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Effects of cooking and storage methods on the micronutrient content of foods

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Food processing has the potential to alter the nutrient quality of foods. This review deals with the effects of home-based cooking and storage practices on the micronutrient content of foods. It describes the effects of cooking, freezing and refrigeration on the vitamin and mineral content of meats, fish, fruit, vegetables and cereals. Based on this review, we suggest that the consumer should be aware of the possibility that losses in nutritional quality of foods may result from an improper use of cooking and storage techniques available at home.

Keywords: Food processing, cooking, storage, vitamins, minerals

Introduction

Nutrients are the building blocks of the human body. They enter into the composition of the cells, regulate their functions and furnish the energy for their work. Nutrients, which are provided by foods, are divided into macronutients (proteins, fats, carbohydrates) and micronutrients (vitamins and minerals). Nutrients may be destroyed or lost when foods are processed because of their sensitivity to heat, light, oxygen, pH of the solvent or a combinations of these (Harris, 1988). Nutrient losses may occur between harvesting and distribution, during household and industrial handling as well as catering and during storage (Somogyi, 1990). This article reviews the effects of home-based cooking and storage practices on the micronutrient content of foods.

Cooking

Cooking is responsible for losses of vitamins and minerals in foods. However, the bioavailability of some minerals, for example iron, may be increased by cooking (Lee and Clydesdale, 1981).

Meat

Thiamine is the nutrient most susceptible to thermal degradation and leaching from meat. For this reason, thiamine retention is widely employed as an indicator of cooking losses in meat. Factors influencing the nutrient stability of cooked meats include the size of the cut, the use of cooking water and the time and temperature of cooking. For a given type of meat, smaller cuts require less cooking time and have a greater thiamine retention (Bognar, 1978). Cooking methods that make no use of water allow a greater retention of thiamine in meat; water-soluble vitamin losses increase proportionally to the quantity of cooking liquid employed (Wilcox and Galloway, 1952; Fig. 1).

In contrast to thiamine, a heat-stable vitamin such as niacin can be recovered almost entirely from cooking broth. For a given cooking method, lower values of time and temperature generally allow a greater retention of B-group vitamins in meats (Noble and Gomez, 1958; Noble and Gomez, 1960; Noble, 1970). In many cases, greater quantities of these vitamins can be recovered from cooked meats than expected on the basis of their theoretical thermolability. It is likely that the coenzyme from in which most of these vitamins are found in meats protect them from thermal degradation. Few studies have been performed on mineral retention of cooked meats; however, a general agreement exists that zinc, copper and iron are the most stable minerals in cooked meats. The degree of meat shrinkage during cooking affects significantly the retention of minerals (Adams and Erdman, 1988).

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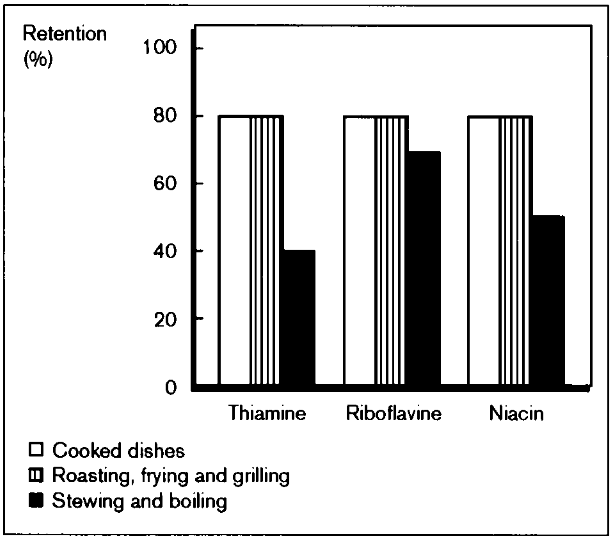

Figure 1. Effect of different types of cooking on thiamine, riboflavine and niacin retention in meats and meat-based dishes. Data from Holland *et al.* (1991).

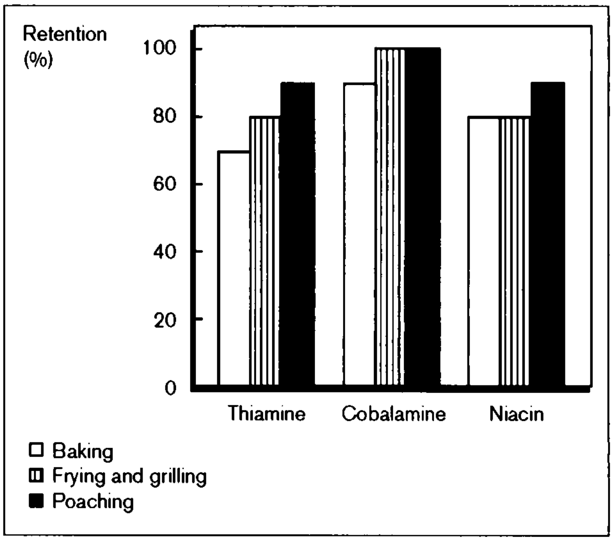

Figure 2. Effect of different types of cooking on thiamine, riboflavine and niacin retention in fish. Data from Holland *et al.* (1991).

Fish

Fish contains a little less thiamine and riboflavine than beef but it is a good source of niacin and cobalamine. Moreover, seafood is rich in minerals and may contribute significantly to the daily allowance of essential minerals (Krzynowek, 1988). The effects of cooking on the retention of some water-soluble vitamins of fish are summarized in Fig. 2.

Fruit and vegetables

As with thiamine, ascorbic acid is very sensitive to heat and oxidation (Harris, 1988). This is the reason why these vitamins are commonly used as indicators of water-soluble vitamin losses in fruit and vegetables. The factors that influence the nutrient content of cooked fruit and vegetables are similar to those outlined above for meats. Generally, the greater the surface : weight ratio of a given vegetable, the lower will be its retention of micronutrients (Adams and Erdman, 1988). As with meats, cooking methods that make use of water are associated with greater vitamin loss from fruit and vegetables (Figs 3 and 4).

Loss of vitamins and minerals from vegetables is mainly because of extraction into the cooking liquid rather than their destruction (Schroeder, 1971). Potassium is probably the most sensitive mineral to this type of loss (Adams and Erdman, 1988).

Cereals

Cereals are not important as sources of vitamins compared with fruit and vegetables. However, processing of cereals may cause some vitamin losses. For example, baking causes a loss of thiamine in bread while niacin is well retained (Fig. 5).

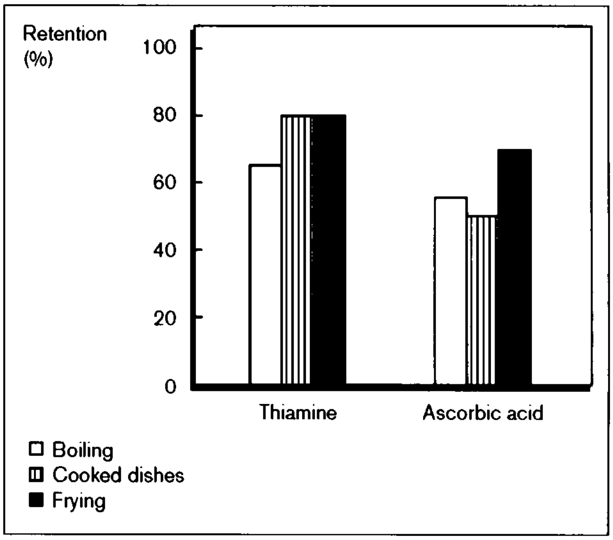

Figure 3. Effect of different types of cooking on thiamine and ascorbic acid retention in vegetables and vegetable-based dishes. Data from Holland *et al.* (1991).

Storage

Freezing

Factors influencing the nutrient stability of frozen foods include the temperature of the freezing unit and its range of fluctuation, the length of storage, the size of

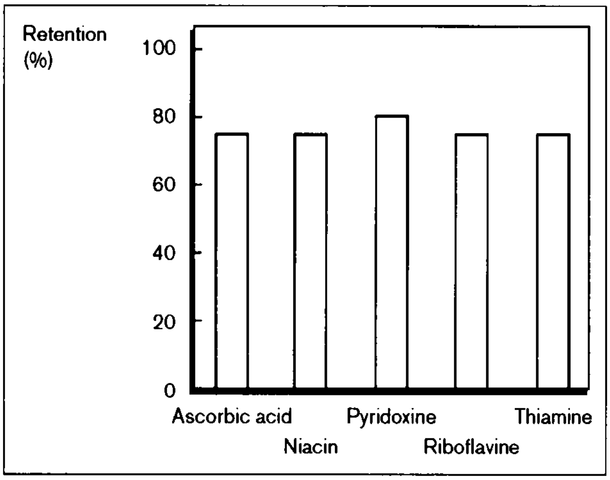

Figure 4. Retention of some water-soluble vitamins in fruit after stewing. Data from Holland *et al.* (1991).

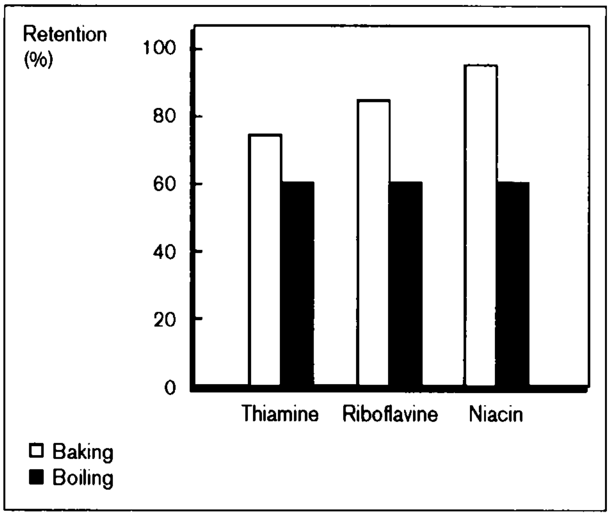

Figure 5. Effect of different types of cooking on thiamine, riboflavine and niacin retention in cereals and cereal-based dishes. Data from Holland *et al.* (1991).

the cut, the thawing method and the packaging method. Ideally, a temperature of at least −18°C should be used to store both animal and vegetable foods (International Institute of Refrigeration, 1972). Unfortunately, freezer compartments of refrigerators generally do not allow such a temperature to be reached. Fluctuations in the freezing temperature may be responsible for significant losses of vitamins in meats and of lower losses in vegetables (Fig. 6).

The length of storage affects significantly the retention of vitamins and minerals. Losses of thiamine tend to increase in meats when the periods of storage are greater (Fig. 6) and a similar pattern can be seen for

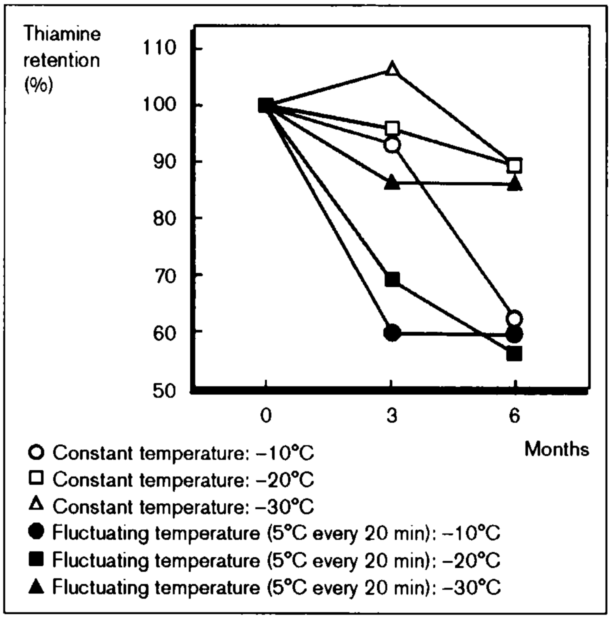

Figure 6. Effect of storage length and fluctuations in freezing temperature on thiamine retention in steaks. Data from Kramer *et al.* (1976).

ascorbic acid in fruit and vegetables. The size of the cut is important for frozen meats, with larger cuts having less exposed surface area and therefore being more resistant to nutrient loss (Ang, 1981). Moreover, the thaw-drip (the blood-like juice which is produced by thawing of meats) may contain a significant quantity of vitamins (Adams and Erdman, 1988). Owing to its nutrient content, the thaw-drip could be used in gravies or soups. However, this should be performed with caution because of the possibility of rapid bacterial growth and contamination of the thaw-drip. Packaging methods are very important in the case of vegetables; these foods should be sealed with a minimum amount of surrounding air and placed in moisture- and vapour-proof wraps.

Refrigeration

Refrigeration is a convenient storage method for many foods of plant origin and for some foods of animal origin. Factors influencing the nutrient content of refrigerated foods of plant origin include storage temperature, storage length, humidity and light. Fresh vegetables should be stored in a vegetable crisper or sealed in moisture-proof bags. The combination of cold temperature and appropriate humidity has been shown to retard wilting, which is constantly associated with loss of vitamin content (Adams and Erdman, 1988). It appears that some vegetables are more sensitive than others to loss of vitamins under refrigerated storage (e.g. broccoli is more sensitive than green beans). Fresh fruits are not stable for long periods of time in the refrigerator and will deteriorate rapidly. Milk may undergo vitamin loss during refrigerated storage, mainly because of its exposure to light and oxygen. For example, milk exposed to sunlight in a clear container loses as much as 50% riboflavine in 2 h. Moreover, riboflavine is converted to lumichrome and lumiflavin which catalyse the inactivation of ascorbic acid. Vitamin A retention in butter and margarine under refrigerated storage is generally good (Adams and Erdman, 1988).

Conclusion

Food processing has the potential to alter the nutrient quality of foods. Now that industrial procedures are known which cause only slight changes in the nutritional value of processed foods (Somogyi, 1990), the consumer should be aware of the possibility that losses in the nutritional quality of foods may result from an improper use of cooking and storage techniques available at home.

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