CHANGE IN THE QUANTITY OF ASCORBIC ACID AFTER THERMAL PROCESSING OF POTATO

ORIGINAL SCIENTIFIC PAPER

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ABSTRACT:

Potato isn't eaten raw, it has to be thermally processed which influences the presence of the vitamin C considering its sensitivity, fast degradability, and a great loss of vitamin C is expected. Many different ways of thermal processing are used such as boiling, frying, baking and similar. The vitamin C loss depends on the different processing ways and potato preparation. This paper aims to show how much quantity of ascorbic acid that is kept in the potato after boiling it in its skin, without the skin and when cut into pieces, as well as after frying and baking in an oven and baking in a foil. The goal of thermal processing is to keep as many nutritional ingredients as possible, and this paper will show which way of processing and preparation is the most convenient for eating.

KEYWORDS: potato, vitamin C, thermal processing

INTRODUCTION

Potato, a vegetable that represents the main food after the grains, is the main representative of bulbous vegetables. This fact states that the potato is consumed largely and its advantages are affordable price, availability during the whole year, as well as the possibility to prepare various meals and to produce a wide range of species of this product. The chemical composition of the potato is rather variable depending on the type, climate, production methods, soil fertility and other factors. Carbohydrates that make around 75% of dry matter are the main source of energy. Potato also contains significant amounts of proteins, vitamins and minerals. It is also rich with enzymes and acids. The potato contains biologically high-value proteins that contain various essential amino acids among which lysin, valin and leucin are especially important [1].

The vitamin C that is essential for human diet, gives to the potato a special value. The vitamin C is unique because it does multiple physiological functions in the body and it is the only vitamin that has a role in almost all organism functions. The ascorbic acid is well-known by its antioxidative effect by which decreases the cancer risk, participates in the synthesis of collagen, carnitine and neurotransmitters, the synthesis and catabolism of tyrosine, as well as some other metabolism processes on the microsome level [2]. Since bone matrix contains collagen, the vitamin C is important for maintaining the connective tissue and wound healing as well as bone formation [2]. Collagen goes into the structure of the essential substance that surrounds the cell membrane and the lack of the vitamin C brings to the capillary fragility. The vitamin C can contribute to decreasing the risk of cardiovascular diseases, stroke prevention and it can cause mild lowering of systolic blood pressure [2].

In human diet, the potato can be used in a processed and unprocessed form. In its unprocessed form, it is still mostly used for human nutrition, especially in less developed countries. Fresh potatoes are baked, boiled or fried and used in many different ways in many different recipes. It is a very grateful food substance used for the preparation of various dishes in the household. It is considered that less than 50% of potatoes are used as fresh and the rest is used for industrial production in various product [3].

The transition to the use of processed food products also arises from the need to facilitate household and catering work. Potatoes are industrially processed into a range of food products for human consumption. According to the quantity of production and consumption in the world, the most important processed products are French fries, chips and mashed potatoes [4]. In the process of industrial potato processing, starch is obtained, which is an important raw material in the pharmaceutical, food, textile and other industries. Starch produces dextrin, starch syrup, glucose and alcohol, which are also widely used in various industries [1].

Ascorbic acid is very sensitive to the action of enzymes and to oxidation in all steps of food processing, storage and preparation. Significant losses of

vitamins can occur at every stage of food preparation, including the processing of raw food itself, washing, removing inedible parts, chopping and mincing, cooking and other thermal processes, storage, etc. [2].

Various literature sources have cited different vitamin C content in potatoes. The vitamin C content certainly varies by many factors, and according to Vreugdenhil et al. [5] 8-54 mg/100 g is present. This paper shows how different preparation and thermal processing affect the loss of vitamin C in potatoes.

EXPERIMENTAL

The testing was performed on 7 potato samples: raw, boiled in the skin, the whole potatoes boiled without the skin, boiled without the skin and cut into cubes, fried in oil, baked in an oven and baked in an oven in a foil. Potato samples are shown in Figure 1. For all evaluation, the samples were ground in a blender or crushed in a saucepan. From the samples prepared in that way, 10 g were weighed and quantitatively transferred into a 100 mL graduated flask and supplemented with distilled water to the mark. Then the filtration was performed. Vitamin C is determined by the iodimetric method, and the procedure for the determination of vitamin C by iodimetric titration is based on its oxidation.

Exactly 25 mL of the solution containing vitamin C is pipetted into an Erlenmayer flask, 5 mL of starch solution is added, and titrated with iodine solution (previously standardized) to the equivalence point when the blue color of the solution disappears. On the basis of the consumed volume of iodine solution, V (I_2), known concentration c (I_2), the content of vitamin C in the sample (g/250 mL) was calculated according to the expression:

$$m\ (\text{vit. C}) = c(I_2) \cdot V(I_2) \cdot M(\text{vit. C}) \cdot R$$

$$m\ (\text{vitamin C}) - \left[\text{g/100 g}\right]$$

where is:
R-dilution,
M (Vitamin C) = 176.12 g/mol [6].

The concentration of standard iodine solution (I_2) is calculated on the basis of the consumed volume of iodine solution (I_2) during standardization, and the known values for concentration and volume taken of the primary standard H_3AsO_4:

$$c(I_2) = \frac{c(H_3AsO_3) \cdot V(H_3AsO_3)}{V(I_2)}$$

$$c\left(I_2\right) - \left[\text{g/mol}\right]$$

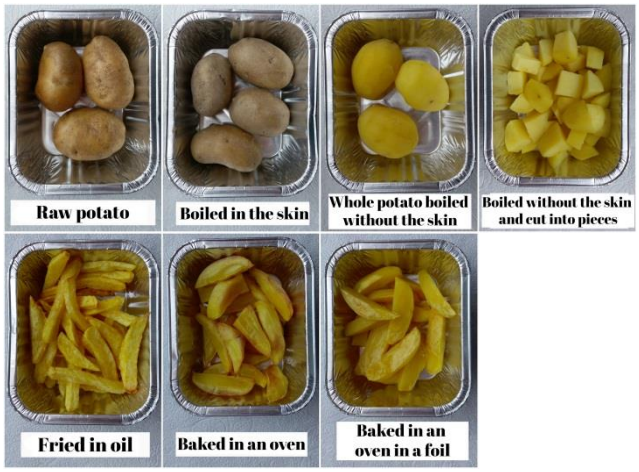

Figure 1. Potato samples

RESULTS AND DISCUSSION

The results of vitamin C content are shown in Table 1. Raw potatoes contain 52.84 mg/100 g of vitamin C. The highest loss was observed in potatoes boiled into cubes 38.75 mg/100 g (73.33%), then boiled potatoes without the skin with a loss of 29.94 mg/100 g (56.66%). Frying potatoes resulted in a loss of 24.66 mg/100 g (46.67%), followed by potatoes baked in a foil with a loss of 23.78 mg/100 g (45%). The most vitamin C is kept in the potatoes boiled in the skin and baked in the oven. When it comes to potatoes boiled in the skin, it shows a loss of 22.9 mg/100 g (43.34%) and baked in the oven 21.14 mg/100 g (40%). From the above results we can conclude that the best way of processing, that is, most of vitamin C is retained in baked potatoes, although potatoes boiled in the skin do not fall behind and certainly these thermal processing methods should be given the priority.

Table 1. The vitamin C content in the potatoes

Processing method	Vitamin C (mg/100 g)
Raw	52.84
Boiled in the skin	29.94
Whole potatoes boiled without the skin	22.9
Boiled without the skin and cut into pieces	14.09
Fried in oil	28.18
Baked in an oven	31.7
Baked in an oven in a foil	29.06

The loss of vitamins can be significantly reduced by careful food preparation. Frying, prolonged boiling, or a combination of multiple methods of food preparation, all increase the loss of vitamins. The

longer the food processing time, the greater the losses, regardless of the procedure used [2].

Potatoes are vegetables that should never be eaten raw but must always be thermically processed. These methods have different losses of vitamin C. As it can be seen from the results, the largest loss of vitamin C is in boiled potatoes cut into cubes. Cooking increases digestibility but significantly affects the loss of vitamins since vitamin C belongs to the group of hydro-soluble vitamins (water-soluble vitamins) and is thermolabile. This sample was chopped, thereby significantly increasing the surface area and significantly destroying cells that come in contact with water, therefore a greater loss of vitamins is expected.

Whole potatoes boiled without the skin have a significantly lower loss, which can be explained by the previous statements, that is, the smaller surface is exposed to flushing and thus the smaller the loss of vitamins.

When it comes to boiling, it can be concluded that the best way to boil potatoes is to boil them whole with their skin. The skin contains a lot of nutrients, but also serves as a protective barrier that protects against nutrient loss. It used to be thought that all the nutrients of a potato were housed in a skin, however, this is not true. The percentage of ascorbic acid, niacin and pyridoxine has been shown to be approximately equal in the potato skin and meat, while the percentage of thiamine is higher in the meat [7].

A surprising fact during the analysis is that a significant amount of this vitamin was retained in potatoes fried in oil. Frying is an operation that involves immersing the product in hot oil (175 °C) until the desired product properties are obtained. During the process, moisture from the food surface migrates to the oil in the form of steam and the oil is absorbed in the food product. The type of oil, the temperature of the oil and the duration of frying greatly influence the final texture, taste and quality of the food. As the moisture evaporates, the product begins to dry [8]. Although the analysis shows considerable vitamin C content, fried potatoes should be avoided. First of all, a suitable frying oil should be chosen, and since deep frying is usually done at high temperatures (between 160 °C and 180 °C), in the presence of air and moisture, the frying oils and fats undergo physical and chemical degradation, which will affect the frying performance and stability of the fried products. In addition, highly oxidized oils can also produce polyaromatic hydrocarbons that are thought to have a carcinogenic effect [8].

The high content of vitamin C is observed in potatoes baked in the oven and baked in foil. This thermal processing method has proven to be the most advantageous and should be preferred when preparing potatoes.

Many researches have been done on this topic and the obtained results of the analysis are in accordance with the research of scientific papers. Babalola et al. [9] found that raw potatoes contained 79.3 mg/100 g of vitamin C, boiled potatoes lost 50.30 mg/100 g (63.43%), fried 43.30 mg/100 g (54.60%) and baked 41.30 mg/100 g (52.08%). So the biggest loss is boiling, and the least baking.

Also, according to Ikanone and Oyekan [10], raw potatoes contain 56.47 mg/100 mL of vitamin C. A maximum loss of 37.34 mg/100 mL (68.90%) was observed when the potatoes were boiled, while frying resulted in a loss of 30.44 mg/100 mL (53.90%). Therefore, different methods of thermal processing, as well as the preparation of potatoes themselves, namely grinding and peeling, result in different losses of vitamin C.

Some studies indicate that there may be three ways to increase the vitamin C content of potatoes: through cultivation, improved crop management and modification of the preparation process. Cultivation has a huge potential to increase the content of vitamin C, which involves the application of traditional or modern molecular genetics, as shown by many studies. Improved crop management involves the application of appropriate agro-technical measures as well as appropriate storage conditions. Modification of the preparation process can lead to a decrease in the oxidative and enzymatic degradation of vitamin C resulting from exposure to moisture, heat and air. These modifications include increasing the dimensions of the sliced products, reducing cooking time or temperature, preparing food with an intact skin, etc. [11].

CONCLUSION

Potatoes are a good source of nutrients, with a special value due to vitamin C (ascorbic acid present). Potatoes must be thermally processed before use, which improves digestibility, but on the other hand affects the loss of nutrients, especially the vitamin C. What the loss will be depends on the method of thermal processing and the preparation of potatoes. The highest loss of the vitamin C was observed in potatoes boiled into cubes and the lowest in potatoes baked in the oven. Therefore, the preference should be given to baking when preparing meals.

If boiling is preferred, then whole potatoes with their skin should be boiled. When preparing the potatoes, cutting should be avoided and, if necessary, the dimensions of the cut cubes should be larger. Preparing the potatoes with the skin is essential for preserving the nutrients. Although analysis has shown that frying potatoes resulted in a loss of vitamin C of 46.67%, potatoes fried in oil should be avoided because oils can produce polyaromatic hydrocarbons that are considered to have a carcinogenic effect.
Potatoes are great food for everyone and their importance in nutrition should not be underestimated.

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