Effect of Processing on Nutrient Content of Foods

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Several factors will influence the nutritional content of the food and the type and level of losses due to processing. These include the genetic make-up of the plant or animal, the soil in which it is grown, use of fertiliser, prevailing weather, maturity at harvest, packaging, storage conditions and method of preparation for processing. The storage conditions and handling after processing are also important to the nutritive value of the food.

The effect of food processing on nutrient content will depend on the sensitivity of the nutrient to the various conditions prevailing during the process, such as heat, oxygen, pH and light. The nutrient retention may vary with a combination of conditions, such as the characteristics of the food being processed, and the concentration of the nutrient in the food. For example, sensitivity of vitamin C to heat varies with pH. It should be noted that the macronutrient and vitamin content of foods are more likely to be affected by processing than the mineral content.

In considering the effects of processing on nutrient content of specific foods, it should be considered whether the food is one that serves as a worthwhile source of a particular nutrient. The losses of protein (amino acids) during blanching of green peas, for instance, might be of more relevance to the diet than that of vitamin C from the same source.

It is important that processing is done within the recommended guidelines e.g. for heat and pH, as over processing will further destroy not only nutrient content but also taste and appearance. Table 1 shows how some nutrients are affected by conditions which may apply during processing.

Heat Processes

Heating can be both beneficial and detrimental to nutrient content of foods. It generally improves the digestibility of foods, making some nutrients more available. A typical example is the protein in legumes, which is made more digestible by heating because of the inactivation of anti-nutrients such as trypsin inhibitors.

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Table 1: Effect of Processing on Nutrient Foods

Nutrient	Effect of Processing
Fat	• Oxidation accelerated by light
Protein	• Denatured by heat (improves digestion)
Amino Acids	• Some are sensitive to light. Lysine bio -availability reduced by non - enzymatic browning
Vitamin C (Ascorbic acid)	• Decreases during storage, drying, heating, oxidation, cell damage (e.g. chopping or slicing) Losses due to oxidation catalysed by copper, iron • Stable to heat under acidic conditions (e.g. pasteurisation of orange juice)
Vitamin B_1 (Thiamine)	• Destroyed by high temperatures, neutral and alkaline (e.g. baking soda, baking powder) conditions. • Lost in cooking water
Vitamin B_2 (Riboflavin)	• Sensitive to light at neutral and alkaline conditions • Moderately heat stable under neutral conditions • Sensitive to heat und er alkaline conditions
Vitamin B_3 (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 • Destroyed by use of copper utensils
Vitamin B_6 (Pyridoxine, Pyridoxal)	• Heat stable in alkaline and acidic conditions • Pyridoxal is heat labile
Vitamin B_{12}	• Destroyed by light and high pH
Carotenes	• Easily destroyed by heat • Oxidises and isomerises when exposed to heat and light
Vitamin A	• Very heat labile – easily destroyed by heat • Easily oxidised
Vitamin D	• Oxidises when exposed to heat and light
Vitamin E	• Oxidises readily

However, if the food contains reducing sugars, such as, glucose, fructose and lactose, there might be non-enzymatic (Maillard) browning, as the sugars reacts with certain amino acids to create an indigestible complex. This can reduce the protein quality of the food. Lysine content is most often affected by this type of reaction.

Some nutrients such as vitamin C are destroyed by heating. Losses of this and other heat labile nutrients will depend on the extent of heating and the other prevailing conditions, such as pH.

Dehydration

There are two processes occurring during drying, the addition of heat and the removal of moisture from the food. Nutritional losses during drying are more due to the application of heat than to the removal of moisture. Generally, except for thiamine (vitamin $B_{1)}$, removal of moisture results in increased concentration of nutrients.

Losses during the drying process will depend on:

- preparation procedures before drying, e.g. slicing, blanching
- drying temperature
- drying time
- storage conditions

Very often the losses during preparation are greater than losses during drying.

Nutrient losses during drying can be decreased by drying at a low temperature and shortening drying time. After drying ensure that foods are stored under dry conditions and at low oxygen levels.

Sulphites

Very often sulphite is added to foods to act as an anti-oxidant and prevent browning. However, this will increase the loss of thiamine. Use of sulphite on meat is restricted in some countries and there is also a limit to the amount that is used in the preservation of fruits and seafood, as this may result in allergic reactions in some consumers.

Blanching

One of the major objectives of blanching before freezing or drying is the destruction or inactivation of enzymes that can affect the colour, texture, flavour and nutritive value of foods during storage. However the process itself can result in significant nutrient losses from fruits and vegetables. The nutrient losses will depend on several factors:

- the food item
- surface area exposed
- the method used (steam blanching or hot water blanching)

Table 2: Losses in Nutrients During Blanching

Food Item	Nutrient	Losses in Steam Blanching %	Losses in Water Blanching %
Peas	Vitamin C	12	26
Peas	Amino acids	13	25
Spinach	Amino acids	60	80

Source: Lund DB. Effects of heat processing on nutrients. In: Harris RS, Karmas E, eds. Nutritional evaluation of food processing. Westport, CT: AVI Publishing Co., 1975.

- contact time
- amount of agitation

Nutrient losses in blanching result from thermal degradation, oxidation and leaching. Losses due to thermal degradation and oxidation are similar for both methods (steam and hot water blanching), but hot water blanching results in more losses due to leaching of water-soluble vitamins, minerals and amino acids. Table 2 shows a comparison of losses using both methods.

The use of higher temperatures during blanching will reduce the time available for leaching but may result in more thermal degradation of nutrients, as many of the deleterious enzymes destroyed by blanching are heat resistant.

When blanching fruits or vegetables the addition of sodium bicarbonate (or other alkali) to the blanching water for preserving the colour should be considered carefully, as while preserving the colour, it also has the effect of softening the texture of the vegetable and increasing destruction of vitamin C and thiamine.

Salting

Salting is most commonly used for meat and fish. Salting results in liquid exuding from the flesh, taking with it some of the water-soluble proteins, vitamins and minerals. Some proteins are also denatured by the salt.

Smoking

Smoking usually follows salting or curing. In addition to being bactericidal, the process has an anti-oxidative function. It reduces the oxidative changes that take place in fats, proteins and vitamins. However, smoking causes nutrient losses due to the associated heat, flow of gases and interaction of the smoke components with proteins.

The heat and flow of gases cause drying of the food item. This decreases the water content thereby causing the changes associated with dehydration such as increasing the protein and fat concentration of the food. In salted or cured foods the decreased moisture content also results in increased concentration of salt and other curing agents. The heat and smoke also cause denaturation of proteins, but the amino acid content is retained.

Some of the substances deposited on foods and absorbed during smoking are carcinogenic. These compounds increase the risk of gastrointestinal cancer in populations where there is a high intake of smoked foods. However, in the Caribbean, especially with widespread access to refrigeration the proportion of smoked foods in the diet has declined and smoked foods are not regarded as staples in the diet.

Concentration

The nutrient changes that occur during concentration will depend on the contents of the mixture and the temperature at which the process takes place. Generally, there is a decreased water content and corresponding increase in other nutrients.

Sugars in solution with water will crystallise out if the water content becomes too low, and this is even more pronounced when the product is refrigerated after the concentration process. This will not, however, affect the sugar content, only the appearance and texture of the food. In the presence of heat and high concentration of salt and minerals, proteins can be denatured, which can result in gelling.

However, many of the products of this method of preservation (jams, jellies, pickles, chutneys, preserves and purees) are not usually considered to form a major part of the diet and contribution of nutrients to the diet is not significant from this source.