/fish kebab, gobi/mushroom/baby corn manchurian, in sweets and in curries and colorful (red, yellow, orange, pink, green and blue) menus dyes can be identified from the street vendors to the seven star grade hotels.

Several of the countries have prohibited the use of most of the synthetic dyes and permitted a limited number dyes under specific allowable limits. The number of allowable colors varied to some extent depending upon the country. In India, Rule 26 of The Prevention of Food Adulteration Act, 1954 (PFA) and The Prevention of Food Adulteration Rules, 1955 & 1999 permit following colors whether isolated from natural sources or produced synthetically in food items; Beta-carotene, Beta-apo-8' carotenal, Methylester of Beta-apo-8 carotenoic acid, Ethylester of Betaapo-8' carotenoic acid, Canthaxanthin, Chlorophyll, Riboflavin (Lactoflavin), Caramel, Annatto, Saffron, Curcumin (or temetic) (namely; Sunset Yellow FCF, Tartrazine, Ponceau 4R, Carmoisine, Erythrosine, Brilliant Blue FCF, Fast Green FCF and Indigocarmine) [15]. The maximum permissible level of food colors that can be added either individually or in blend form to different food is 100 µg/g (parts per million 'ppm') except in canned foods where the level of 200ppm is allowed. Studies have also shown that various non-permitted colors (Amaranth, Auramine, Blue VRS, Congo red, Fast Red E, Green S, Malachite Green, Metanil yellow) are being used in foods which are known to produce adverse effects in experimental animals [15]. Therefore stringent regulations should be made by the Rule 26 of The Prevention of Food Adulteration Act and Rules.

Bisphenol A and PFCs

Bisphenol A (BPA) a synthetic hormone used in canned foods. A new study has found that the majority of our exposure to dangerous BPA is through canned foods and as food preservatives [19]. Diethylhexyladipate (DEHA) is a plasticizer from plastic bottles and some cans lined with polycarbonate-tiny amounts of BPA are formed when polycarbonate bottles are washed with harsh detergents or bleach (e.g., sodium hypochlorite). Some food or drink cans may be lined with a lacquer to stop the food interacting with the tin however tiny amounts of BPA may be released. At high levels of exposure, BPA is potentially hazardous because it mimics the female hormone estrogens [6,7]. The studies also provided the BPA migrate from food package materials [20,21]. As it is discussed in earlier chapter that BPA can able to migrate from plastics, additional burden of BAP from canned or tin food is expected in Indians.

The new generation chemical that migrates from food packing materials to food is perfluorinated organic chemicals (PFCs). From the Canadian study in early 2000's PFCs have been detected in food stuffs [22]. High concentrations of PFCs can also be detected in raw food materials, food items as well as human blood which produce carcinogenic effect in rodents and monkeys [23]. The role of some food processing and packaging might play as a source of PFCs through the diet. From the research results in Spain and USA, it is sufficiently clear that cooking with non-stick cookware, or packaging some foods, could contribute to a higher human exposure to PFCs [24,25]. Clarke et al. [26] studied dietary intake estimate of PFOS and other PFCs in UK retail foods. Two of the representative studies revealed PFCs concentrations could migrate from the food pack materials [27,28]. Therefore PFCs is a new set of chemicals that enter in to Indians as fast food services from the western countries expand at rapid rate.

In food industry, fatal food additives needed to be avoided because processed foods lack nutrient density, meaning that many of the vitamins and minerals have been lost during processing. The following foods additives are additional food poisoning; phthalates are another synthetic hormone often found in canned foods. Phthalates are a chemical associated with endocrine disruption in animals and in some human studies. They are often found in personal care products as well as canned foods. Other major food additive is Mono Sorbitol Glutamate (MSG) which linked to the hormonal imbalances, weight gain, brain damage, obesity, and headaches, and it's still found in a surprising amount of foods. All foods are made up of hundreds of naturally occurring compounds that can have varying effects on us, depending on how much we eat and how sensitive we are. Toxic compounds like lectins and glycoalkaloids are naturally present in some vegetables like potatoes and legumes. Other toxic compounds like pesticides, heavy metals and toxins of fungal and bacterial origin could cause also contaminate food during manufacture, storage and transportation. It is estimated that 51% of food commodities are contaminated with pesticide residues in India [29]. The following chemicals are found in Indian food commodities; pesticides (organophosphates, antimony), radionuclide's, nitrites (food preservatives), toxic heavy

metals (cadmium, copper, lead, mercury, tin, and zinc), fluoride, sodium hydroxide, and Polychlorinatedbiphenyls (PCBs) and lead to food contamination as most of the chemicals may not affected with temperature.

Street food and food borne illness

Street food industry provides significant percentage of the total food intake of the millions of the peoples in India with the disadvantage is largely un-regulated which leads to health risk [2]. The following factors are of needed to be considered; all mobile street vendors use tap water for the cooking and other use, water is not available in vending site thus used sparingly, all mobile units offered take away service with newspaper/plastic used for the packaging material, only 30% of the vendors considered the food safety standards at the time of procurement and the storage practices for raw ingredients were found to be poor due to lack of awareness and knowledge and frequent heating and reheating of the food products by the food vendors also leads to food contamination. Food poisoning can cause fatal effects or even death to people who are at risk when eating street food. In recent days food poisoning epidemics in India is increasing. Food can transmit disease from person to person as well as serve as a growth medium for bacteria that can cause food poisoning.

Bhelpuri and Panipuri is very popular street food in India which is consumed by large amount of population of different age groups. In this particular regard, the microbiological quality of Panipuri sold in Amravati, India was studied [2]. Forty water sample of Panipuri were aseptically collected from eleven locations of Amravati City. Analysis of the food samples revealed that 93% of Panipuri water samples had high loads of bacterial pathogens such as *Escherichia coli* (41%), *Staphylococcus aureus* (31%), *Klebsiella* sp. (20%), *Pseudomonas* sp. (5%) and yeast (3%). It is suggested that regular monitoring of the quality of street foods must be practiced to avoid any food-borne infection in future [2]. All these bacterial and yeast are responsible for the food borne and diarrheal diseases in India. The Local Government and the ministry should consider establishment of adequate facilities and utility services as well as provision of necessary information, education and training programs for vendors and consumers. The study also shows the need for more respect of Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) to reduce street foods contamination.

Many factors contribute to human health concerns in the South East Asian Region, including inadequate access to clean water, the increased use of pesticides and other chemicals in agriculture and food processing, and the lack of producer and consumer education [30]. The rapid urban population growth in India means that many people live in conditions of extreme poverty, filth, overcrowding, and poor sanitation. That has also aggravated food safety problems. The quality of food inspection programs, including retail inspections, is in consistent around the region. Many countries, like India, lack critical enforcement of health and food safety regulations against street food vendors due to a shortage of health inspectors. In most countries of the South East Asian Region, laboratories with the capacity to detect common food borne hazards are rare, and where they do exist, the high cost of testing is an obstacle. In countries that have a regulatory framework for monitoring food control, enforcement is often weak, owing to inadequate infrastructure and staffing [31].

Food safety challenges

In order to overcome the food safety challenges, we need to know all types of pathogens and chemicals causing food safety hazards. Identification of emerging food hazards and contaminants and to develop, validate and apply of innovative methods for detection and control of pathogens and chemicals responsible for food-borne illness. Risk assessment and risk management in food safety should be established. What is the most cost-effective point to intervene in the food supply chain needs to be adopted. There is a considerable scope for improving the hygienic conditions for the food vendors. This standard provides guidelines with respect minimum check points which if exercised would ensure a safe food to the common consumer. Indian Standards Food Hygiene (IS 2491: 2005) on the subject as a code of practice and Hygienic conditions for food hawkers (IS 10971: 1984) have been published for the guidance for the users which would help at some extent as well.

Nevertheless, there is significant increase of awareness about the food safety in India. A Food Safety and Standards Bill, 2006 has been introduced to regulate the sector and a Food Safety and Standards Authority of India has been setup under the Ministry of Health and Family Welfare [31]. A number of new tools for risk assessment and tracking of the contaminants and the source of the food are being developed. These include early methods for detection, identification and software's. Problems of the food material being procured from store and street vendors needs further attention as it is difficult to trace back the origin of food material from such places. There is a strong need of collaboration between food industry, academia and regulatory authorities to setup a comprehensive food safety system in the country to enable the country to compete qualitatively in the international food market. Also strengthen domestic food safety standards and require imported food producers to meet food safety standards equivalent to those required for domestically produced food. Harmonize existing status to provide recall, civil penalty and other authorities to all federal food safety activities. Invest adequate resources to develop information systems that provide public health officials with the necessary information to develop sound food safety policy. Increase funding for new and existing systems for chemical hazard surveillance and food borne illness [31].

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