

Chapter -II
Review of Literature

2.1. History of food adulteration

Adulteration, a term which is applied for the deterioration of different food articles by mixing them with cheap and inferior substances. A smaller amount of food adulteration has been practiced from very old time. A Greek botanist Theophrastus (370-285 BC) reported use of artificial flavor in the food. Pliny and Elder (23-79 AD) provided detailed description of adulteration in variety of food product. The Greek and Roman classics contain allusions to wine makers and dealers who colored and flavored their wine. Henry VIII cherished saffron so much that he condemned saffron adulterers to death. In England adulteration was started from 13th century, where bakers cheapened their wares or scanted the weight.

Some of the commonly used additives in the 19th century were poisonous for e.g. alum (K$_2$SO$_4$.Al$_2$(SO$_4$)$_3$.24H$_2$O) were used to whiten bread, and chalk added to the flour, while mashed potatoes, plaster of Paris (calcium sulphate), pipe clay and even sawdust could be added to increase the weight of their loaves. Rye flour or dried powdered beans were used to replace wheat flour and the sour taste of stale flour were developed with ammonium carbonate. Brewers too, often added mixtures of bitter substances, some containing poisons like strychnine, to 'improve' the taste of the beer and save on the cost of hope. By the beginning of the 19th century the use of such substances in manufactured foods and drinks was so common that town dwellers had begun to develop a taste for adulterated foods and drinks; white bread and bitter beer were in great demand.

Frederick Accum was the first to raise the alarm about food adulteration. Accum was a German chemist who had come to London in 1793, and who quickly established himself as a chemical analyst, consultant and teacher of chemistry. By 1820 Accum had
become aware of the problem through his analytical work and this led him to publish “A
treatise on adulterations of food and culinary poisons” – that was first serious attempt to
expose the nature, extent and dangers of food adulteration. The title page of the book
bore a skull and a quotation from the Old Testament 'there is death in the pot' (II Kings
chap.4, verse 40). The first edition sold out within a month; a US edition was published
in the same year and a German translation was brought out in 1822. In his preface Accum
remarked that the art of counterfeiting and adulteration had developed in England to such
an extent that spurious articles of all kinds could be found everywhere, but he regarded
the adulteration of food and drink as a criminal offence. 'The man who robs a fellow
subject of a few shillings on the highway is sentenced to death', he wrote, but 'he who
distributes a slow poison to the whole community escapes unpunished'. By this time
tea and coffee drinking had become popular in England but, being imported, both were
expensive and as the fashion spread cheaper varieties were needed for sale to the masses.
Many of these were not genuine tea and coffee but were made to look like the real thing
by chemical treatment. Spent tea leaves and coffee grounds could be bought for a few
pence per pound from London hotels and coffee shops. The used tea leaves were boiled
with copperas (ferrous sulphate) and sheep's dung, then coloured with prussian blue
(ferric ferrocyanide), verdigris (basic copper acetate), logwood, tannin or carbon black,
before being resold. Some varieties of cheap teas contained or were made entirely from
the dried leaves of other plants. Exhausted coffee grounds were treated in a similar way,
adulterated with other roasted beans, sand/gravel, and mixed with chicory, the dried root
of wild endive, a plant of the dandelion family. Chicory itself was sometimes adulterated
with roasted carrots or turnips and the dark brown coffee colour was achieved by using
'black jack' (burnt sugar).

While the adulteration of tea and coffee was fraudulent, the products were not as
dangerous as some of the substances added to beer and porter (stout). Accum described a
substance called 'bittern' sold to brewers of bitter beer in large quantities. It contained
copperas (ferrous sulphate), extracts of Cocculus indicus, quassia and liquorice juice.
There was also a preparation of ground coriander seeds, with Nux vomica and quassia,
again to impart bitterness to the brew. While the sale of such poisons was illegal under an Act of Parliament passed during the reign of George III, there were no reliable tests for these vegetable poisons before the 1820s and so the law was not rigorously applied and few offenders were caught.

By his analyses of many commodities Accum recognized the presence of lead and copper salts by the black precipitate they produced with hydrogen sulphide. Copper was further identified by the deep blue colour produced with ammonium hydroxide solution. The white precipitate of barium sulphate when barium chloride solution was added to liquids containing vitriol indicated the presence of sulphates. The starch in rice powder or wheat flour, often added to thicken cream, could be identified by the blue colour produced by a dilute solution of iodine in aqueous potassium iodide. Red wine adulterated with the juice of bilberries or elderberries produced a deep blue precipitate with lead acetate. Of all forms of adulteration the most reprehensible was the use of poisonous colouring matters in the manufacture of jellies and sweets. The bright colours used to attract children often contained lead, copper or mercury salts. Table 1 lists other adulterants identified by Accum. In Britain his analytical work on food adulteration was forgotten and during the next 30 years unsafe culinary practices continued to thrive.

Ten years later Thomas Wakley (1795-1862), surgeon, MP and editor of the medical weekly, The Lancet, started a new campaign against the adulteration of food and drugs. Wakley commissioned an article on poisonous confectionery in which the poisons contained in various items of coloured sweets, already condemned by Accum, were again identified. They included gamboge, a yellow gum that acts as a violent purge and irritant, and brightly coloured lead, copper and mercury compounds. The trade in highly coloured sweets had grown extensively in the decade since Accum first mentioned the problem. Even the sweet wrappers were often coloured with the same poisonous salts to make the sweets look more attractive. For Wakley this article was the first step in what would later become a long campaign to expose the dangers of adulteration and to secure legislation to protect the public.

In 1850 Sir Charles Wood, chancellor of the exchequer, speaking in parliament
about the adulteration of coffee with chicory, said that he had been advised that neither chemical nor any other tests could show for certain whether coffee contained chicory or not. In quick response, Arthur Hill Hassall (1817-94), a London-based physician, showed that it was easy to identify chicory mixed with coffee using a good microscope. He followed his examination of coffee with one of common brown sugar in which he observed under the microscope large numbers of minute living insects - sugar mites. Hassall's agreed to be the Commission's chief analyst between January 1851 and the end of 1854, and tested 2500 samples of food and drink, carefully recording the names and addresses of the vendors and the dates of purchase. He published the analysis results in The Lancet as reports of the Analytical Sanitary Commission. These reports appeared weekly at first and later less frequently. For the first three months no indication of the provenance of adulterated samples was given, but vendors were warned that the names of tradesmen who sold adulterated samples would be published in future reports. Wakley undertook to bear any expenses that might be incurred as a result of legal action. From the beginning Hassall made sure that those who sold unadulterated foods were named with commendation.

Before Hassall's the microscope had been ignored as an analytical tool, but it proved invaluable for identifying foreign vegetable matter, living or dead insects, minute traces of adulterants, and crystals of foreign organic matter for which no chemical tests were available. The microscope allowed him to estimate the amounts of adulterants present by counting the particles of foreign bodies, even when there were only traces. In one sample of mustard, for example, he estimated that there was one part of turmeric powder in 547 parts of mustard. He used chemical analysis to identify alum in bread, and iron, lead and mercury compounds in cayenne pepper, copper salts in bottled fruits and pickles, or Venetian red (iron oxide Fe₂O₃) in sauces, potted meats and fish. He also used chemical methods in the analysis of coloured sweets and to test for alkaloids in beer. The latter were much more difficult to identify than the mineral salts and in Hassall's day the main qualitative tests were colour changes brought about by various reagents like sulphuric acid, potassium chromate, ferric, stannous or mercuric salts, usually in acid
Hassall's work showed that adulteration was the rule rather than the exception and that adulterated articles were often sold as genuine. He was meticulous both in his scientific work and in accurately recording where and when the samples had been purchased. He presented a mass of evidence in support of his results and became widely recognised as an authority; he was even mentioned by Charles Kingsley in his children's book. The water babies, published in 1863. Kingsley wrote of those who 'invent poisons for little children and sell them at wakes, fairs and tuck shops.

Table 2.1 Some other adulterants identified by Accum (1820)

<table>
<thead>
<tr>
<th>Food</th>
<th>Adulterant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red cheese</td>
<td>Coloured with red lead (Pb$_3$O$_4$), and vermilion (mercury sulphide, HgS)</td>
</tr>
<tr>
<td>Cayenne pepper</td>
<td>Coloured with red lead</td>
</tr>
<tr>
<td>Pickles</td>
<td>Coloured green by copper salts</td>
</tr>
<tr>
<td>Vinegar</td>
<td>Sharpened' with sulphuric acid; often contained tin and lead dissolved when boiled in pewter vessels</td>
</tr>
<tr>
<td>Confectionery</td>
<td>White comfits often included Cornish clay</td>
</tr>
<tr>
<td>Red sweets</td>
<td>were coloured with vermilion and red lead</td>
</tr>
<tr>
<td>Green sweets</td>
<td>often contained copper salts (e.g. verdigris: basic copper acetate) and Scheele's or emerald green (copper arsenite)</td>
</tr>
<tr>
<td>Olive oil</td>
<td>Often contained lead from the presses</td>
</tr>
</tbody>
</table>

Table 2.2 Other adulterants found by Hassall (1851-54)

<table>
<thead>
<tr>
<th>Product</th>
<th>Adulterants for bulk and weight</th>
<th>Adulterants for colour, taste and smell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custard powders</td>
<td>Wheat, potato and rice flour</td>
<td>Lead chromate, turmeric to enhance the yellow colour</td>
</tr>
<tr>
<td><strong>Coffee</strong></td>
<td>Chicory, roasted wheat, rye and potato flour, roasted beans, acorns etc</td>
<td>Burnt sugar (black jack) as a darkener</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>Tea</strong></td>
<td>Used tea leaves, dried leaves of other plants, starch, sand china clay, French chalk Plumbago, gum, indigo, Prussian blue for black tea, turmeric, chinese yellow, copper salts for green tea</td>
<td></td>
</tr>
<tr>
<td><strong>Cocoa and chocolate</strong></td>
<td>Arrowroot, wheat, Indian corn, sago, potato, tapioca flour, chicory</td>
<td>Venetian red, red ochre, iron compounds</td>
</tr>
<tr>
<td><strong>Cayenne pepper</strong></td>
<td>Ground rice, mustard seed husks, sawdust, salt</td>
<td>Red lead, vermilion, Venetian red, turmeric</td>
</tr>
<tr>
<td><strong>Pickles</strong></td>
<td></td>
<td>Copper salts for greening</td>
</tr>
<tr>
<td><strong>Gin</strong></td>
<td>Water</td>
<td>Cayenne, cassia, cinnamon, sugar, alum, salt of tartar (potassium tartrate)</td>
</tr>
<tr>
<td><strong>Porter &amp; stout</strong></td>
<td>Water</td>
<td>Brown sugar, Cocculus indicus, copperas, salt, capsicum, ginger, wormwood, coriander and caraway seeds, liquorice, honey, Nux vomica, cream of tartar, hartshorn shavings, treacle</td>
</tr>
</tbody>
</table>

**In Great Britain** in the 18th and early 19th century, coffee, tea, and cocoa were placed under protection laws by Parliament, passed not so much in the interest of the consumer as to keep up internal revenues. About middle of the 19th century. Chemical and microscopic knowledge had reached the stage that food substances could be analyzed,
and the subject of food adulteration began to be studied from the standpoint of the rights and welfare of the consumer.

In 1860, the first food law framed in the interest of the purchaser was passed. That law, lacking sufficient means of enforcement, remained largely ineffective until 1872, after that administrative official were appointed and penalties for violation were involved to enforce the law. In the United States the federal Food and Drug Act of 1906 was the result of a long and stormy campaign led by Dr. Harvey Washington Wiley. This law defined food adulteration and the misbranding of products; and also it provided regulations covering the interstate movement of food and penalties for violations. The act was superseded in 1938 by the more rigorous Food, Drug, and Cosmetic Act administered since 1940 by the Food and Drug Administration (now within the Dept. of Health and Human Services). The law included various commodities with enforcing truthful and informative labeling of essential commodities, maintaining staff laboratories, and formulating definitions and standards promoting fair dealing in the interests of the consumer.

The law was amended in 1958 and 1962 to define and regulate food additives and food coloring. Imported goods that violate the provisions of the act may be denied admittance to the United States and if not removed within a given time may be destroyed. The federal law also had a watch on traffic from one state to another and is supplemented by local regulations that require food handlers to be licensed, thereby discouraging the spread of disease; it provides for the inspection by health officers of meat and other foods, of restaurants, and of dairies and cold storage methods. Food may be poisonous for reasons other than deliberate adulteration. Even many sad incidents occur in modern time also. In 1994, because of lead oxide in ground paprika in Hungary causes death of several thousand people and recently many children were poisoned by milk containing poisonous chemical in 2009.

2.1.1 Some major Incidence of adulteration in abroad

In 1987, Beech-Nut paid $2.2 million in fines for violating the Federal Food, Drug, and
Cosmetic Act by selling artificially flavored sugar water as apple juice.

In 1997, **ConAgra Foods** pled guilty to federal criminal charges that one of its units illegally sprayed water on stored grain to increase its weight and value.

In 2007, Samples of wheat gluten mixed with melamine, (presumably to produce artificially inflated results from common tests for protein content,) were discovered in many U.S. pet food brands, as well as in human food supply. The adulterated gluten was found to have come from China, and U.S. authorities concluded that its origin was the Xuzhou Anying Biologic Technology Development Company, a Xuzhou, China-based company.

In 2008, **China's milk** supplies were found to have been significant portions of contaminated with melamine. Infant formula produced from melamine-tainted milk killed at least six children and were believed to have harmed thousands of others. (See: 2008 Chinese milk scandal.)

### 2.1.2. Some major Incidence of adulteration in India

1998 Sep 4, adulterated **mustard oil** kills 31 people due to dropsy.  
www.hinduonnet.com/folio/fo9910/99100220.htm

1999 Oct 31, Bureau of **Indian Standards (BIS)** raided several products of brand, according to regulation given by the Prevention of Food Adulteration (PFA) Act and against claims made by the producers. The print media created history by publishing not only the findings but also the brand names and the names of manufacturers.  
www.hinduonnet.com/folio/fo9910/99100220.htm

2000 Jan 1, The Prevention of Food Adulteration Act, 1954 (Act No. 37 OF 1954) was applicable all over the country and came into effect on 1st June 1955, www.epao.net/epSubPageSelector.asp?src

2003 Aug 8, the Food Adulteration wing of the State Health department send samples of the soft drinks. The Democratic Youth Federation of India launched a statewide "direct action" program against the multinational soft drink giants on August 9. www.hindu.com/the hindu/2003/08/08/stories

2008 Mar 22, The latest food sample survey conducted in the city indicates an alarming increase in the adulteration levels with devastating consequences. ISO-9001-2000 certified laboratory which also has the approval from Agmark, Government of India, www.thehindu.com/2008/03/22/stories

2008 June 30th, In Nagpur, huge stocks of adulterated spices confiscated from the unit, Mayur Masala Products, in the city’s Lakadganj small scale industries’ area mainly included chilly and turmeric powder and a few pepper varieties. Besides pepper with sawdust, chemicals and artificial colors unfit for human consumption and product were labeled with bogus ‘Agmark’ standardization seals to lend authenticity to the products which was sold under the brand names ‘Mayur’ and ‘Ganga’ in the markets in Gondia (Vidarbha, Maharashtra), Raipur, Bilaspur (Chhattisgarh), Tatanagar and Ranchi (Jharkhand). (Source:Times of India)

2009, July 15th, Rajasthan Food Department seized over 10 quintals of adulterated pulses that were processed and polished to give fine appearance by using of toxic colouring agents and soapstone powder. Colour agents like tetrazene were used which is also not at all permissible as an additive. (Source: Times of India)

2.1.3. Recent major Incidence of adulteration Incidence in Varanasi

2009 Sep 20 8 kg spurious desi ghee were and adulterated garam masala with other material from Varanasi in Shivpur. People used to prepare desi ghee by mixing hydrogenated (vanaspati) ghee and chemicals. Besides, they also used to make adulterated garam masala. (Source: Times of India)

2009, 26 October VARANASI: in collection of food samples as per norm is evident, especially from Varanasi Nagar indicate that as many as 58 food samples (90 per cent of them being dairy products), which failed food analysis test, have been registered under
PFA Act and the number of failed samples can be close to 100, (till the month of September) this year have failed the food analysis test, showing signs of adulteration, while over 450 cases have been pending for the past five years.

Another interesting revelation of the cases of food adulteration registered under PFA Act in the city is the fact that almost three-fourth (75 per cent) of these cases belong to adulteration of milk products, including khoya, sweetened curd and even cream, in different parts of the city. Similarly, areas that have registered maximum number of samples of food adulteration include Sigra, Luxa and Nadesar while trans-Varuna areas include Pandeypur and Bhojubir (Source:Times of India)

2009, 16 September VARANASI: As many as 10 food samples were collected from different parts of the city, including Visheshwarganj Mandi, and a number of samples of desi ghee and other milk products, including sweetmeat and dal, were collected. The health department of VNN had also collected a dozen food samples during surprise inspections. While two samples of desi ghee were collected from Vishesharganj Mandi, a prominent market in the city, a number of samples of sweetmeats and dal were also collected from Bhelupur, Durgakund and Sarnath. The practice was believed to increase during the festive season. (Source: Times of India)

2.2 History of food adulteration India

In India, like most of the developing countries, both the industrial and non-industrial sectors are engaged in food processing activities. The industrial sector is subjected to quality checks whereas the non-industrial sector, by its very nature, is outside the realm of quality checks and statutory controls. Rapid urbanization and sociological changes had also increases the impact on the life-style of a large segment of the population due to enhanced demand for pre-packaged and recooked ready-to-eat (RTE) foods. The annual production of RTE foods in the industrial sector of India is 34, 5,411 tones (Anon., 1995). However, RTE foods produced in the non-industrial sector, including bakery products like bread, biscuits, rusks, cakes, and other RTE foods such as potato chips, are two to three times that produced in the industrial sector (Agarwal, 1990, 1994; Alagh,
1990; Chowdhry, 1990; Sharma & Sharma, 1994). It has been suggested that the consumption of such foods could sometimes lead to harmful effects (NIN, 1994, annual report).

Colour additives are known to be one of the causes of such harmful effects. The variety of synthetic colours, developed in the middle of the nineteenth century, were a reliable and economical method of partly restoring the original shade of the foods (that would otherwise be virtually dull) and also were used as a competitive substitute to the natural colourants (but were more expensive) (Achaya, 1984; Rao, 1990). The use of synthetic colours by the food processing industry is increasing because they are considered as important adjuncts. Vanaspati (PHVO) entered India in 1960s as a solid cooking fat that was promoted as vegetable ghee. It accounts for ~10 % of total production of edible oils. Indian vanaspati is prepared by partial hydrogenation of mixture of vegetable oils.

In India it was not until the late nineteenth and early twentieth century’s with the urbanization of societies and the depopulation of rural areas that food laws, as understood today, were prepared. This process was hastened by pressure that developed as the public rebelled against the generally unhygienic conditions of the period at the same time, current knowledge of the risks, actual and potential has considerably increased. Therefore, Reorientation and further consolidation of food laws have become necessary to protect the health of the consumer from the many new risks to which he has become exposed and over which he has little personal control. The government for the first time passed a central act in 1954 called as prevention of food adulteration act.

The Ministry of Food Processing Industries (MOFPI) took a keen interest and initiative in the implementation of the task force recommendations, and drafted a new Food Bill in 2002. The primary focus was to integrate the existing food laws and to bring about a single statute under a single regulatory authority, and to provide regulatory system for the production, manufacture, processing, and sale of safe and suitable food. In order to rationalize the multiplicity of food laws, the GOI constituted a group of ministers to suggest legislative and other changes to formulate a modern, integrated food law,
which will be a single reference point in relation to the regulation of food products. After extensive discussions and consultations, the Food Safety Standards Bill, 2005 (the Bill) was drafted, and on January 15, 2005 posted for public comments. The GOI notified the proposed legislation to the World Trade Organization on June 27, 2005. 

The Lok Sabha passed the Bill after incorporating the PSCs recommendations on July 26, 2006. The Bill was also passed on the August 2, 2006 in the Rajya Sabha (Upper house of the Parliament of India). The President of India signed the Bill on August 23, 2006 and was finally enacted as, The Food Safety and Standards Act, 2006 (No. 34 of 2006). The GOI notified the enactment in the official gazette on August 24, 2006.

The Food Safety and Standards Act, 2006 (the Act) has 12 chapters containing 101 sections and two schedules. The Act incorporates the salient provisions of the Prevention of Food Adulteration Act 1954, and is based on international legislations, instrumentalities and Codex Alimentarius Commission. This Act with its three tier structure (an apex food safety and standards authority, a central advisory committee and various scientific panels and committees) is expected to lay more emphasis on science based and participatory decisions while adopting the contemporary approach in both standard setting and implementation.

2.3. Impact of adulterants on health

Food adulteration is common in almost all developing countries. Rising incomes and slowly changing tastes and preferences in the metro cities fuel a growing demand for soft drinks, dairy products, meat, olive oils and other processed products. In a developing country which is at the lowest rung of the development ladder, food adulteration consists of relatively simple measures, the best examples of which are the addition of water to milk, mixing inferior quality of food to more expensive varieties and the use of non-permitted and harmful colours in the preparation of homemade processed foods for sale. On the other hand, in countries which have a developed food industry sector, food adulteration has a broad spectrum starting from simple procedures to most complicated technological procedures needing high level technical competence. It is obvious that in
such food adulteration, technical expertise of very high order is utilised by the adulterator in performing such type of crime. India unfortunately comes in the latter category. Starting from the simple procedure of adding water to milk or selling diluted buffalo milk as cow's milk or using skimmed milk powder for making high quality buffalo milk, the adulteration process goes to the other extreme of utilising non-permitted food additives in making processed package foods or making perfect imitations of well known brands of food which can sometimes escape the most careful scrutiny of the food inspectorate.

The common use of toxic coloring agents as an adulterant for fruits, vegetables, sweets are very dangerous when it comes to health of a person. It can lead to serious health issues like cancer, cardiac problems, insomnia and paralysis and other neurological problems or death as well. Some adulterants such as honey adulteration seems to be safer than the adulteration with the toxic chemicals as this will only have an economic impact without any health issues. Even milk can be completely adulterated, by making it artificially with chemicals such as urea, soap, artificial sweeteners etc.

To make cheaper coffee, Mogdad seeds and Roasted chicory roots have been used as adulterants. But those are highly toxic and play an important role in increasing the blood pressure. **Oleomargarine or lard** is the fatty acid added to butter, which is cheap and can be easily made industrially. **Rapeseed** that has been linked with adverse effects in asthma, allergies and hay fever, is commonly added to sunflower oil and soyabean oil. **Rye** can cause both physical and mental harm, including convulsions, miscarriage, necrosis of digits, and hallucinations. But rye flour has been added to barley, bread, wheat flour, and even alum to disguise the use of low-quality flour.

**All artificial colours** are highly toxic such as copper, zinc or indigo-based green dyes, are added to soft and hard drinks, and in colouring sweets etc. **Sudan-1 yellow and Sudan Red colour** is added to chilli powder. Those colours are responsible for making tumors in the liver and bladder and finally cancer. **Amylum** is the polysaccharide carbohydrate, which forms the crystalline form in the liver and creates digestion problem. It is added to sausages as a thickening, stiffening or gluing agent. **Cutting oil** has been used for making milk. When milk is made by cutting oil, there is no chance to grow any
kind of virus/bacteria and so preservation is unnecessary.

There are many applications of **urea** such as to grow more food dyeing in textile, bright colour rice, bright colour puppet rice, preservation of fish, meat and vegetables, food additive for cow which sells in the Eid-ul-Azha, flavour-enhancing additive for cigarettes. It forms *dermatitis or inflammation of the skin* (rashes), bulkiness of the body, *kidney and liver damage* etc. **High fructose corn syrup** or cane sugar can be used to adulterate honey. It is fully responsible for *obesity, diabetics, foot ulcers, eyes and nerve damages* etc. Formaline has been used for the preservation of noodles, meat, fish etc. It creates in the body violent coughing, *headaches, Asthma, Bronchitis*, and some other complicated diseases.

**Turmeric** is the basic ingredient of all our Indian cooking. Any Indian dish is not complete without it, but it may be adulterated with, *Lead chromate*, (which adds color as well as weight to it, being heavier), *Metanil Yellow dye* or any starch based items like flour or rice powder or even industrial starch. Except flour or rice powder, all the other adulterants are health hazardous and cause irreparable damage to our system when eaten at regular intervals for a long period of time. Take for instance **Lead chromate**; it is one of the most toxic salts of lead. It can cause *anemia, paralyses, mental retardation and brain damage in children and abortion in pregnant women*. Metanil yellow dye which is another non-permissible toxic colorant, is used mostly to color Besan or gram flour, pulses, miscellaneous prepared foods namely sweetmeats like *ladoo, burfi, jelabi, dalmoth, papad*, etc. to get that attractive deep yellow color. Food grade colors are available in the market but being more costly; traders take advantage of the lackadaisical approach of the law enforcing authorities and substitute it with the said cheap and non-permissible dyes and colors.

The puffed rice or any other white colored eatable looks so dazzling white and bright, and attractive on the show windows of a sweetmeat shop, which may have been treated by **ultra marine blue** a chemical dye which is a non-permissible and prohibited and for that rich deep pink color (Gulaabi) **Rhodamin-B** is used- again a non-permissible colorant. This colorant has also proven to be carcinogenic.
Argemone seeds that grow as weeds in the mustered fields are mixed with mustard seeds and its oil is mixed with mustered oil. Just a trace amount is all right, but when added deliberately it causes serious health hazards and even death. Dropsy is a straight after effect of consumption of this oil. It may also cause swelling, irregular fever, low pulse rate, enlargement of the liver, respiratory distress which may lead to heart failure.

Ghee is adulterated to the extent of 80 to 85 percent with Vanaspati. In actuality it is Vanaspati flavored with 15 or 20 percent of ghee by special process. In north India, vanaspati is used as a cooking medium, maximum consumption can be ~20g/person /day. In Delhi which is multicentre market, 37% of market is for vanaspati. Vanaspati is widely used in the preparation of commercially fried, processed, bakery, ready to eat and street foods. In bakery industry, vanaspati, butter and specialty fats (margarines, shortenings, gel) account for 60, 20 and 10 % respectively of total usage.

Dried seeds of volatile oil are added to cloves, while mineral acids to vinegar, papaya seeds to black pepper. Aniseed or 'sauf' that after food tit-bit, is dyed with malachite green dye for that nice green color. In food grains and whole spices extraneous matter like stalks, stems, and foreign seeds are added.

Melamine is described as being "Harmful if swallowed, inhaled or absorbed through the skin. Chronic exposure may cause cancer or reproductive damage and they are Eye, skin and respiratory irritant.” However, the short-term lethal dose is on a par with common table salt with an LD50 of more than 3 grams per kilogram of bodyweight. According to U.S. Food and Drug Administration (FDA) scientists, when melamine and cyanuric acid are absorbed into the bloodstream, they concentrate and interact in the urine-filled renal microtubules, then crystallize and form large numbers of round, yellow crystals, which in turn block and damage the renal cells that line the tubes, causing the kidneys to malfunction.

The European Union set a standard for acceptable human consumption of melamine at 0.5 milligrams per kg of body mass, Canada declared a limit of 0.35 mg and the US FDA’s limit was put at 0.63 mg, but was later reduced to 0.063 mg daily. The
World Health Organization’s food safety director estimated that the amount of melamine a person could stand per day without incurring a bigger health risk, the "tolerable daily intake" (TDI), was 0.2 mg per kg of body mass. Ingestion of melamine may lead to reproductive damage, or bladder or kidney stones, which can lead to bladder cancer.

![Structure of melamine](image)

**FIG.2. 1 Structure of melamine**

A study in 1953 reported that dogs fed 3% melamine for a year had the following changes in their urine: (1) reduced specific gravity, (2) increased output, (3) melamine crystalluria, and (4) protein and occult blood. (Wikipedia)

**In September 2008**, several companies were implicated in a scandal involving milk and infant formula which had been adulterated with melamine, leading to kidney stones and other renal failure, especially among young children. **By December 2008**, nearly 300,000 people had become ill, with more than 50,000 infant hospitalizations and six infant deaths. In a study published in the New England Journal of Medicine, it was reported that melamine exposure increased the incidence of urinary tract stones by seven times in children.

Melamine was added to enhance protein content tests after water was added to fraudulently dilute the milk. Because of melamine's high nitrogen content (66% by mass versus approx. 10–12% for typical protein), the protein content of food appear higher than their true value. Officials estimate that about 20 percent of the dairy companies tested in China sell products tainted with melamine. **On January 22, 2009**, three of those involved in the scandal (including one conditional sentence) were sentenced to death in a Chinese court.

**Castor oil** which is often mixed in ground nut oil can cause abortion in cases of
pregnant women. When the amount adulterated goes beyond 0.7 microgram per KG of body weight. **Khesari Dal** which is often mixed in Arhar Dal can cause lower limb paralyses known as Lathyrism. *Lathyrus sativus* species (Khesari Dal) has a toxic Amino acid known as **Beta oxalyl amino alanine** which is responsible for the above condition.

The **Acceptable Daily Intake** (ADI) has been defined as the amount of a substance that can be consumed everyday throughout the lifetime of an individual without any appreciable health effects (*JECFA, 1996*). The ADI of erythrosine was reduced from 2.5 to 0.1 mg kg) body-weight, as it produced effects on thyroid function in Short term Studies in rats (*Larsen, 1991*). It has also been reported that the consumption of a particular brand of aniseed (saunf), having very high levels of ponceau 4R, produced symptoms of *glossitis of the tongue in children* (*NIN, 1994, annual report*). Based on toxicological evaluation of synthetic food colours the Central Committee for Food standards (**CCFS, India**) has been constantly updating the food regulations. As a part of these regulations, certain colours such as **amaranth and fast red E were banned** and the reduction of the synthetic food colour limit from 200 to 100 ppm in all foods except in canned foods, jams and jellies has been recommended.

Different countries permit different synthetic food colours. The USA permits seven, including Fast red (which is prohibited for use in India), Iran and Australia, thirteen each and in the European Union (EU) sixteen synthetic permitted food colours are permitted. European countries have been harmonizing the regulations, and most of the controls on colourings in food stem from EU directives. Each country is attempting to review these controls by surveillance work. India permits addition of **eight colours**, viz. erythrosine, carmoisine, ponceau 4R, tartrazine, sunset yellow, brilliant blue FCF, Fast green FCF, and indigo carmine up to specified food items. In India, the Prevention of Food Adulteration (PFA) Act, which lays down specifications on the addition of additives to foods, was amended in 1995 (Prevention of Food Adulteration Act, 1995) and permitted the use of the above-mentioned synthetic food colours in or upon food items. In the last couple of years, organized, modern retailing has emerged, with supermarkets and big stores having refrigerated display cases, unlike the 12 million or
more small mom-and-pop stores which sell food and other items in garage style outlets behind a counter. But its ugly face is not the same everywhere. (Wikipedia)

Table 2.3: List of metals and their effect

<table>
<thead>
<tr>
<th>Metal</th>
<th>Food involved</th>
<th>Toxic effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>Fruits</td>
<td>Dizziness, chills, cramps, paralysis, death.</td>
</tr>
<tr>
<td>Lead</td>
<td>Water (through lead pipes), Processed food</td>
<td>Paralysis, brain damage,</td>
</tr>
<tr>
<td>Mercury</td>
<td></td>
<td>Paralysis, brain damage, blindness.</td>
</tr>
<tr>
<td>Zinc</td>
<td>Food stored in galvanized ironware</td>
<td>Dizziness, vomiting</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Water</td>
<td>Cardiac failure</td>
</tr>
<tr>
<td>Barium</td>
<td>Rat poison in food</td>
<td>Violent peristaltic, movement, convulsions</td>
</tr>
<tr>
<td>Copper</td>
<td>Copper tarnished utensils containing acid foods</td>
<td>Vomiting diarrhea abdominal pain</td>
</tr>
<tr>
<td>Tin</td>
<td>Canned food</td>
<td>Colic pain vomiting, photophobia</td>
</tr>
</tbody>
</table>

Table 2.4: List of pathogenic microbes and their effect

<table>
<thead>
<tr>
<th>Pathogenic microbes</th>
<th>Food</th>
<th>effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clostridium botulinum</em></td>
<td>Processed food</td>
<td>Muscular paralysis, respiratory failure</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Processed food, meat, fried egg, vegetables,</td>
<td>Salmonellosis, vomiting diarrhea, fever</td>
</tr>
<tr>
<td><em>Apergillus flavus</em></td>
<td>Corn and groundnut</td>
<td>Liver damage and cancer</td>
</tr>
<tr>
<td><em>Penicillium islandicum</em></td>
<td>Rice</td>
<td>Liver damage</td>
</tr>
<tr>
<td>Ascaris</td>
<td>Vegetable grown in sewage</td>
<td>Ascariasis</td>
</tr>
<tr>
<td><em>Entameoba hystolytica</em></td>
<td>Vegetable grown in sewage</td>
<td>Amoebic dysentery</td>
</tr>
</tbody>
</table>
2.4. Causes of Food Adulteration

Let us be clear that food adulteration in India under the law includes both willful adulteration of food and "substandard" foods which do not conform to the prescribed food standards but are not done intentionally. Taking an overall view of all types of food adulteration, three major underlying causes could be identified:

i. **Inadequate availability of food** to meet the demands of the consumer prompting the unscrupulous food traders to use any means to stretch the supply to earn more money.

ii. The more important reason is the basic dishonesty of the food traders and an urge to **make quick and easy money**. In fact, this urge to make money in an unscrupulous manner is possibly the basic reason for the majority of crimes committed in the modern day society, be it theft, burglary, bank looting or murder. This dishonesty to earn easy and quick money is not only restricted to the food traders who commit crime of food adulteration but can also apply with equal force to the law enforcer who might make an alliance with the food trader with most disastrous results.

iii. There are significant numbers of cases of food adulteration committed by **small traders** due to their ignorance about the standards they are expected to maintain. It is true that all food standards after they are developed are circulated by government notification for the knowledge of all traders; but it is equally true that there is an **abyssal gap between the traders and the law enforcers**, especially when they are small and medium traders e.g. the street corner food sellers.

2.5. Food safety knowledge & practices

2.5.1 Food safety

**Food safety is defined as** food that is free from all hazards, whether chronic or acute, that may make food injurious to health of the consumer *(Krueger R. 1998).* However, the term “safe food” represents different ideals to different audiences *(World Health Organization; 2003).* Unlike in the West, in the Indian context improper cooking and cross-contamination may not be perceived as major food safety concerns; Research in
other parts of the world suggests that many people’s stance on food safety issues changes depending on their mood or the last thing they have read or seen (Elmi M. 2004, FSA, 2000).

Epidemiologic surveillance summaries of foodborne diseases clearly indicate that consumer behaviours such as ingestion of raw/undercooked foods and poor hygienic practices are important contributors to outbreaks of food borne diseases (Patil et al., 2004). Unusan (2007) reported that people of all ages seem to think they know how to handle food safely, but their self-reported food-handling behaviors do not support this confidence. A review of the consumer food safety literature indicates many gaps that have an impact on food borne diseases at home (Vitas, 2005; Hillers et al., 2003; Jay, Comar, 1999b; Kendall et al., 2004; Kennedy et al., 2005; Li-Cohen, 2002; Redmond, 2003; Unusan, 2007; Yang, 2000).

The growing concern about pesticide residues was obvious in some areas, which to a large extent is fueled by recent and extensive media coverage of the controversy about pesticide residues in carbonated beverages. (Subba Rao, 2007; Mago C, 2009; CNN, 2003).

2.5.2. Attitude of Indian consumer

The Indian consumers are noted for the high degree of value orientation. Such orientation to value has labeled Indians as one of the most discerning consumers in the world. Even, luxury brands have to design a unique pricing strategy in order to get a foothold in the Indian market. Indian consumers have a high degree of family orientation. This orientation in fact, extends to the extended family and friends as well. Brands with identities that support family values tend to be popular and accepted easily in the Indian market. Indian consumers are also associated with values of nurturing, care and affection. These values are far more dominant that values of ambition and achievement. Product which communicate feelings and emotions gel with the Indian consumers. Quantitative techniques especially questionnaire surveys to elicit information on food safety practices certainly have some value indicating what people know but there is little information on
whether the respondents actually behave in the way claimed (Worsfold & Griffith, 1997).

In a similar study conducted in a different context in the United Kingdom, it was reported that there was no consensus on what people perceived about food safety, however, the study reported that the respondents from Hindu and Muslim backgrounds in the sample seemed more concerned about food hygiene (FSA, 2000). In the Indian cultural context too, the object of cooking is not simply to produce material suitable for eating, but to conjoin the cultural properties of the food with those of the eater. For instance, vegetables almost always need the application of fire to make them edible. Cooking them means that they may be ritually washed to render them of sufficient rank to be permitted to enter the food area (Achaya, 1994).

Most consumers had a positive attitude toward food safety and believed government intervention would help in improving the quality of street foods. Such data can form the basis for seeking the attention of government to undertake measures to improve the quality of foods served at various food outlets. Also, it was found that very few consumers received information on food safety from various sources like magazines, TV/radio, posters, newspapers, health workers, nongovernment organizations, etc. This calls for attention of food safety educators to use a variety of audio-visual aids to spread the messages on food safety. Such area-specific data on consumers’ knowledge on food safety can assist in developing food safety education programs. (GURUDASANI, 2009)

2.5.3 Indian tradition and food safety

Apart from psychology and economics, the role of history and tradition in shaping the Indian consumer behavior is quite unique. Perhaps, only in India, one sees traditional products along side modern products. For example, hair oils and tooth powder existing with shampoos and toothpaste. Unlike in the West, in India adulteration is a major food safety concern because semi-processed primary agricultural produce and other raw material are procured from the market before they are further processed and made suitable for cooking at home. Similarly, improper cooking and cross contamination may
not be perceived as major food safety threats in the Indian context because certain food safety measures are traditionally practiced by the people perhaps even without the knowledge of scientific rationale behind them. For example, traditionally, cooked food falls into two main classes—(i) **Kuccha foods** are those freshly cooked using water (like rice, unleavened bread called roti, cooked legumes called dal) and usually served hot to the family within the kitchen area. (ii) **Pucca foods** are those made using fat, which can be taken out of kitchen for consumption outside the family (like fried/deep fried snacks and saouries) (*Achaya, 1998*).

This classification is probably based on the vulnerability of cooked foods to spoilage and contamination. In many Indian homes, domestic hearth is an area of purity and sanctity frequently next to the area of worship so it is usually located far from water disposal areas and well demarcated from sitting sleeping and visitor receiving areas. Before entering the cooking area the cook is obliged to take a bath and wear fresh garments (*Achaya, 1994*).

Although, the innate cultural practices imbibed through generations have their own virtues, there is a growing concern about food borne illnesses in India. An estimated 4,00,000 children below 5 years age die each year due to diarrhoea. Several millions more suffer from multiple episodes of diarrhoea and still others fall ill on account of hepatitis A, enteric fever, etc. caused by poor hygiene and unsafe drinking water (*UNICEF, 2004*). Though most food borne diseases are sporadic and often not reported, in India, a nation-wide study carried out recently, reported an alarming 13.2% prevalence at household level (*NIN, 2006*).

**Home food preparers** need to take many precautions to minimize pathogenic contamination of home-prepared foods because they are the final line of defense against food borne illnesses (*Medeiros et al., 2004*). In over 90% of households in India, it is the women who are involved in the preparation of meals (*NIN, 2006*). **The role of food handlers**, usually mothers, in ensuring food safety and hygiene at household level is well accepted (*Medeiros et al., 2004*). An understanding of the status of their food handling knowledge and practices is needed. There has been limited, rather no research on food...
safety knowledge and behaviors of mothers in India.

2.5.4. Effect of age on food safety knowledge
In over 90% of households in India, it is the mother who is involved in the preparation of meals, (Polasa K, 2006) and adolescent girls are indeed future mothers and food preparers. Education about food and nutrition issues at a young age influences the attitudes of youngsters and enhances their knowledge and skills required for them to understand contemporary issues related to food (Lytle LA 1995) Research also indicates that through adolescent girls, their younger siblings, families, and other community members may also be reached (Delisle H 2001) Schools provide the most effective and efficient ways to reach adolescent girls, (Raghunatha Rao, 2007) as school settings provide opportunities for maintaining continuous and concentrated contact with them, making interventions cost-effective, and schools offer the advantage of carrying out such education interventions within the context of the child’s natural environment (Lytle LA 1995) Although only 40% of all adolescent girls in India attend upper-primary and high schools, the number is huge, considering the vastness of India’s population. (WHO, 2006) There has been scant research on food safety knowledge and practices of adolescent girls in India. An understanding of the status of the food safety knowledge and practices of adolescent girls is needed before any food safety education material can be prepared for their use.

Earlier studies conducted on adults have indicated that food safety knowledge tends to increase with age and practice: (Bruhn & Schutz, 1999; Byrd-Bredbenner et al., 2007; Rimal, Fletcher, McWatters, Misra, & Deodhar, 2001; Unusan, 2007) Williams et al. (1992). Children and adults are usually unaware of basic methods of food handling and preparation, although a substantial proportion of food-borne illnesses can be attributed to improper preparation according to Redmond and Griffith (2003). Studies conducted in various south Indian cities proved that many adolescent girls takes a number of precautions while cooking food even at home. The common safety concerns about outside food were unclean surroundings, quality of ingredients used, personal hygiene of the food handlers, uncovered containers, cooking in re-used oils, and fly infestation or in summary microbiological contamination of street food and restaurant food is a concern (Bhat RV, 2001; Chandrashekhar U 2003; Sudershan RV,2007)
Although the girls were not referring to microbiological contamination directly, they were associating cleanliness of surroundings, personal hygiene of food handlers, and quality of water as safety concerns pertaining to outside food. These perceptions of the adolescent girls are in tune with the perceptions of the mothers in south India (Subba Rao, 2007).

According to a girl quoted in this article “we like to eat samosa (refined wheat flour dough stuffed with spicy curry and deep-fried in oil), cut fruits, pani puri, chips and colas, which are sold in front of our school. We check the smell and appearance of the food before buying; if it emanates bad smell we do not buy it.” (A group of girls, RangaReddy District, AP) Apart from these, noodles, savories, bakery items, ice creams, and mutton biryani (a spiced rice preparation with meat and vegetables) ranked high among the frequently consumed outside food.

A study conducted in by Raghunatha Rao et al 2007 among urban adolescent girls in a south Indian city indicated that about 51% of the adolescent girls consume instant food items 3-4 times a week, nearly 68% reported daily consumption of bakery items, and 48% of the girls consumed carbonated drinks 1-2 times a week (Raghunatha Rao, 2007) However, studies in India have indicated that some of these street food items either contain some additives (like synthetic colors) not permitted under Indian food regulation or that the permitted additives were used in excess of the permitted levels (Pratima Rao 2008). Surprisingly, food additives hardly figured as food safety concerns among adolescent girls.

Similar concerns were also expressed in the United Kingdom and Ireland by children as well as some adults, as they perceived that food prepared by someone else involved an element of risk attributed to a variety of reasons, including unhygienic premises and poor staff training. (FSA, 2000; FSAI 2008.) Despite being concerned about the quality of outside food, many girls were not as careful about consuming snack food obtained away from home. One common trait observed across groups was that the girls said taste was the major draw, whereas hygiene, safety, and nutrition did not really matter. However, according to some of them, quality of such food was often judged by
smell and appearance.

People of all ages seem to think that they know **how to handle food safely**, but their self-reported food-handling behaviors do not support this confidence. Studies in adults and children conducted mostly in the late 1990s have revealed gaps in food safety knowledge and a disconnection between food safety knowledge and the reported food-handling practices. In the US studies, the percentage of people who report taking deliberate risks in handling food has varied between 10% and 50%, whereas 20% to 50% of households have reported having experienced physical symptoms associated with foodborne illness. The proportion of people reporting the use of safe food-handling procedures has been shown to be much larger than the observed proportion (**Worsfold D, 1997**). These numbers correspond to the statistics from the 1980s that over 10% of the US population experienced a foodborne illness each year, at an annual cost of $10 billion to the national economy. Earlier studies in adults have indicated that food safety knowledge tends to increase with age and practice: females have higher scores than males, and respondents under the age of have shown the greatest need for additional food safety education. Furthermore, respondents from urban areas tend to have lower scores than those from rural areas (**Millward L 1995; Neuman 1994**) and the “occasional cooks” (often men and young adults) or well-educated people and those with a high income tend to report more unsafe food-handling behaviors. (**Neuman 1994, NFI, 2003, Subba Rao, 2007; . Sudershan, 2008**) However, only a handful of studies have been conducted to explore the food safety knowledge, perceptions, and practices among younger populations, children (**Mago 2003**) and college students. (**Bhat RV 2000, CNN 2003**).

### 2.5.5. Impact of education on food safety practices

Very few studies have been conducted on safe **food-handling knowledge or practices** of youth.

In Kansas, a study of 80 9- to 12-year-olds involved in 4-H programs or after-school programs found that 86% of the children reported preparing meals, with 70 percent of those children knowing the meaning of "food safety." However, the majority did not know about
foodborne illnesses (59%), cross-contamination (85%), internal temperatures (75%), and proper thermometer usage (70%), and only 45% of them consistently washed their hands before starting food preparation (Bryant & Barrett, 2000).

Because many parents work outside of the home, 70% of households have no adult supervision of children during the day. It is estimated that more than 50% of the children in these homes shop and prepare their own food (Goldman, 1990), and 65% of teenagers reported going to the supermarket on their own at least once a week (Anonymous, 1990). Such findings conclude that many children may grow into adulthood without learning the basic principles of safe food preparation (Williamson, Gravani, & Lawless, 1992).

In a previous study of the food-handling practices and food safety knowledge of 4th- and 5th-grade students in west-central Illinois, a need for education in safe food handling in the primary grades was identified (Barclay et al., 2001). These results warranted further research to investigate food-handling practices and food safety knowledge of 3rd- through 10th-grade students in west-central Illinois.

All the mothers seemed to have encountered food adulteration at some point of time. The commonly stated instances of adulteration were adulteration of milk with water, expensive oils with cheap oils, wood powder/artificial colour in red chilli powder, powdered tamarind seeds in coffee, papaya seeds in pepper, pebbles in rice and pulses and suji (semolina) in sugar.

2.5.6. Impact of food adulteration on health

There are many substances in the world that are harmful to human health. Henson and Traill (1993) define food safety as “the inverse of food risk—the probability of not suffering some hazard from consuming a specific food”. Buzby (2001) express that food safety risks “veterinary drug and pesticide residues, food additives, pathogens (i.e., illness-causing bacteria, viruses, parasites, fungi, and their toxins), environmental toxins such as heavy metals (e.g., lead and mercury) and persistent organic pollutants (e.g., dioxin), and unconventional agents such as prions associated with bovine spongiform encephalopathy (BSE) in cattle.
Foodborne disease (FBD) has an enormous public health impact, as well as significant social and economic consequences. It is estimated that each year FBDs causes approximately 76 million illnesses, 325,000 hospitalizations and 5,000 deaths in the U.S.A., and 2,366,000 cases, 21,138 hospitalizations and 718 deaths in England and Wales (Mead et al. 1999; CDC 2003). There are reports of foodborne illness associated with the consumption of fruit juices at several places in India and elsewhere (Parish 1997; Sandeep et al. 2001). A study conducted during the period September 2002 to August 2003 in Hyderabad, India, revealed that a total of 42 outbreaks were reported with 1,008 people being affected. Some of the foods involved were kheer, lemon rice and khoa, and the organisms involved were Staphylococcus aureus and Bacillus cereus (Bhat 2004). Thus, in view of this, food quality and safety should receive high priority for sustained economic growth of any country.

Each year millions of people worldwide suffer from food borne disease and illness resulting from the consumption of contaminated food which is one of the most widespread public health problems in the contemporary world (Notermans, gallohof, zweitering and mead, 1995; WHO, 2000). Studies have estimated that between 50 and 87% of reported food-borne disease outbreaks have been associated with the home (Redmond & Griffith, 2002). Common mistakes identified comprise serving contaminated raw food, raw food of animal origin, and the practice of poor hygiene (WHO, 1999). Despite these scientific facts little is known about the food safety practices and knowledge of the population as whole with minimum analysis of sub population at of risk. (Bruhn CM, 1999).

The top five risk factors of food borne outbreaks in food service operations include improper holding temperatures, inadequate cooking, contaminated equipment, purchase and receipt of food from unsafe sources, and poor personal hygiene. These are all directly related to food handler error and can be prevented if food handlers follow proper food safety practices (FDA, 2000, 2004 Harrington, R. E. 1992). Scientists generally agree that food safety risks are low, though highest for foodborne pathogens such as Escherichia coli O157:H7”. In recent years, many food companies have
developed and marketed foods in response to increasing consumer concern and interest in terms of between diet and health. Not only consumers interested in the particular health benefits offered by the product, but also the taste and price when making purchase decisions. Understanding how individuals perceive characteristics of foods and the factors effecting consume decision can assist policy maker and producer of food. Knowing consume decision effecting factors can supply advantages for producer. In addition the policy maker can develop new strategies according to this like studies.

Though the problem of adulteration of foodstuffs is rampant in India, women did not seem to be too concerned about this. With about 11% of all foodstuffs being adulterated in India (Ministry of Health and Family Welfare (MOHFW), 2004) this problem seems to have become a way of life that most people do not seem to consider it as a health hazard. Most of the adulterants (like water in milk, chalk powder in turmeric and artificial colour in chillies powder) cited in an earlier study (Beniwal & Khetarpaul, 1999). Most women were aware of the common adulterants in foodstuffs, but alerting the regulatory authorities in case of adulteration does not figure as an option because most of them lack confidence in the Government machinery. This attitude is largely responsible for their acceptance of food adulteration as a way of life. This scenario is perturbing because there was some instances of food adulteration especially that of edible oils with argemone (Argemone Mexicana) oil leading to deaths (Singh et al., 2000).

In India, the complacent attitude of the general public due to illiteracy, ignorance and dejection has probably led to a state of mass inertia, with the result, the entire burden of controlling the quality of food stuffs rests with government and its enforcement machinery (Gopalakrishnamurthy, 1985). Inadequacy of staff and general laxity of administration are one set of causes for malfunctioning of the PFA Act in India (Shah, 1985). Perhaps some of these issues may be behind shaping the women’s opinions in the Indian context. Elsewhere in the world too, Government machinery seems to be falling short of people’s expectations (FSA, 2000; FSAI, 2003).

As regards the existing safe food handling practices, though there are subtle differences within the groups, most of them are attributable to the innate cultural and
behavioral attitudes and practices that have been passed on to them for generations. Although they are able to directly relate aspects of personal hygiene to food safety, the importance of usage of soap for washing hands has not percolated. There was a general perception that home cooked foods are safer than prepared foods bought from outside.

In less developed countries, many people are poisoned because of the consumption of food produced under unhygienic condition, lack of hygiene education, drought contaminated water, inappropriate food storage condition lack of cleaning and pesticide residue. However food poisoning is not limited to developing countries there are various causes which is responsible for food poisoning such as lack of required care during preparation of food, demand for cheap food, storing of food under unhygienic condition and proper packaging of the materials. (Eves & Kipps, 1995; Medeiros et al 2004; soner & ozgen, 2002). According to Mead et al an estimate of 76 million people annually are effected by food born diseases in USA in which 325,000 were admitted to hospitals and 500 cases were fatal. A Total of 84,340 and 77,515 cases of food borne diseases were notified in Turkey in 1999, 2000 respectively. (Soner & Ozgen 2002; ministry of health of turkey, 2006).

2.5.7. The attitudes of consumers towards food safety and their practices

The issue of food safety has been in the public eye as never before. Current socioeconomic trends influence the food choices and eating behaviors of consumers (U.S. Department of Health and Human Services 2000). The global food supply allows consumers to enjoy a variety of foods, but it also potentially exposes them to new pathogens. The consumer assumes at least part of the responsibilities for reducing food borne illness. The Food Safety Survey conducted by the Food and Drug Administration (FDA) and the Food Safety and Inspection (FSIS) compared consumer knowledge in the years 1993, 1998 and 2001 and found that, in general, food safety knowledge increased (Cates 2002). The most dramatic change was in consumers’ knowledge about microbes. In 1993, 79% of consumers surveyed knew about Salmonella, which had increased to 93% in 1998 and 2001. However, good knowledge is no certification of good practices.
The attitudes of consumers towards food safety and their practices concerning food are themes of interest to food producers and retailers, public authorities and health educators (Wilcooky, Pun, Khanonax, & Aung, 2004). Food safety agencies around the globe should play an important role in the education of consumers.

Consumers appear to be more interested in convenience and saving time than in proper food handling and preparation. Mass production, environmental factors and inadequate knowledge on the part of food handlers have contributed to increased contamination of primary foodstuffs (Kaferstein et al. 1997).

According to Worsfold and Griffith, (Griffith C, 1997) quantitative techniques, especially questionnaire surveys to elicit information on food safety practices, indicate what people know. What do consumers know about food safety principles and what do they do to protect themselves from food borne diseases? The results of consumer studies concerning food safety knowledge and practices have shown that consumers are aware of and are thinking about food safety, although there are also many gaps in food safety knowledge and practices that may result in food borne diseases (Dookeran, & Duncan, 2006; Medeiros et al., 2004; Patil, 2004; Hlebec, 2006).

Can knowledge alone change the attitudes towards food safety? It has been reported that effective and relevant food safety training can enhance food handling practices at workplace since proper attitudes can reduce the incidence of food borne illnesses. In fact, sustainability of safe food handling practices depends on the ability to link positive behavior, attitudes and continued education of food handlers (Howes, McEwen, Griffiths, & Harris, 1996). In doing so, food handlers pose no risk to consumers owing to their compliance with good hygiene practices in the food supply chain. Furthermore, food handlers can ensure that production, processing and distribution of food under their control comply with hygiene requirements relevant to GHP regulations.

Several studies have identified the need for continued consumer education about the hazards of improper food handling (Finch & Daniel, 2005; Karabudak, Bas, & Kızıltan, 2008; WHO, 2000). Food safety education should be given not only to
consumers but also to managers and staff working in food-beverage processing businesses so as to bring behavioral changes and to ensure the adoption of positive attitudes (Coleman & Roberts, 2005; Powell, Attwell, & Massey, 1997). Studies show that the food safety knowledge of managers and staff working in small and developing catering businesses is at an insufficient level (Bolton, Meally, Blair, McDowell, & Cowan, 2008; Walker & Jones, 2002). An efficient and continuous food safety education will enable consumers (children, youth, adults and the elderly) to learn the methods for preventing health threatening food safety problems and change their misguided habits. Programs should include practical information on microbiology of food-borne diseases, personal hygiene, suitable cleaning procedures, proper home food preparation, and prevention of cross-contamination and food storage practices (Sammarco et al., 1997).

A study by Clayton, Griffith, Price, and Peters (2002) reported that food safety training does not necessarily guarantee that the workers carry out the safe food handling behaviors. An evaluation of school food service employees' food handling practices and food safety knowledge and attitudes by Henroid and Sneed (2004) found that the employees' food safety knowledge was high but observation of their food handling behaviors showed that safe food handling practices were not practiced.

A previous study suggested that this disparity between knowledge and practices occurs because much training, particularly with formal certification, is designed using the KAP model (Rennie, 1995). While assuming that individual behaviors or practices (P) depend on their knowledge (K), this approach suggests that merely providing information leads to attitudinal changes (A) and, ultimately, behavioral changes (Worsfold, Griffith, & Worsfold, 2004). Another study suggested that this model erroneously assumes that knowledge is essential to behavioral change (Ehiri, Morris, & McEwen, 1997).

A positive motivational atmosphere in working environment significantly contributes to higher productivity, employee loyalty and a generally positive attitude in the workplace. In terms of work efficiency and job satisfaction, superiors must devise strategies to assess employee comments and incentive systems. However, financial
incentives do not ensure higher work satisfaction or a stronger affiliation to the company in the long run. For some employees, individual recognition may be an important motivational force. Food processing companies often stress prioritizing the fulfillment of the production norm, while identifying factors that may have contributed to unfulfillment of a previous production norm is often neglected. MacAuslan (2003) stated that the foundation of hospitality training involves identifying motivation, evaluation, leadership and training as the key management skills that are often missing in small businesses. A management module must be introduced for supervisors and managers, especially in small businesses. Additionally, many authors (Rennie, 1994, 1995; Ehiri et al., 1997) have criticized the effectiveness of applying the KAP model in food safety training, asserting that while doing so may increase food safety knowledge, a positive change does not always occur in food handling.

Educational material about Good Housekeeping Practice should be available to the general public from many sources. Food safety messages should focus on the younger members of a population with educational programs, but more importantly, with relevant training. It is also of vital importance to properly educate educators and teachers in order to transmit food hygiene principles to children, and through them, to their parents. Only safety-conscious consumers can become active partners within the food safety circle (Gilmet, & Noonan, 2001).

2.5.8 Causes of difference in perception and food practices

Results from the 2000 Home Food Safety Study by Audits International revealed that 40% of all food safety errors were attributed to lack of education, another 40% were due to lack of conscious awareness, and the remaining 20% were due to lack of motivation (Daniels, Daniels, Gilmet, & Noonan, 2001).

Various studies have also found discrepancy in the knowledge and practices of the consumers pertaining to food safety on the household front. Assessing the knowledge without practices is an incomplete picture of consumer awareness on food safety because obtaining high reported values does not indicate that the knowledge is being utilized at
the right time. Utilizing one’s knowledge to protect one’s self and others from food safety hazards is more important than good knowledge scores.

Good knowledge with poor practices reflects the lack of involvement and importance that the issue of food safety holds for the consumers. As described by Linton et al. (1998), there are many food handling errors that can cause foodborne illness in food retail establishments, including poor personal hygiene and cross-contamination. Research has also described failure to avoid unsafe foods, neglect of cleaning and sanitation, improperly trained staff and unaware consumers as other threats to food safety (Herrmann and Warland 2000; Stivers and Gates 2000; Medeiros et al. 2001).

In fact, many studies have revealed that old or very young consumers and consumers of low educational backgrounds and income levels are exposed to much more risks when compared with young consumers (Baker, 2003; Dosman, Adomowicz, & Hrudey, 2001; Goktolga, Bal, & Karkacier, 2006). In another study, significant differences were found in food safety perceptions for age, gender, household income, education and employment in the food industry.

In addition, a significant relationship has been determined between the perception of safe food by consumers and their behavior (Roseman & Kurzynske, 2006). Food mishandling is thought to be more acute for young adult men and individuals with an educational educational level beyond high school than other groups (Altekruse, Yang, Timbo, & Angulo, 1999). Cakiroglu and Ucar (2007) found that food hygiene perception scores are higher in women than men, as well as in the above-45 group than in other age groups and in university graduates. In many societies women are more informed about appropriate methods of food handling and storage than men. Better educated consumers often recognize the importance of food safety and younger respondents have shown the greatest need for additional education on food safety (Bruhn & Schutz, 1999; Li-Cohen & Bruhn, 2002; Sudershan et al., 2007).

Sammarco et al. (1997) stated that consumers do not have enough knowledge about personal hygiene, food preparation and storing practices and that many consumers do not even have basic information about detergents, disinfectants, sterilization, harmful
Consumers need to know which behaviors are most likely to result in illness in order to make decisions about food handling and consumption behaviours (Hillers et al., 2003), and then need to be motivated to act on that knowledge as a precondition for behavioural change (Medeiros et al., 2004).

It is known that poor hand washing practices inevitably lead to retention on the hands of bacterial and viral pathogens, which are obtained from handling raw produce or from toilet activities (Snelling, Kerr, & Heritage, 1991). In contrast, in a study carried out in West Indies, it was reported that 88.1% of consumers washed their hands thoroughly with soap before and after preparing meals while only 10.7% did so ‘sometimes’ (Surujlal & Badrie, 2004). In the National Australian food safety telephone survey, most people (82.3%) reported that they washed their hands with soap or detergents and almost the same proportion felt it was very important to wash hands before and after preparing meals (Jay, Comar, & Govenlock, 1999).

2.5.9. Factors affecting consumer response to food safety

Many researchers have analyzed factors affecting consumer response to food safety. Dosman, Adamowicz, and Hrudey (2001) found that women older respondents and households having higher income level tended to perceive food safety risk as greater than individuals in other categories. Flynn, Slovic, and Mertz (1994) found that women perceive risks to be higher than do men. Kreowski, Slovic, Bartlett, Flynn, and Mertz (1994) found that older individuals being more likely to rate risks higher than younger individuals. Baker (2003) found that women, older respondents, households having higher education level and members of households with young children were the most likely to have an extreme risk avoidance response. Low personal perception of the risks related to food safety issues would imply that consumers ignore the potential risk from microbiological hazards and apply improper measures during home food preparation and storage practices, improper thawing of food, or cross contamination, or inadequate storing and reheating of cooked foods. Moreover, an essential knowledge of food
pathogens microbiology may motivate consumers to use safe food storage, preparation and cooking procedures (Altekruse, Street, Fein, & Levy, 1996).

The study of Ziya et al 2006 has identified the difference between consumer characteristics and the selection of type of primary preference in food purchases in Turkey estimated using multinomial logit model. The estimation was based on the data collected household survey in June 2004. The results show that the age of respondents, gender of respondents, education and income level were among the important household characteristics influencing primary preference in food purchases. As a result, households who have high-income and high-education level more interested in food safety than households who have low-income and low-education level. In addition, female and old respondents are more interested in food safety than male and young respondents.

2.5.10 Consumer response towards Packaged Food and Food Labels

Most of the participants considered packaged/prepackaged food safer than unpackaged food sold in the eateries, because they presumed that the packages protect the food from exposure to flies, insects, and dust. “Packaged food items are safe because they are properly covered.” With regard to the food labels, many of the girls said that they were in the habit of checking food labels while buying packaged food items. Many girls in all the states reported checking the price, best-before date, date of manufacture, and in some cases they look for the list of ingredients.

Although checking quality symbols was a habit among very few girls in KTK, AP, and KER, this issue did not figure in the discussions in TN. Among those who checked quality symbols, ISI (quality symbol given by the Bureau of Indian Standards) was most commonly known, whereas symbols like AGMARK (a symbol given to agricultural products meeting certain quality standards under the Agriculture Marking and Grading Act) and FPO (quality symbol for fruit products under the Fruit Products Order of the Indian government) were hardly known to them. As many of the girls felt that products of reputable brands were safe, they often went by brand names while buying packaged food.
A quote of girl from sae article which said that “While buying packed foods from supermarket, I always look for date of manufacture on the label.” (14 years old, eighth grade, Hyderabad District, AP) To this comment, another participant in the group, who was 12 years old and in the fifth grade, added, ‘‘I too check the label on chocolates and biscuits and check for brand names, but I don’t do this for chewing gums and toffees.’’ ‘‘In case of packaged foods, we examine the date of packing and name of the firm.’’ (15 years old, tenth grade, Kottayam District, KER) Food labels not only contain nutrition information but also indicate food safety information like ‘‘best before’’ date, quality certification, declaration on allergens, and so on. Studies in other parts of the world have reported that about 40% of consumers do not check the food labels (Surujlal M, 2004; Yang S, 2000). However, others have observed that women, more so those with higher educational levels, were more likely than men to check food labels. (FSAI, 2008; Sudershan, 2008). In the Indian context, Subba Rao et al observed that literate women were more likely to check label information. In the present study this may also be true, because all the girls attended school.

Though, studies in other parts of the world reported that about 40% of the consumers do not check the food labels (Surujlal & Badrie, 2004; Yang, Angulo, & FSAI, 2008; Sudershan, 2008). Altekruse, 2000), it was observed that women, more so those with higher educational levels, were more likely to check food labels than men (FSAI, 2003; Yang et al., 2000). In KER this trend was clearly seen perhaps because it is the state with highest literacy rate in India (Census, 2001).

Literate respondents were more in the habit of checking labels on packed foods than their illiterate counterparts. However, efforts can be intensified to familiarize quality symbols on food labels, which can be identified even by the illiterates. At the same time, reporting to the health authorities in case of food poisoning or adulteration needs to be inculcated among the people. From this study, it can also be concluded that the Anganwadi Centers can be the focal points for food safety education to the mothers. The group discussions have an inherent limitation that the individuals may not produce the most accurate picture of their food safety behaviors and there is always a possibility of
reporting their best behaviors in order to present themselves favourably to others in the groups. Carrying out observational studies may give more accurate inferences about the food safety knowledge, attitudes and practices of mothers.

2.6. Legal awareness on food practices

Food is one of the essentials components for proper maintenance of human health. Access to pure, nutritious food, free from any type of adulteration is the right of every citizen. In the early times, consumer was considered as King of the market but in the contemporary society, consumers are no longer safe against the mal practices such as, substandard goods and unsatisfactory services. The consumer has every right to reject any product or services rendered by any manufacturer in the market and can mould them to produce goods of their choice. But Indian consumer are ignorant, illiterate and do not know the role of consumption vis-à-vis economic system as well as quality of life. When they are ignorant of their rights, they cannot know their responsibility as consumers. Consumers in the market find themselves deceived by wrong weights and measures, adulterated and substandard products causing great damages to health. Neelkanta and Anand (1992) found that people prefer to absorb and endure the wrong done to them rather than fight against injustice. This is because consumers do not know the ways and means of facing them confidently.

At present the consumer awareness in India is in its infancy. Vast majority of the people are not even aware of consumerism as a movement closely connected with the protection of their interest. Many constitutional provisions have been made by government to protect the consumers. Until and unless these provisions are availed of by the consumers, the protection of consumer becomes inevitable. There is a great need to make them aware of their rights and responsibilities.

2.6.1 Food safety law for Indian consumer

Article 25 of the Universal Declaration of Human Rights states that: Everyone has the right to a standard of living adequate for the health and well-being of himself and of his
family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.

**The Right to Life** is also guaranteed by Article 21 of the Indian Constitution, which the Supreme Court of India has read as protecting the right to health and a safe environment: "environmental, ecological, air, water, pollution, etc., should be regarded as amounting to a violation of Article 21." (Virendra Gaur vs. State of Haryana, 1995 2 SCC 577).

The United Nations now projects that by the middle of the next century the Indian population will actually exceed that of China (1.5 billion compared with 1.4 billion in China) and more than 55 percent of the Indian population will live in urban locations (26 percent in 1996).

Even more important, India has more than 250 million middle-class consumers and is likely to grow with economic prosperity. Income growth, urban-rural population composition, family size, and many other demographic factors are likely influence diet preferences significantly. But dietary changes in India may not be similar to most other countries because it is predominantly vegetarian.

The Directorate of Prevention of Food Adulteration is responsible for checking adulteration/misbranding of food articles. Food adulteration is thus a punishable offence under the provisions of **Prevention of Food Adulteration Act, 1954 and the Rules made in India**. The Central Government framed rules known as the "Prevention of Food Adulteration Rules, 1955". Under sec.23 of the Act the responsibility of implementation of Prevention of Food Adulteration Act and Rules framed there under vests in the State Governments and Union Territories. Each State Government and Union Territory has created its own structure/organization for implementation of the Act.

### 2.6.2 Regional laboratory for food safety

A Central Food Laboratory established under the act is located at Kolkata for the purpose of testing suspected food products. The Central Food Technology Research Institute
(CFTRI), Mysore has been recognized another laboratory for testing of adulteration food. The regional laboratories have also been established at PAU, Ludhiana, Pusa Delhi and Haryana State food Testing Laboratory. Now almost every state has its own food-testing laboratory to analyze the sampled suspected foodstuffs. Consumer awareness of quality of food and alertness in detecting common types of food adulteration can help in arresting this menace and enable Government to achieve the objective of ‘Health for All by 2000 A.D. There are various authorities that time to time check these issues in various food items, Food Inspectors, Local (Health) Authorities, Food (Health) Authorities, Public Analyst and Chemist. They also have duty to organize training program on food safety for consumers, traders, vendors and street food hawkers. Another act also exists the Food Safety and Standards Act, 2006, (FSSA) enacted by Parliament in August 2006. All considerations for the prevention of food adulteration should, therefore, focus on these three major underlying causes and it is obvious to anyone that prevention is undoubtedly the most difficult task.

2.6.3 Impact of legal awareness on consumers

The legal enforcement is only one measure for the prevention of food adulteration and it will not have any appreciable impact unless and until there is adequate supply of food at a reasonable price which the average consumer can afford, awareness of the small traders about the food standards which they are expected to maintain, awareness of the common consumer regarding the dangers of adulterations and how to take advantage of the legal machinery to force the traders to get the proper food and lastly, a sense of honesty among the food traders, big and small, in the maintenance of the safety and quality of food.

The poor performance of the Indian Public Health System is widely acknowledged. Analysts have attributed this failure to a number of factors, which include almost all the components that make a system functional, that is, infrastructure, human resources, logistics, and participation of the community. However, some attribute this failure primarily to low and declining public investment in healthcare and secondarily to structural and managerial weaknesses in the system.
2.6.4. Monitoring agencies for food practices

The foods most commonly involved in food-borne disease are meat and meat products, poultry, eggs, milk and milk products, sweetmeats and rice preparations. Besides domestic consumption, more and more food is moving across international borders for a combination of social, economic and technological reasons. The establishment of the World Trade Organization paved the way for several multilateral agreements on trade which include agreements on the Application of Sanitary and Phytosanitary (SPS) measures and on Technical Barriers to Trade (TBT). These agreements encourage countries to adopt international standards. In its pursuance of harmonization the SPS agreement specifically mentions the Codex Alimentarius Standards as the international standard and guideline. Within the context of the TBT agreement, the Codex Alimentarius Commission has been recognized as an international standardizing body.

The Codex Alimentarius Commission, a body of 165 member countries, administered jointly by the Food and Agricultural Organization and the World Health Organization (FAO/WHO) is committed to protecting the health of the consumers, ensures fair practices in the food trade and facilitates international trade in food. The Codex General Principles of Food Hygiene has recommended a Hazard Analysis Critical Control Point (HACCP) based approach as a means to enhance food safety and has indicated how to implement the principles.

The HACCP concept was developed in the 1960s as a system to ensure the safety of food products. The HACCP can be defined as a system which identifies, evaluates and controls hazards which are significant for food safety. Its introduction signaled a shift in emphasis from end product testing to preventive control at all stages of food production. The HACCP system was initially developed for use by food processors for preventing food-borne hazards. However, the application of the HACCP system has been expanding to form a basis for regulated food control and as a standard for international food trade. It is being promoted internationally as a preventive system of hazard control that is considered to be the most effective and efficient way to ensure food safety. It is an action oriented program to identify and reduce food-borne diseases.
The application of HACCP is compatible with the implementation of quality management systems such as ISO 9000 series and is the system of choice in the management of food safety within such systems. The HACCP system consists of the following seven principles: (i) Conduct a hazard analysis; (ii) Determine the Critical Control Points (CCPs); (iii) Establish critical limits; (iv) Establish a system to monitor control of the CCP; (v) Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control; (vi) Establish procedure for verification to confirm that the HACCP system is working effectively; and (vii) Establish documentation concerning all procedures and records appropriate to these principles and their application.

### 2.6.5 Food Regulation in India and HACCP

In India, quality control with regard to food products is being enforced through various regulatory mechanisms like the Prevention of Food Adulteration Act (PFA), Agriculture Grading and Marketing (AGMARK), Fruit Products Order (FPO), etc. The Bureau of Indian Standards (BIS) has recently launched a HACCP certification program for the food industry. The Mother Dairy of Delhi and the Punjab Cooperative Milk Federation has received HACCP certificates. The Agriculture and Processed Food Export Development Agency (APEDA) has helped mango processing units in Andhra Pradesh in implementation of HACCP. While efforts are being made to implement HACCP in the organised sector of the food industry, there is a need to implement HACCP in the unorganized sector also as it accounts for 70-80% of food produced and processed in India.

### 2.6.6. Food Laws in India - Food Regulation in transition

The Indian Parliament has in 2006 passed the Food Safety and Standards Bill, 2006, which overrides all other food laws, when it comes into effect:

- The Prevention of Food Adulteration Act, 1954
- The Fruit Products Order, 1955
- The Meat Food Products Order, 1973
- The Vegetable Oil Products (Control) Order, 1947
- The Edible Oils Packaging (regulation) Order, 1988
- The Milk and Milk Products Order, 1992
- Any other order issued under the Essential Commodities Act, 1955, relating to food

Currently, the Food Safety and Standards Bill, 2006, is being implemented, by setting up a Food Safety and Standards Authority of India. A date, when this will happen, is not yet
published. For the time being, importers and food processors have to orient themselves to the various old laws mentioned above.