INTRODUCTION
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Cereals and millets form the staple food of mankind. These include wheat, rice, maize, barley, oats, rye and various other millets. Raw foods may vary widely in their vitamin content as a result of genetic differences, climatic or soil conditions, maturity at harvest and handling conditions following the harvest.

An analysis of reports and data reveals both favourable and unfavourable effects of the food processing techniques used on nutritional quality of foods. There are many factors which may contribute to nutrient loss during processing. The factors include: air exposure (oxidation), light, pH, water content, natural biological enzyme systems of the food and the combined effect of these factors and heat.

On the positive side, heat processing destroys antinutritional factors such as trypsin and amylase inhibitors in cereal grains, peas and beans, thus improving the digestibility and bioavailability of proteins and carbohydrates in processed products. Heat processing also increases the palatability of food, resulting in an increased appeal and consumption. Wheat and rice are two most commonly used cereals generally considered as a staple food. Wheat is the most important cereal used throughout the world for consumption. Wheat flour is used to produce bread-stuffs which is superior to other cereals because of
gluten (Clark 1956). It is also a common cereal used throughout India for various traditional preparations and recently for processed foods. Nutritive value of wheat varies slightly from year to year (Shrinivas et al 1984). Wheat is grown in large quantities in temperate climates. It is extensively grown in the U.S.A., Canada, Argentina, Australia, Europe, Russia, Egypt, Pakistan, China and India. Common species of wheat are 1). Triticum vulgare (common hard wheat). 2). Triticum durum (Durum wheat). 3). Triticum compactum (soft white wheat).

Rice is the principal food crop serving half of the world's population. It is a staple food for people living in China, India, Pakistan, Korea, Ceylon, Thailand, Indonesia and Philippines (Shivraj 1972). Rice is also used as one of the ingredients in many recipes throughout India. Rice is grown in large quantities in all Asian countries. Rice is rich in carbohydrates, unique in its protein, consisting of large amounts of glutelin compared to maize and sorghum. (Virgil et al 1974).

Wheat and rice both are necessary to be processed for human consumption. Bread, biscuits, toast, wheat flakes, shredded wheat, semolina, wheat germ, cake, noodle, macaroni, spaghetti are industrial products obtained from wheat. Rice flakes, beaten rice, paddy puffed rice and puffed rice are processed products obtained on a large scale from rice.
Wheat and rice are also processed at home scale for daily consumption. Wheat flour is commonly used for the preparation of chapati and poori. Chapati is a traditional recipe for Gujarat but new for southern coastal families, also for the people of hilly region, in West Bengal, Orissa and Bihar (Govilkar 1984). About 80 to 90% of wheat consumption in India is in the form of Chapati (Austin et al 1971). Commonly available varieties of rice are raw milled and raw handpounded. The parboiled rice are cooked by boiling, steaming and pressure cooking. Rice in combination with dal is used for preparation of recipes like Idli, Dhokla, Dosa, Uthappam, Handwa, Vada and Kichari.

Legumes and pulses are next to cereals and millets for mankind. The edible leguminous seeds are important source of proteins in the diet of millions of people in Asian, African and Latin American countries. Whole legumes and dehusked split legumes known as dal are used in the preparation of several recipes in India. Generally whole legumes are soaked in water overnight and cooked in excess water. Excess water is then discarded. The cooked legumes are seasoned with salt and condiments and consumed. Soaked legumes are also germinated and cooked. Legume flour alone or in combination with cereals is fermented and cooked for the preparation of a variety of recipes. Ungerminated and germinated soaked legumes are widely consumed as a side dish along with main
food items prepared out of cereals.

Soaking, germination and fermentation are the processing methods generally adapted before the cooking process. These three methods are advantageous in destroying food toxins present in legumes. Trypsin inhibitors, haemogglutinins and growth inhibitors are destroyed by autoclaving the legumes at 15 lbs pressure for 30 minutes.

Cooking is a broad term which includes baking, broiling, roasting, boiling, frying and stewing. The baking method requires dry heat (temperature greater than 212°F) while boiling and stewing require moist heat. Frying involves cooking in oil at a temperature much higher than 212°F. Changes that take place due to cooking are destruction or reduction of microorganisms, inactivation of undesirable enzymes, destruction of potentially hazardous natural toxins present in foods or those produced by microorganisms and change in colour, flavour and texture.

Considering all the above points food processing is defined as a process which includes all treatments to foodstuff from the place of origin to the point of consumption. More than 95% of our food is processed. Most foodstuff are not fully acceptable and must be trimmed or cooked to make them more palatable and acceptable.

Higher temperature, unless for extremely short duration or a matter of seconds, results in the breakdown of protein
and fat but very little effect is seen on carbohydrates (Shrinivas et al. 1984). The time for which chapatti or bread is exposed to heat is more important than the amount of surface exposed (Martin. 1985). Carbohydrates may be made more bio-available and more digestible as a result of processing. Mild heat treatments can swell and rupture the polysaccharide molecules, enhancing digestion by amylases. Over heating however, can cause browning and thereby reduced digestibility. The decrease in availability of carbohydrates is due to their interaction with proteins (Joshi. 1995). Loss of nutrients during processing has been reported by many investigators. Veena et al. (1963) reported a decrease in the protein content during the cooking of bajra, wheat and barley at high temperature. Toepfer et al. (1955) accounted a loss in protein content during oven roasting. Pathak et al. (1978) observed a loss in protein content due to an increase in temperature.

To make food more palatable and acceptable various processing methods are used. The methods are washing, cutting, soaking, germination and fermentation. These processes are generally used before the food is to be cooked. Cooking of food also implies various methods, such as deep fat frying, shallow fat frying, roasting, grilling, baking, simmering, boiling, pressure cooking, microwave cooking and solar cooking.
A variety of cooking procedures are utilized at home. Choice of home processing method can directly affect the nutrient intake of a family. (Miloslav 1986).

Nutritional evaluation of food processing refers to two discrete variables. These are the changes in nutrient level, the dependent variable and as function of processing, the independent variable. Various food processing methods either accelerate or retard the change in nutrient level. Food processing covers simple treatment applied to food in kitchen. Treatment applied renders the food more appetising, attractive and digestible (Chopra et al 1978). Various cooking methods with descriptions are presented in Table -1.

Conventional Cooking

Boiling and cooking are essential household procedures that are sometimes also used in the food industries but generally under better controlled conditions. Perhaps the most utilized cooking procedure for foods of plant origin is boiling. Food is cooked by pressure cooking, cooking with water to cover food and boiling with water. Average retention of the minerals, calcium, iron and phosphorus is only about 75%, when vegetables are cooked covered with water, while 85% of minerals are retained after pressure cooking or cooking with minimal water.
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<td>Food subjected to microwave radiation in an oven</td>
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<td>Food cooked in closed containers by solar energy.</td>
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Table: 1 Method of Cooking:
Thiamine, riboflavin, niacin and ascorbic acid are reduced by 10% when pressure cooked with minimum water. Further 10% loss is obtained in food cooked with covered water. Retention of vitamins and minerals are lowest when volume of the cooking water is huge, duration of cooking is long and the size of the particles is small. Pressure cooking in sauce pan retains most ascorbic acid in vegetables. Excessive heat and more usage of cooking water results in destruction of 50% of some heat labile and water soluble nutrients.

Roasting means to cook food by dry heat without covering it. Food is roasted or baked on heated metal, on stones or under hot coals, in hot ash or in an oven. Food prepared by this method includes chapatti, roti, nan, and other unleavened breads, potatoes, sweet potatoes, other tubers, jowar, corn, paddy, groundnuts, cashewnuts, walnuts, pistachios etc. Broiling or grilling refers to cooking of food by exposing it to direct heat. The food is cooked in part by contact with the hot broiler (conduction) and partially due to the radiant energy. Many food preparations are made by using more than one method of heat transfer.

Frying is a unit operation, which is used to alter the quality of food. A second consideration is the preservative effect that results from thermal destruction of microorganisms and enzymes and reduction in water activity at the
surface of the food. When food is placed in hot oil, the surface temperature rises rapidly and water is vaporised as steam. The main purpose of frying of food is to develop characteristic colours, flavours, and aromas in the crust of fried food.

Deepfat frying is a process in which heat is transferred in combination with convection within the hot oil and conduction to the interior of the food. The surface of the food receiving similar heat treatment produces a uniform colour and appearance. Deepfat frying is suitable for all foods of all shapes, but irregularly shaped foods tend to contain a greater volume of oil when it is removed from the pan. (Fellows, 1996).

Shallow or contact frying method is most suitable for foods which have a large surface area to volume ratio. Heat is transferred to the food mostly by conduction from the hot surface of the pan to the thin layer oil. The thickness of the layer of oil varies owing to irregularities in the surface of the fried food. This together with the action of bubbles of steam which lift the food off the hot surface, causes temperature variation as frying proceeds and produces the characteristic irregular browning of shallow fried food.

The effect of frying on nutritive value of foods depends on the process used. High oil temperature produces a rapid crust formation. This reduces the extent of changes to the
back of the food and therefore retains a higher proportion of nutrients. A 17% loss of lysine was reported in fried fish (Tooley et al 1972). Cooking of liver slice in a pan with margarine over a slow gas flame resulted in the loss of 15% of thiamine, 6% of riboflavin and 13% of niacin. Cooking frozen liver slices increased the loss of thiamine and decreased the loss of riboflavin (Miloslaw 1986).

In the context of diet and nutrition, food lipids serve as a source of energy, provide essential fatty acids (linoleic acid and linolenic acid) and facilitate the absorption of fat soluble vitamins (Mead et al 1986 and Linschneer and Vergroesen 1988).

The various components of food lipids perform many desirable organoleptic, physical, nutritional and biological functions. Edible fats and oils are excellent cooking media. They can be heated to above 100°C to provide rapid cooking (without the steam associated with boiling water) and simultaneously impart surface texture known as crispness and flavour to fried foods. Many of the desirable food flavours and aroma which occur in minute concentration are derivatives of lipid components. At low concentration carbonyl compounds derived from unsaturated fatty acids via oxidation (enzymatic and auto-oxidative) are important compounds of flavors of many foods (Min and Smouse 1988).
Dietary lipids are hydrolysed by pancreatic lipase. The fatty acids and monoglycerides are absorbed in the upper segment of the small intestine. These are mostly resynthesized to triglycerides in the mucosal epithelial layer and assembled into chylomicrons, which enter the bloodstream via the lymphatic system. These chylomicrons are metabolized in liver and tissue (Mead et al. 1986).


Microwave cooking:

Microwave heating is rapid and does not overheat the surface, which produces minimum heat damage and no surface browning. Compared with conventional cooking, microwave rendering of fats improves the colour, reduces time by 95% and cost by 30% (Decareau 1985). It does not cause
unpleasant odours. Microwave heating offers no nutritional advantage over steaming (Schiffman et al 1972). Microwave energy is a form of electromagnetic energy. When food is placed in the path of microwaves, some of the electromagnetic energy is absorbed and converted to heat. Microwaves are reflected by metals. Microwave heating accomplished by high energy, electromagnetic radiations is an extremely efficient process that permits virtually no heat loss. Thomas et al (1994) reported higher thiamine retention and no loss of riboflavin when beef patties were cooked by microwave as compared to when grilled by conventional method. Beef roasted retained more thiamine and riboflavin after the conventional method than microwave cooking. Rapid heating in a microwave reduces the thermal destruction of nutrients at a given location (Datta and HU 1992).

Soaking and Germination:

Soaking, germination and fermentation are the processing methods generally adopted prior to cooking. Soaking, germination and sprouting are three processes which are associated with the development of sprouts. These bring out the desired changes in dry seed grains and legumes. These are complete food, cheap, simple and easy to prepare. Sprouts are finest single food, complete and rejuvenating food. In the dry state they lack in several vital nutrients. When they are sprouted they undergo various processes involved in sprouting. The
shoots absorb, multiply, pick up or manufacture the missing nutrient not present in enough quantity in the dry state. One kilogram of dry seeds produce nearly six kilogram of sprouts. The water which increases the bulk undergoes amazing changes due to the action and interaction of O$_2$, temperature and darkness upon the seeds. Seeds becomes juicy, sweet, anticonstipative and predigested. The seeds burst and the seedlings appear. Thereafter the process of sprouting further enhances.

Sprouted grains are predigested food which has already been acted upon by enzymes. Some carbohydrates are converted into easily digestable sugars. The enzyme diastase sets to work on the carbohydrate portion of sprout grains or seeds. Sprouts are better digestable compared to unsprouted and cooked ones. Oligosaccharides are reduced by as much as 90% making sprouts antigas formative.

The process of sprouting increases the quantity of vitamins several fold. Vitamin"C" increases more than six times and B complex vitamins considerably. They contain the full spectrum of minerals, which undergo significant changes. They change the compound into the water soluble form which can be easily assimilated (Vaish 1985).

Burkholder (1980) reported an enormous increase in "B" complex vitamins. A nonsignificant increase was observed for thiamine. He has reported increase in riboflavin (1350%).
niacin (500%), biotin (51%), pantothenic acid (200%), pyridoxine (500%), folic acid (600%) and inositol (100%) for oats. Bailey (1982) reported 100% increase in thiamine on the sprouting of mung and three fold increase in vitamins E and C. 85% of vitamin C is present in grain and 15% in shoot.

Total protein is increased about 21/2 times in the process of sprouting. During sprouting of wheat sucrose increased two fold, maltose sixty fold, glucodifructose four fold, raffinose three fold leading to quick energy food.

Sprouted legumes are a major source of food proteins. During germination the proteins undergo considerable changes because of proteolytic activity. The proteins are changed significantly in the early stage of germination of legumes with the break down of low molecular weight fractions followed by high molecular weight components. This results in an increase in the level of free amino acids and peptides which are translocated to the embryonic axis (Ganesh 1975).

During germination globulins which are the most predominant class of protein in most legumes are decreased (Danielson et al 1956).

Andy et al (1983) reported loss of protein until 18 hrs. of germination, thereafter protein concentration begins to increase. It is possible that hydrolytic products of protein are used for synthesis of new cellular materials and enzymes that are involved in the breakdown of lipids and
carbohydrates. Raffinose, stachyose and verbascose decrease on germination (Sudesh et al 1985).

Glutamate dehydrogenase (GDH) is present in large amounts in the mitochondria of all plants. A possible role of GDH in germinating legumes seeds has been the production of ammonia from glutamate for asparagine synthesis. GDH is involved in the reassimilation of ammonia liberated by conversion of glycine to serine in the mitochondria during photorespiration (Hewitt et al 1977). The nitrogen atom which occurs in natural compounds in several different state of oxidation is incorporated into organic molecules mainly in the form of ammonium ions or amino acids which are readily deaminated to yield ammonia can incorporate the ion in to organic compound.

Nitrogen fixation is the process by which molecular nitrogen or dinitrogen is reduced to ammonia. Biological reduction of nitrogen is confirmed to prokaryotic microbes, such as Azobacter species. Synthesis of extra cellular protein taking place in outer surface of plasma membrane includes, exoenzymes and certain toxins, extra cellular proteins contain few or no cystin residue (Rose 1976). Bact. lactis viscosum, Bact. pneumonia, Bact. radiobacter, Bact. prodigiosum, Bact. mesentericus, Bact. astersporous, Bact. azophile and planobac nitrigenus can fix atmospheric nitrogen.
The productivity of nitrogen fixation by Azotomonous fluorescence is approximately equal to 12 mg of nitrogen per gram of substance utilized. Reduced compounds like mannitol, sorbitol, glycerol have a productivity of N\textsubscript{2} fixation which is 1-2 mg higher. Productivity is higher when Azotomonous fluorescence utilize lactic rather than pyruvic acid. They can utilize amino acids and peptone as the source of carbon and nitrogen (Mishustin et al 1971).

Nonspore forming bacteria can also fix nitrogen. Micrococcus forming yellow colonies are able to fix 3 mg of N\textsubscript{2} per gm of sugar (Lohnis et al 1987). The micrococci activity reduces nitrate to nitrite (Coretti 1977 and Favier et al 1980). Mixed cultures reduce residual nitrite and nitrate (Berwal et al 1998).

Fermentation :-

The fermentation process makes the food more palatable and easy to digest. It makes better utilization of available raw material. According to George Burgstron (1957) there are three types of mechanisms by which fermentation increases the nutritional value. The first mechanism is due to microorganisms. The micro-organisms are not only catabolic but they also synthesize several complex vitamins and other growth factors. The second mechanism by which fermentation can enhance nutritional value is by liberation of nutrients locked into plant structure cells, present in certain grains
and seeds. The third mechanism by which fermentation can enhance nutritional value involves enzymatic splitting of cellulose, hemicellulose and releases polymers into simple sugar. Cereals and millets with combination of pulses are used to prepare many fermented products. Flour is generally fermented and used to prepare products like Dhokala, Handwa, Idli, Khaman, Vada etc. Fermented foods are highly acceptable and palatable to children, adults and sick people.

Many authors have reported changes in protein, thiamine and riboflavin during soaking, germination and sprouting, fermentation and cooking. They are reported in Table - 2.

**Bioavailability of the Nutrients**

Bioavailability of the many nutrients depends upon the nutrients present in the food. Nutrient such as protein, carbohydrate, fat, vitamins etc. According to Roger et al (1950) 20% protein diet and 20% fat diet both require higher amounts of riboflavin, 40% fat diet requires two times higher amounts of riboflavin. High fat diet decreases $B_2$ level in the organs and feaces, but high fat diet with 20% protein does not alter tissue $B_2$ level. This may be due to the inter-relationship of protein, lipid and riboflavin. Riboflavin requirement is also based on the thiamine requirement and both are also dependant on the carbohydrates. Coenzyme forms of these vitamins are essential for the metabolism of
<table>
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<th>Grain/Pulse or Product</th>
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<th>Riboflavin</th>
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<td>Aliyu et al (1981)</td>
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<td>Ragi</td>
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<td>-</td>
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Tongnual et al (1979)
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protein, fat and carbohydrates.

Thiamine, Riboflavin and niacin are the examples of B complex groups required as coenzymes for the availability of the dietary proximate components. The vitamin B$_2$ complex can be divided into three subgroups. The first comprises nicotinic acid and riboflavin, which together are associated with more or less clearly defined deficiency diseases. The second group includes pyridoxine, pantothenic acid, biotin, folic acid and p-aminobenzoic acid. The third subgroup of the vitamin B$_2$ complex includes inositol, choline and possibly methionine. All the three are lipotrophic factors, which prevent the formation of fatty livers produced by feeding various supplements to experimental animals. Absence of lipotropic factors from the diet of rats causes loss of hair (Robinson 1945). B$_2$ vitamins are curative factors for the prevention of nutritional macrocytic anemia (Wills et al 1945). FAD is a coenzyme form synthesised from riboflavin in a two reaction pathway. First the 5' OH group of riboflavin's ribityl side chain is phosphoregulated by flavokinase, yielding flavin mononucleotide (FMN). FAD may then be formed by coupling FMN and AMP in pyrophosphate linkage in a reaction catalysed by FAD pyrophosphorylase (Donald et al 1995). The level of FMN and FAD are limited by the activities of the flavoprotein enzymes, just as the accumulation of the flavoprotein apoenzymes may be dependent upon adequate levels.
of FMN & FAD. It is known that FAD which is not bound to protein is much more easily subjected to enzymatic hydrolysis than bound FAD. Level of FAD and FMN can be used for the assessment of riboflavin states of the individual (Debashis et al 1995).

The literature reviewed suggests that very little work has been carried out for chemical composition and bioavailability of freshly prepared staple foods which are used daily as a part of a meal. Human diseases are either hereditary or due to environment or food. To change food habits is relatively easy as compared to heredity and environment. Knowledge regarding nutrients present in cooked food helps the housewife and dietitian to plan a diet and to survey or to find out the source of the nutritional deficiency in order to achieve good nutritional status.


Retention of certain vitamins due to heat processing may be as low as 10% or as high as 100%. As a result of
these variations it is difficult to make general statements about the effect of heat processing on nutrients (Joshi 1995).

Minerals are generally not sensitive to heat during processing, but are susceptible to leach into water during processing in cooking water. A decrease in calcium content in vegetables and in cowbeans is reported by many workers (Dakota et al 1978, Ganesh et al 1978 and Oyabiodum et al 1981) whereas an increase in calcium content is reported by Khalil and Sawaya (1984).

A decrease in the phosphorous content was observed during the cooking of broadbean and the traditional Nigerian breakfast "koko" and "kosai" (Shahy et al 1980). It may be due to leaching off in cooked water (Osinubi et al 1981).

Cooked food showed an increased PER on roasting of the legumes (Chandraseker et al 1978) whereas a decrease in PER was observed due to the autoclaving of soy (Womack et al 1974).

Reduction in lysine during the wet heating of groundnut (Zombade and Sathe 1977) and in cystine due to autoclaving (Iriarte and Barnes 1966) may be responsible for the decrease PER.

Germination is also a beneficial process. Germinated seeds are better digestable and have low flatuence and show increased B group vitamins and Vitamin C. Mineral salts
present therein undergo a significant change with the help of water, oxygen, temperature and darkness.

Fermentation of food is reported to be a beneficial process to improve the biological value of proteins. PER of the fermented product is nearer to casein. Fermentation shows a 30% increase in tryptophan (Miloslav 1986).

Tabekhia et al (1980) reported a significant increase in phosphorus content due to the breakdown of phytic acid. Riboflavin content of the food products showed a 100 to 150% increase due to fermentation in corn, wheat, bengalgram, soyabean, mothbean, greengram, blackgram, lentils (Rajalakshmi 1970, Sultana et al 1981, and Eka et al 1980).

Invitro protein digestibility of fermented foods is also higher (Moneim et al 1995).

The Literature reviewed suggests that very little work has been carried out on the chemical composition and bioavailability of freshly prepared staple foods which are daily used as a main part of the meal, therefore, rice and wheat were used for the preparation of various recipes commonly used in daily cooking. These recipes were analysed for nutrients such as protein, fat, thiamine, riboflavin, iron, calcium and phosphorus. Freshly prepared products fed to the animals were studied for the availability of the above nutrients. Study was also carried out to determine the
beneficial effect of fermented foods such as Idli and Vada. Further the nutrient loss during the deep fat frying of common snacks was also studied. Changes in protein, riboflavin, thiamine, vitamin "C", iron, calcium, and phosphorus content during soaking, germination and cooking of the commonly used legumes content was also determined.