Impact of Nutrition on Human Health: A Study of Increasing Consumption of Processed Food in India

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Abstract

Proper nutrition offers one of the most effective and least costly ways to decrease the burden of many diseases and their associated risk factors.Processed foods/ Fast foods are those which have been altered from their natural state, either for safety reasons or for convenience. The set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans is called food processing. Processed foods have many benefits including improved taste, prolonged self life and availability of product throughout the year. But some ultra processed food also imposed some detrimental health risks to consumers like obesity, diabetes, cardiovascular diseases etc. Even some of the food additives added to food to preserve flavor or enhance its taste are carcinogenic. So we should try to avoid ultra processed food and should give more stress on unprocessed or minimally processed foods. Government and health authorities should also promote the healthy eating habits by regulating the excessive use of food preservatives/food additives.

Keywords: Human Health, Processed foods, Fast food outlets

Introduction

The attainment of good nutrition depends on and encompasses the entire food supply. Plant and animal foods and their various components are the primary vehicles that provide nourishment to human beings. Nutrition is vital, not only in the growth and development of humans and animals but also in the prevention and treatment of disease.Fast food is a term given to food that can be prepared and served very quickly. While any meal with low preparation time can be considered to be fast food typically the term refers to food sold in a restaurant or store with low quality preparation and served to the customer in a packaged form for take-out/ take away. Trans fats which are commonly found in fast food have been shown in many tests to have a negative health effects on the body. The fast food consumption has been shown to increase calorie intake, promote weight gain and elevate risk for diabetes. Originally, foods were grown and eaten directly from a relatively unpolluted Earth. Wild foods were sought and gathered. Cleaner oceans, lakes and rivers fed us nutritious fish. Animals in the wild provide protein foods to hunters and their tribes. As the human population multiplied, the world expanded, farming progressed, trade specialties developed, and town markets shared a variety of goods among a diversity of people. Techniques for food preparation and preservation, such as pickling, salting, and smoking, were developed to deal with the new problems of storage, waste, and food-borne illnesses. With advanced technology, our modern food industry's reliance on processing and additives continues to increase (Haas, 2004). So in this way **processed foods** come into existence. They have been altered from their natural state, either for safety reasons or for convenience. The set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans is called **food processing**. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life food products. Similar processes are used to produce animal feed. The methods

used for processing foods include canning, freezing, refrigeration, dehydration and aseptic processing etc.

India is world's second largest producer of food next to china and has potential of being the biggest with its food and agricultural sector. The food processing industry is one of the largest industries in India and it is ranked 5th in term of production, consumption, export and expected growth. The food industry is on a high as Indians continue to have a feast and large disposable incomes (Harchekar, 2008). As per ministry of food processing, Government of India, food processing industry consist of following segments:

Table 1. Segments of food processing industry

Segments	**Products**
Dairy	Whole milk powder, skimmed milk powder, condensed milk, ice cream, butter and ghee, cheese.
Fruits and Vegetables	Beverages, juices, concentrates, pulps, slices, frozen & dehydrated products, potato wafers/chips, etc
Grains and Cereals	Flour, bakeries, starch glucose, cornflakes, malted foods, vermicelli, beer and malt extracts, grain based alcohol
Fisheries	Frozen & canned products mainly in fresh form
Meat and Poultry	Frozen and packed - mainly in fresh form, Egg Powder
Consumer Foods	Snack food, namkeens, biscuits, ready to eat food, alcoholic

In present scenario, food processing is used as a major way to enhance human nutrition. It improves global food security by enhancing the nutritional composition of foods and its availability to expanding population of world. On industrial scale, environment friendly advance techniques with minimal loss of bioactivities are highly desirable for the food processing in foods industries. Human health will be benefitted by processed food products that meet food safety regulations. The present need of time is to meet the challenge of food security and availability of food that is not only for feeding purpose but also rich in nutrition, because it is associated with well development of human resources in any country and it directly affects their contributions to the world (Satyanarayana et al., 2012).

Food processing increases seasonal availability of many foods, often improve the taste of food significantly, enables transportation of delicate perishable foods across long distances and makes many kinds of foods safe to eat by de-activating spoilage and pathogenic micro-organisms. Processed foods are usually less susceptible to early spoilage than fresh foods there by reducing the incidence of food borne disease. Processed food freed people from the large amount of time involved in preparing and cooking "natural" unprocessed foods. Modern food processing also improves the quality of life for people with allergies, diabetics, and other people who cannot consume some common raw food elements (Laudan, 2010).

On the other hand, nearly every food preparation process reduces the amount of nutrients in food. In particular, processes that expose foods to high levels of heat, light, and/or oxygen cause the greatest nutrient loss. Nutrients can also be "washed out" of foods by fluids that are introduced during a cooking process. For example, boiling a potato can cause much of the potato's B and C vitamins to migrate to the boiling water. Similar losses also occur when you broil, roast, or fry in oil, and then drain off the drippings (Table 2).

Table 2: Loss of nutrients in processed food as compared to raw food (Source: USDA Table of Nutrient Retention Factors (2003))

Vitamins	**Freeze**	**Dry**	**Cook**	**Cook+Drain**	**Reheat**
Vitamin A	5%	50%	25%	35%	10%
Retinol Activity Equivalent	5%	50%	25%	35%	10%
Alpha Carotene	5%	50%	25%	35%	10%
Beta Carotene	5%	50%	25%	35%	10%
Beta Cryptoxanthin	5%	50%	25%	35%	10%
Lycopene	5%	50%	25%	35%	10%
Lutein+Zeaxanthin	5%	50%	25%	35%	10%
Vitamin C	30%	80%	50%	75%	50%
Thiamin	5%	30%	55%	70%	40%
Riboflavin	0%	10%	25%	45%	5%
Niacin	0%	10%	40%	55%	5%
Vitamin B6	0%	10%	50%	65%	45%
Folate	5%	50%	70%	75%	30%
Food Folate	5%	50%	70%	75%	30%
Folic Acid	5%	50%	70%	75%	30%
Vitamin B12	0%	0%	45%	50%	45%
Minerals	**Freeze**	**Dry**	**Cook**	**Cook+Drain**	**Reheat**
Calcium	5%	0%	20%	25%	0%
Iron	0%	0%	35%	40%	0%
Magnesium	0%	0%	25%	40%	0%
Phosphorus	0%	0%	25%	35%	0%
Potassium	10%	0%	30%	70%	0%
Sodium	0%	0%	25%	55%	0%
Zinc	0%	0%	25%	25%	0%
Copper	10%	0%	40%	45%	0%

Groups of food depending upon the type/extent of processing:

New classification of food has been proposed by Monteiro et al. (2010) according to the extent and purpose of the industrial processing applied to food. Food stuffs have been divided into three main groups:

Group 1 (Unprocessed or Minimally Processed Foods): 42.5% food come under group 1 which include mostly rice and beans and meat and milk.

Group 2 (Processed Culinary and Food Industry Ingredients): 37.5% food come under group 2 which include mostly vegetable oils, sugar, and flours.

Group 3 (Ultra-Processed/ ready to eat Food Products): 20% food come under group 3 which include mostly breads, biscuits, sweets, soft drinks, and sausages. The share of group 3 foods increased with income, and represented almost one third of all calories in higher income households.

Implication of Proceeded Foods in human health:

Obesity and processed food: Fast food has become a prominent feature of the diet of children in the United States and, increasingly, throughout the world. Fast food consumption was associated with a diet high in energy and energy density and low in essential micronutrient density. Frequent fast food consumption may contribute to weight gain (Bowman et al., 2004). A survey was conducted by Bowman and Vinyard (2004) on Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. It was observed that at least one in four adults reported eating fast food. Fast food provided more than one-third of the day's energy, total fat and saturated fat; and was high in energy density. Negligible amounts of milk and fruits, but substantially large amounts of non-diet carbonated soft drinks were reported consumed at fast food places. Adults who reported eating fast food on at least one survey day had higher mean body mass index values than those who did not eat fast food on both survey days.

The American diet is said to be increasingly energy-rich but nutrient-poor. To help improve the nutrient-to-energy ratio, the 2005 Dietary Guidelines for Americans recommend that consumers replace some foods in their diets with more nutrient-dense options. Such dietary guidance presupposes the existence of a nutrient density standard. However, it was observed that the concept of a nutritious food is not based on any consistent standards or criteria. Usually the healthy foods are defined by the absence of problematic ingredients like fat, sugar, and sodium etc. rather than by the presence of any beneficial nutrients they might contain. The naturally nutrient rich (NNR) score, which is based on mean percentage daily values (DVs) for 14 nutrients in 2000 kcal food, can be used to assign nutrient density values to foods within and across food groups. Use of the NNR score allows consumers to identify and select nutrient-dense foods while permitting some flexibility where the discretionary calories are concerned. This approach has implications for food labeling, nutritional policy making, and consumer education. Nutrient claim of any processed food has been considered by the Food and Drug Administration based on the ratio of a beneficial nutrient to the food's energy content, as opposed to a specified minimum amount of a nutrient per serving size (Drewnowski, 2005).

To reduce the risk of obesity in case of children WHO recommended the consumption of a diet rich in micronutrients but with a relatively-low energy density. Dietary behaviour is strongly influenced by the dietary environment, shaped by food supplies, investment policies and advertising. Substantial resources have been invested in food production of a sort that does not promote better health; agriculture and food supply sectors have benefited from decades of public-sector support, but this practice has encouraged the production of meat, dairy, oils and sugar and the withdrawal from sale of fruit, vegetables and fish. The result is an 'obesogenic economy', i.e. a market economy that encourages weight gain, in which children are a prime target (Lobstein, 2008).

Further Bowman et al. (2004) studied the Effects of fast-food consumption on energy intake and diet quality among children in United States.On a typical day, 30.3% of the total sample reported consuming fast food. Fast-food consumption was highly prevalent in genders, all racial/ethnic groups, and all regions of the country. Children who ate fast food, compared with those who did not, consumed more total energy (187 kcal; 95% confidence interval [CI]: 109-265), more energy per gram of food (0.29 kcal/g; 95% CI: 0.25-0.33), more total fat (9 g; 95% CI: 5.0-13.0), more total carbohydrate (24 g; 95% CI: 12.6-35.4), more added sugars (26 g; 95% CI: 18.2-34.6), more sugar-sweetened beverages (228 g; 95% CI: 184-272), less fiber (-1.1 g; 95% CI: -1.8 to -0.4), less milk (-65 g; 95% CI: -95 to -30), and fewer fruits and nonstarchy vegetables (-45 g; 95% CI: -58.6 to -31.4). So consumption of fast food among children seems to have an adverse effect on dietary quality in ways that reasonably could increase risk for obesity.

In a study on Mexican children aged between 1 to 4 years, it was observed that processed food promote malnutrition among children (González-Castell, 2007). [1] The foods consumed by Mexican children was categorised into three groups according to the preparation process and temporality: a) Processed Modern Foods (PMF), b) Processed Traditional Foods (PTF) and c) Non-Processed Foods. The contribution of PMF and PTF was as follows, respectively: Energy: 17%, 31%; total protein: 14%, 25%; non-animal protein: 10%, 10%; animal protein: 17%, 34%; carbohydrates: 18%, 26%; fiber: 4%, 5%; total fat 15%, 41%; saturated fat 16%, 52%; and cholesterol 7%, 7%. The contribution of PF to the diets of Mexican children accounts for >39% of energy, total protein, animal protein, carbohydrates and fat.

Kant and Schatzkin (1994) examined the association of consumption of foods from the fats, sweets, and the alcohol group ("other group) with nutrient profiles. Nearly one-third of total daily energy intake was contributed by foods from the "other" category. As the proportion of daily energy intake from "other" foods increased, total daily energy intake also increased, as did the percent energy from carbohydrate and alcohol. However, percent energy from fat and protein, intake of all examined micronutrients (except vitamin E), nutrient density, and the proportion of the population meeting the RDA of various nutrients declined with increasing intake of "other" foods. So the consumption of foods from the "other" group displaced nutrient-dense foods from the diets of respondents.

In another survey conducted in Brazil (2002-3), it was observed that over the last three decades, the household consumption of Group 1 and Group 2 foods has been steadily replaced by consumption of Group 3 ultra-processed food products, both overall and in lower- and upper-income groups. Group 3 items represented more than one-quarter of total energy (more than one-third for higher-income households). The overall nutrient profile of Group 3 items, compared with that of Group 1 and Group 2 items, revealed more added sugar, more saturated fat, more sodium, less fibre and much higher energy density (Monteiro et al., 2011). The high energy density and the unfavourable nutrition profiling of ultra-processed food products (Group 3) induce obesity and other potential harmful effects in adult as well as children.

High heat processed foods promotes risk for various diseases

Diet based on high-heat-treated foods including pizzas and cake etc. promotes risk factors for diabetes mellitus and cardiovascular diseases. The modern Western lifestyle is characterized by the consumption of high-heat-treated foods because of their characteristic taste and flavour. However, it has been shown that treating food at high temperatures can generate potentially harmful compounds that promote inflammation and cardiovascular disease in subjects with diabetes. A study conducted by Birlouez-Aragon et al. (2010) on group of individuals who were feed on two diets one that was based on mild steam cooking and another that was based on high-temperature cooking. These 2 diets differed mainly in their contents of Maillard reaction products (MRPs). The Maillard reaction is any reaction between a reducing carbohydrate and an amino acid and occurs in foods during storage and heat treatment, with the rate and diversity of chemical reactions accelerating as the temperature increases. Maillard reaction products (MRPs) are chemically highly diverse and comprise taste- and flavor-active molecules and health-beneficial compounds (Millard, 1912; Lindenmeier et al., 2002; Rufian-Henares & Morales, 2007). In addition to this other carcinogens are also generated such as acrylamide or heterocyclic amines (Jagerstad& Skog, 2005; Slayne&Linebak, 2005; Cheng et al., 2006).

MRPs were assessed in the diet and in subjects' feces, blood, and urine samples, with Ne-carboxymethyllysine as an indicator of MRPs. Biological indicators of glucose and lipid metabolism as well as oxidative stress were analyzed in subjects. It was observed that in comparison with the steamed diet, high-heat-treated diet induced significantly lower insulin sensitivity and concentrations of plasma cholesterol and triglycerides increased. So diet based on high-heat-treated foods increases risk of type 2 diabetes and cardiovascular diseases in healthy people. Further high content of sodium

in processed foods like processed meat (18%), bread and bakery products (13%), dairy products (12%), and sauces and spreads (11%) promote the cardiovascular diseases (Mhurchu et al., 2011).

Health Implications of Furan, acrylamide and other hazardous chemicals in heat processed food:

Furan and acrylamide are two important carcinogens found in diet consist of high heat processed food products. **Furan** is small cyclic ether with aromatic character and a low boiling point of 31^{o}C. Furan was reported in number of foods with highest level being present in coffee. It was reported to be present mainly in high heat processed food. They are generally formed by thermal degradation of carbohydrates (Yaylayan et al., 2003), ascorbic acid (Perez Locas&Yaylayan, 2004) or unsaturated fatty acids (Becalski& Seaman, 2005; Mark et al., 2006). Furan is carcinogenic in rats and mice and has been classified as 'possibly carcinogenic to humans' (International Agency for Research on Cancer 1995). Carcinogenicity of Furan is probably attributable to its genotoxic mechanism' (EFSA, 2004). Other possible dietary sources of furan include canned meats, malts (16-195 µg/kg), gravies (13-174 µg/kg), caramels (220-400 µg/kg) and soy sauce (17-90 µg/kg) (Maga, 1979; Crews & Castle, 2007).

Furan causes loss of ATP after bioactivation to metabolites which cause an irreversible uncoupling of hepatic mitochondrial oxidative phosphorylation, this activates cytotoxic enzymes, including endonucleases that produce DNA double-strand breaks prior to cell death (Kedderis&Ploch, 1999).
Acrylamide has been found in certain foods that have been cooked and processed at high temperatures (roasted, fried, grilled, and baked food products), and the levels of acrylamide increase with the time of heating. However, the mechanisms of formation of acrylamide in food are poorly understood. A few studies suggested that temperature and duration of heat processing are important factors. Acrylamide levels rise very strongly with time when potato chips are fried. Similarly, a 10 to 20-fold increase in acrylamide levels has been reported between cooked and over-cooked fried potatoes. In contrast, acrylamide formation has not been demonstrated at temperatures below 120°C. Further studies suggested that there exist a link between Maillard reaction (high heating of food products) and formation of acrylamide (Bagriantseva et al., 2010; Food Safety consultations, Report of Joint FAO/WHO Consultation, 2002).

The recent discovery of the formation of acrylamide in certain high heat-treated foods, domestically or industrially, has raised considerable concern, since acrylamide, besides neurotoxicity and reproductive toxicity, is considered as genotoxic carcinogen. As acrylamide is genotoxic, it may induce heritable damage. It induces chromosomal aberrations, micronuclei, sister chromatid exchanges (SCE), polyploidy, aneuploidy and other mitotic disturbances (e.g. C-mitosis) in mammalian cells (Tritsche, 2003)

Acrylamide also show carcinogenic potency in rats that is similar to that of other carcinogens in food, but the intake levels for acrylamide are likely to be higher. For humans, the relative potencies of cancer-causing agents in food are not known. Only limited human population data are available for acrylamide and these provide no evidence of cancer risk from occupational exposure. All such studies have limited power to detect small increases in tumour incidence (Crump, 2000; Park et al., 2002).
Acrylamides are neurotoxic and also effect fertility in case of animals. Animal studies demonstrate that acrylamide damages the testes and adversely affects fertility. Acrylamide is genotoxic *in vivo* in somatic cells and germ cells, and therefore has the potential to induce heritable damage at gene and chromosome level. Neurotoxicity is the only recognized adverse effect of oral acrylamide exposure in humans. Single exposures to large doses of acrylamide to humans and animals induce changes in the central nervous system while prolonged exposure to low levels result in peripheral neuropathy in the presence or absence of central nervous system involvement (Tyl et al., 2000).
Currently, adequate dose–response relationships and mechanistic information regarding carcinogenicity of acrylamide are lacking. Once this information becomes available, the health risk from acrylamide exposure through food can be assessed. In addition to acrylamide, another harmful

compound named **3-monochloropropanediol (3-MCPD)** is also produced in high heat processed food products. 3-MCPD is formed in a variety of industrially and domestically produced foods in the presence of fat and chloride. 3-MCPD is considered a non-genotoxic carcinogen, hence a threshold of effect is assumed and sufficient data are available to establish a safe level of intake (Tritscher, 2003).

Heterocyclic amines (HCAs) and Polycyclic aromatic hydrocarbons (PAHs) constitute another important class of carcinogenic chemicals which are found in Indian home cooked and commercially available meat foods (Zaidi &Rawat, 2011). Grilling of meats is a popular cooking method, primarily because of the wonderful taste it imparts on meats. It can also be a healthy alternative to other cooking methods, because some of the meat's saturated fat content is reduced by the grilling process. However, grilling also presents a health risk as it induces the formation of **HCAs and PAHs**. HCAs form when a meat is directly exposed to a flame or very high-temperature surface. The creatine-rich meat juices react with the heat to form various HCAs, including amino-imidazo-quinolines, amino-imidazo-quinoxalines, amino-imidazo-pyridines, and aminocarbolines. HCAs have been shown to cause DNA mutation, and may be a factor in the development of certain cancers. PAHs form in smoke that's produced when fat from the meat ignites or drips on the hot coals of the grill. Various PAHs present in the resulting smoke, including benzopyrene and dibenzo[anthracene, adhere to the outside surface of the grilled meat. PAH exposure is also believed to be linked to certain cancers.

Genotoxicity of Heat processed foods:

Heat processed food contain large number of compounds which are genotoxic like acrylamide, Furan, 3-MCPD, HCAs and PAHs etc. Jägerstad and Skog (2005) identified the briefly four classes of cooked food toxicants, e.g. acrylamide, heterocyclic amines, nitrosamines and polyaromatic hydrocarbons. Many of these compounds have been recognised for decades also as environmental pollutants. Cooking conditions and dietary habits can contribute to human cancer risk through the ingestion of genotoxic compounds from heat-processed foods. Such compounds cause various types of DNA damage including nucleotide alterations and gross chromosomal aberrations. Most genotoxic compounds begin their action at the DNA level by forming carcinogen-DNA adducts, which result from the covalent binding of a carcinogen or part of a carcinogen to a nucleotide. International Agency for Research on Cancer (IARC) have regularly evaluated the genotoxic and carcinogenic potential of these cooked food toxicants and has come to the conclusion that several of these food-borne toxicants present in cooked foods are possibly (2A) or probably (2B) carcinogenic to humans, based on both high-dose, long-term animal studies and in vitro and in vivo genotoxicity tests.

Food additives and Human Health:

Food additives are substances added to food to preserve flavor or enhance its taste and appearance. Some additives have been used for centuries; for example, preserving food by pickling (with vinegar), salting, preserving sweets or using sulfur dioxide as in some wines. With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin. With the increasing use of processed foods since the 19th century, there has been a great increase in the use of food additives of varying levels of safety. This has led to legislation in many countries regulating their use. For example, boric acid was widely used as a food preservative from the 1870 to the 1920 but was banned after World War II due to its toxicity, as demonstrated in animal and human studies.

In a study conducted by McCann (2007) it was observed that a mix of additives commonly found in children's foods (artificial colors and a sodium benzoate preservative) increases the mean level of hyperactivity (inattention, impulsivity and overactivity). World Cancer Research Fund (2010) warned against the excessive use of processed meats as they may contain sodium nitrate higher than their threshold limit. Extreme caution should be taken with sodium nitrite as it is mainly used a food coloring agent. Sodium nitrite is added to meats to produce an appealing and fresh red color to the consumer. Sodium nitrite can produce cancer causing chemicals such as nitrosamines which can incresae the pancreatccancer risk by 67% (Barnum, 2003; Cross et al., 2010)

Various food colours like Blue 1, Blue 2, Red 3, and Yellow 6 also enhanced health risks in humans. They may be carcinogenic and act as potential allergens. Blue 1 is used to color candy, soft drinks, and pastries and there has been some evidence that it may cause cancer in mice, but studies have not been replicated. Blue 2 can be found in pet food, soft drinks, and pastries, and has shown to cause brain tumors in mice. Red 3, mainly used in cherries for cocktails has been correlated with thyroid tumors in rats. Yellow 6, used in sausages, gelatin, and candy can lead to the attribution of gland and kidney tumors in animal models and act as carcinogens, but in minimal amounts (International Food Information Council, 2004). So after realizing the health risks associated with processed foods and food additives, we should start avoiding them or to start eating less of them.

Conclusion:

Processed foods usually contain tasty ingredients like sugar, salt and fat. To decrease transportation costs and extend shelf life, they contain less water, leaving each bit of food more densely packed with calories which in turn have negative health effects. The diet of present has resemblance with diet of our ancestors which is the main cause of the current "obesity epidemic". Since fat and sugar were historically hard to come by, our bodies are built to hold on to them to help us get through the lean times. This may have served us well in the caveman days, but not so much in the era of the KFC Double Down sandwich.

But we can't simply abandon food processing technology, if the nearly 7 billion people on the planet are to be fed, we must embrace it. However, Interventions in the obesogenic market need to be considered. We should keep in mind that "reducing the burden of obesity-related chronic disease requires a more appropriate use of technology that is guided by public health interests rather than short-term economic considerations. Further governments and health authorities should use all possible methods, including legislation and statutory regulation, to halt and reverse the replacement of minimally processed foods and processed culinary ingredients by ultra-processed food products.

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