Food Processing: need and effect on nutrient content

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ABSTRACT
Processed foods or modified raw foods made by the addition of hormones, additives, preservatives, other chemical or heat treatments that alter the natural healthy enzymes, fatty acids, vitamins and minerals. In comparison to raw and unprocessed foods, processed foods are usually safer, durable and with high level of bioactivity of nutrients. At present, the advancement in food processing methods and techniques is necessary to meet the challenges of food security & safety, nutrition demand and availability of food at the global level. Therefore, the present review comprises the information about the effects of food products on health at global level by means of several examples of processed foods with their nutritional contents before and after processing. All the necessary data and information is gathered through secondary sources.

KEYWORDS
Nutrient, Modified Raw Food, Processed Food, Bioactivity

We all process foods every day when preparing a meal for ourselves or our family and virtually all foods undergo some form of processing before they are ready to eat. Some foods are even dangerous if eaten without proper processing (Henry and Chapman, 2002). Dagur Jonson explained that food processing is the transformation of raw ingredients, by physical or chemical means into food, or of food into other forms which can be easily prepared and served by the consumer. Food processing typically involves activities such as mincing and macerating, liquefaction, emulsification, and cooking (such as boiling, broiling, frying or grilling); pickling, pasteurization, and many other kinds of preservation; and canning or other packaging. Processed foods are usually less susceptible to early spoilage than fresh foods and are better suited for long distance transportation from the source to the consumer (Johns Hopkins center). In this demanding era, the advancement in research is necessary to meet the challenge of food security and availability of food that is not only for feeding purpose but also rich in nutrition, because it is associated with well development of human resources in any country and it directly affects their contributions to the world (Satyanarayana et al., 2012).

Groups of Processed Food

Group I

It contains least processed foods that have been undergone to some processes that does not alter the nutritional properties of the original foods which remain recognizable as such, while aiming to preserve them and make them more accessible, convenient, sometimes safer, and more palatable.
Such processes include cleaning, removal of inedible fractions, portioning, refrigeration, freezing, pasteurization, fermenting, pre-cooking, drying, skimming, bottling and packaging. Fresh meat and milk, grains, pulses (Zaidi and Rawat, 2011), nuts, and fruits, vegetables, roots and tubers sold as such, are least processed by various means (Tortoe et al., 2011).

**Group II**

Extracted Substances from whole food include oils, fats, flours, pastas, starches and sugars. Mostly they are not consumed by themselves. Traditionally they are ingredients used in the domestic preparation and cooking of dishes mainly made up of fresh and minimally processed foods but now the use of group II foods has been transformed. They have become the raw material bases for the third group, of ultra-processed foods (Nautiyal, 2011).

**Group III**

This group contains the ultra-processed foods that are basically derived from group II ingredients, typically combined with sophisticated use of additives, to make them edible, palatable. In general, these foods are not similar to group I foods, although they may be shaped, labelled and marketed so as to seem wholesome and ‘fresh’. Unlike the ingredients included in group II, ultra-processed foods are typically not consumed with or as part of minimally processed foods, dishes and meals. Ultra processed foods have great value of micronutrients and the biofortification techniques are largely applied to this kind of (Nautiyal, 2011). Therefore, the aim of this review is to provide the recent information about the effects of food products on health at global level by means of several examples of processed foods with their nutritional contents before and after processing.

**Methodology**

All the necessary data and information is gathered through secondary sources.

**Human Need of Nutrient and Food Security**

Nutrient required for normal body functioning that either cannot be synthesized by the body is known as essential nutrient and thus must be obtained from a dietary source (Ahmed et al., 2009). Major groups of essential nutrients in human diet are essential fatty acids, essential amino acids, vitamins and dietary minerals (Atuobi et al., 2011). Every human require nutrients to meet their metabolic needs, inadequate consumption of even one of this nutrient will result in adverse metabolic disturbances leading to sickness, poor health, impaired development in children as well as in adults (Basseri and Austin, 2011). The dietary habit in this developing and faster world has greatly made changes in the nutrition transition shifts and in the preset scenario the unprocessed foods present its nutritional quality only when it is consumed in fresh condition. Processed foods are getting attention to be consumed by the peoples because its durability, nutrition content (for e.g. increased by biofortification means) is also comparable to fresh food and easy availability (Bioavailability).

The availability of fresh and nutrient rich agro foods is a growing problem in many countries and the demand for food is relatively inelastic in manner and thus the need of food security which can be defined as “all people at all times having both physical and economic access to the basic food they need”(World Bank). The World Health Organization (WHO, 1985) recommends an intake of between 2500 – 3400Kcal of energy per person per day. It is recommended that an individual should consume between 65-86g crude proteins per day out of which 35g (or 40%) must be animal protein. While many developing countries have energy intake that is far below the minimum recommended daily per capita intake, the world today faces the greatest challenge of overcoming inadequate consumption of protein (especially animal protein), vitamins (vitamin A, C and folic acid) and minerals (iron) which may result in various deficiency symptoms (diseases). These factors have made it necessary to provide new nutritive values to raw agricultural products by its processing and enrichment through available techniques and methods (Wiebe, 2003).

**Benefits**

Processing (including preparation) makes food healthier, safer, tastier and more shelf-stable. While the benefits are numerous, processing can also be detrimental, affecting the nutritional quality of foods. Blanching, for example, results in leaching losses of vitamins and minerals. Also, milling and extrusion can cause the physical removal of minerals during processing.
The nutritional quality of minerals in food depends on their quantity as well as their bioavailability (MacEvilly and Peltola, 2003). Cooling is the primary technology used to maintain freshness, whereas many more technologies have been invented to allow foods to last longer without becoming spoiled. These latter technologies include pasteurization, autoclavation, drying, salting and separation of various components (Saldana et al., 2011). Advance techniques of separation such as centrifugation, milling and pressing have enabled concentration of particular components of food, yielding flour, oils, juices and so on and even separate fatty acids, amino acids, vitamins and minerals (Matthaus and Ozcan, 2011). Such large scale application of techniques has changed the nutritional content of food, saving certain nutrients while removing others. Because processed foods are often cheaper, more convenient (in purchasing, storage, and preparation), and more available, the consumption of processed foods has been increasing throughout.

**Fast Facts about Food Processing (Henry and Chapman, 2002)**

- Humans have been processing foods-preserving them for future use and to ensure their safety-for centuries.
- Food processing provides the means to extend shelf-life of otherwise perishable foods, thus increasing choice and reducing the dependency on seasonality.
- Storage losses in fresh foods are generally greater than those associated with food processing, and food processing can improve the nutritional value of certain foods.
- The addition of nutrients to foods and drinks is used globally as a public health measure and is a cost-effective means of ensuring nutritional quality of the food supply.
- Canned, fresh and frozen fruits and vegetables all provide nutrients needed for a healthy diet. Exclusively consuming fresh fruits and vegetables ignores the nutritional benefits provided by processed foods, which include both manufactured foods as well as foods processed in the home. The world because of many nutrition-related health complications with unprocessed foods.

**Drawback**

Nearly every food preparation process reduces the amount of nutrients in food. In particular, processes that expose foods to high levels of heat, light, and/or oxygen cause the greatest nutrient loss. Nutrients can also be "washed out" of foods by fluids that are introduced during a cooking process. The table below compares the typical maximum nutrient losses for common food processing methods. This table is included as a general guide only. Actual losses will depend on many different factors, including type of food and cooking time and temperature.

**Effect of Processing on Food Nutrient (Audrey Morris, 2004)**

**Fat**

- Oxidation accelerated by light.

**Protein**

- Denatured by heat (improves digestion).

**Amino Acids**

- Some are sensitive to light. Lysine bioavailability reduced by non-enzymatic browning.

**Vitamin C (Ascorbic acid)**

- Decreases during storage, drying, heating, oxidation, cells damage e.g. chopping or slicing, losses due to oxidation catalyzed by copper, iron. Stable to heat under acidic conditions e.g. pasteurization of orange juice.

**Vitamin B₁ (Thiamine)**

- Destroyed by high temperatures, neutral and alkaline conditions (e.g. baking soda, baking powder) conditions and lost in cooking water.

**Vitamin B₂ (Riboflavin)**

- Sensitive to light at neutral and alkaline conditions, moderately heat stable under neutral conditions and sensitive to heat under alkaline conditions.

**Vitamin B₃ (Niacin, Nicotinamide)**

- The most stable vitamin, stable to heat and light, leaches into cooking water folate, decreases with storage, or prolonged heating, lost in cooking water and also destroyed by use of copper utensils.
Table 1. Typical maximum nutrient losses due to cooking

<table>
<thead>
<tr>
<th>Vitamin and Minerals</th>
<th>Freeze</th>
<th>Dry</th>
<th>Cook</th>
<th>Cook + Drain</th>
<th>Reheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Retinol Activity Equivalent</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Alpha Carotene</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Beta Carotene</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Beta Cryptoxanthin</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Lycopene</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vit A- Lutein+Zeaxanthin</td>
<td>5%</td>
<td>50%</td>
<td>25%</td>
<td>35%</td>
<td>10%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>30%</td>
<td>80%</td>
<td>50%</td>
<td>75%</td>
<td>50%</td>
</tr>
<tr>
<td>Thiamin</td>
<td>5%</td>
<td>30%</td>
<td>55%</td>
<td>70%</td>
<td>40%</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0%</td>
<td>10%</td>
<td>25%</td>
<td>45%</td>
<td>5%</td>
</tr>
<tr>
<td>Niacin</td>
<td>0%</td>
<td>10%</td>
<td>40%</td>
<td>55%</td>
<td>5%</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>0%</td>
<td>10%</td>
<td>50%</td>
<td>65%</td>
<td>45%</td>
</tr>
<tr>
<td>Folate</td>
<td>5%</td>
<td>50%</td>
<td>70%</td>
<td>75%</td>
<td>30%</td>
</tr>
<tr>
<td>Food Folate</td>
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<td>50%</td>
<td>70%</td>
<td>75%</td>
<td>30%</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>5%</td>
<td>50%</td>
<td>70%</td>
<td>75%</td>
<td>30%</td>
</tr>
<tr>
<td>Vitamin B12</td>
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<td>0%</td>
<td>45%</td>
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<tr>
<td>Calcium</td>
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<td>0%</td>
</tr>
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<tr>
<td>Phosphorus</td>
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<td>70%</td>
<td>0%</td>
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<tr>
<td>Sodium</td>
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<td>25%</td>
<td>55%</td>
<td>0%</td>
</tr>
<tr>
<td>Zinc</td>
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<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Copper</td>
<td>10%</td>
<td>0%</td>
<td>40%</td>
<td>45%</td>
<td>0%</td>
</tr>
</tbody>
</table>

(USDA Table of Nutrient Retention Factors (2003), Typical Maximum Nutrient Losses due to cooking [1])

**Vitamin B6 (Pyridoxine, Pyridoxal)**

Heat stable in alkaline and acidic conditions, Pyridoxal is heat labile.

**Vitamin B12**

Destroyed by light and high pH Because of reduced nutritional value of raw agricultural and unprocessed foods, processed foods are often ‘enriched’ or ‘fortified’ with some of the most critical nutrients like certain vitamins or dietary minerals, during and after processing. Therefore, processed foods have an inferior nutritional profile compared to whole, fresh foods (Satyanarayana and members). The well documented evidences from epidemiological studies indicate several degenerative diseases, cardiovascular diseases and some types of cancers are linked with diet and nutrition uptake and its regulations.

All these diet-related problems are likely to change eating habits, processing technologies, and products.

**Strategies and Trends for Future Food Processing and Production**

If the aim is to understand and improve nutritional quality of any raw food to meet the food security challenges and human health following points could be helpful for food processing industry:

- Physical characteristics of agricultural products are the most important parameters in design of grading, conveying, processing and packaging systems.
- Creation of desired food products by new processing technologies based on micro-structure analysis of food.
- Understanding the chemical basis of taste, texture and flavor.
• Understanding the influence of food structure on human physiology and nutrition role of food constituents/food viscosity in energy intake
• Preservation of original cell structure.
• Re-evaluation of existing processes in the light of new knowledge and conventional/traditional technologies.
• Improvements and research.
• Selection of the best conventional methods.
• Novel products creation of desired food products:
  1) Micro-structure analysis of food
  2) Chemical basis of taste, texture and flavour: study and alterations
  3) Maintenance of original cell structure, and bioactivity of nutrients in food.
  4) Study on influence of food structure on human physiology and nutrition role of food constituents/food viscosity in energy intake.
• Final processing of food by advance methodologies like fortification.
• Final processed food with improved nutritional quality.
• Improved product performance.
• Novel innovative technologies.

Regarding the above mentioned points some strategies and trends for future food processing and production related trends that may be helpful for the improvement of the final processed food product quality.

Conclusion

Today, for better and for worse, nearly all our food is processed in some way. Food processing offers important benefits to businesses and consumers, including a more varied food supply and foods with a longer shelf life. Certain aspects of food processing, however, raise concerns over dietary health, worker health, and food safety.

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Dagur Jonson is the CEO of LibiusInc a company which provides an internet appropriation service to companies in the food processing industry like: http://www.marelfoodsystems.com and http://www.marel.com.


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USDA (2003) Table of Nutrient retention factors.


