Evaluation of the Effect of Different Methods of Cooking on Nitrate and Nitrite Residues in Potatoes on Human Health

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Abstract

Introduction: Potato is one of the foods with high nutritional value. High content of nitrate and nitrite in potato is one of the most challenging issues in its consumption and health of individuals. One of the ways to increase the potato quality index is to use cooking processes, and thus, reducing nitrate and nitrite content in the diet, in order to improve the health of the community. Thus, the objective of this research was to evaluate the effect of different cooking method on nitrite and nitrate in potato on human health.

Methods and materials: In this descriptive research, 60 potato samples were randomly selected from fruit and vegetable square of Tehran, and the mentioned samples were measured in terms of nitrite and nitrate contents by Greece- Illosoay method. Then, the considered baking methods were applied and the nitrite and nitrate contents were re-measured. Results: Nitrate and nitrite in the tested samples were 162.3 to 378.7 and 1.7 to 4.9 mg/kg, respectively. The peeling, washing and rinsing of potatoes reduced the nitrate and nitrite contents. Boiling, steaming and frying had a significant effect on reducing nitrate and nitrite contents. Conclusion: The use of boiling, steaming and frying methods can have a significant effect on nitrate and nitrite in potatoes and thus human health.

Keywords: Nitrate; Nitrite; Cooking method; Potato; Human health

Introduction

Nitrate of vegetables is one of the most important quality characteristics of them. Nitrate is naturally found in water, air, soil and food, especially vegetables. (1) Vegetables have high importance in diet due to having vitamins, minerals and fiber. The consumption of vegetables at adequate level prevents cardiovascular disease, diabetes and obesity, but vegetables usually contain high contents of nitrate and nitrite. Nitrate and nitrite consumption through food can be harmful to health. Nitrate itself is not toxic, but its metabolism in the body can produce toxic substances. High intake of nitrate and nitrite leads to methemoglobinemia, leading to shortage of oxygen in the body. (2) Nitrate can be reduced to nitrite in the oral cavity and stomach. This compound in the stomach can react with amines and amides and create carcinogenic groups called n-nitrosamine compounds. (3) Researchers argue that N-nitrosamine compounds in stomach are associated with an increased risk of stomach, esophagus and gallbladder cancer. (4) For example, they have reported that high contents of nitrate in the diet were associated with stomach cancer in the United Kingdom, Colombia, Chile, Japan, Denmark, Hungary and Italy. (5) Potato is one of the crops with favorable nutritional value containing high contents of carbohydrates, protein, fat, and vitamins. It is the fourth most important source of human nutrition after the wheat, rice and corn. Nearly 75-87 percent of nitrate and 16 to 43 percent of nitrite received by humans enter the body through vegetables. (6) It is estimated that about 65 to 75 percent of the nitrate received through potatoes enters the body. (7) Nitrate is also used as a preservative and antimicrobial agent in various foods such as cheese, meat, fish and beverages. (8) Given the increasing population growth, demand for foods has grown increasingly. For this reason, the excessive and uncontrolled use of organic fertilizers has become common in many parts of world for more production of this crop. In this regard, it was found that increasing nitrogen content increased the potato nitrate content. (9,10) In fresh vegetables, the content of nitrate is usually very low, but its content increases due to inappropriate harvesting and the presence of bacteria. Reduced consumption of nitrogen fertilizers as well as Blanching, peeling, freezing and cooking can reduce the content of nitrate in them. (11) Skubina et al. reported that peeling of beet leads to 20 and 6.6% reduction in nitrate and nitrite contents, respectively. Moreover, cooking with boiling water and steaming caused 66.48 and 8% reduction in nitrite content and 69.55% and 15% reduction in nitrate content, respectively. In addition cooking with microwave increased nitrate and nitrite contents by 23 and 19%, respectively. (12) Thus, the objective of this research was to evaluate the effect of cooking process on three methods of boiling, steaming and frying on the nitrate and nitrite contents in potatoes.

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Sampling was performed at four seasons as nitrate and nitrite contents of potato at different seasons are variable. In each sampling, 10 potatoes were selected and 3 of them were randomly selected each time to measure their nitrate and nitrite contents. Each sample was divided into four equal 10-gram parts and experiments were performed on them. Finally, the sample that had higher nitrate and nitrite content was used for boiling, frying, and steaming. For each of these samples, the measurement was repeated three times and the mean of them was considered as the nitrate or nitrite content in that sample. In order to determine the nitrite and nitrate content in each of the samples, the extraction step was first performed using the chemical reagents and solutions. Then, the absorbance rate of the samples was measured at 538 nm using a spectrophotometer, and finally, the nitrite and nitrate content in the sample was determined after plotting the absorbance-concentration chart. Samples were first measured without nitrate and nitrite reagents, and then, they were measured after adding the reagent. Then, the difference between these two obtained numbers was included in the equation obtained from the standard curve of passing reagent. Then, the difference between these two obtained numbers was included in the equation obtained from the standard curve of passing reagent.

Cooking techniques were used as follows:

**Boiling:** Cooking the potatoes in boiling water for 25 minutes to be softened

**Steaming:** Cooking the potatoes at 99% moisture at 100°C for 20 minutes

**Fry:** Frying potatoes at 150°C for 4 minutes

### Results

Nitrate and nitrite contents were measured before applying different cooking methods. The nitrate content was obtained 216.5 ± 7.29, 162.3 ± 8.77, 378.7 ± 9.22 (mg NO • kg) in the first, second, and third samples, respectively, and the nitrite content was obtained 1.7 ± 0.03, 4.9 ± 0.3, and 2.49 ± 0.4 (mg NO • kg) in the first, second, and third samples, respectively [Table 1]. Then, nitrate and nitrite contents were re-measured after applying the three cooking methods in this study.

The results revealed that the nitrate content in the first sample was 119.1 ± 3.2 using boiling method, 154.2 ± 3.2 using steaming method, and 93.7 ± 1.7 (mg NO • kg) using the frying method. In the second sample, it was found 94.2 ± 4.2 using frying method, 110.3 ± 1.8 steam method, and 83.3 ± 2.3 (mg NO • kg) using boiling method. In the third sample, it was found 231 ± 5.5 using boiling method, 265.3 ± 7.4 using steaming method, and 216.3 ± 6.2 (mg NO • kg) using frying method [Table 2]. The results of comparison of Tables 1 and 2 revealed a significant difference in nitrate reduction after application of different cooking methods compared to that before applying these methods. Finally, in the first sample, the nitrite content was obtained 0.55 ± 0.01 using boiling method, and 0.84 ± 0.02 using the steaming method, and 2.21 ± 0.3 using the frying method. In the third sample, it was found 1.13 ± 0.2 (mg NO • kg) using frying method [Table 3].

The results of Tables 1-3 comparison showed a significant difference in the reduction of nitrite content after applying different cooking method compared to that before applying these methods.

### Discussion

Excessive consumption of nitrate and nitrite by using various foods, including potatoes, is very harmful to human health. Nitrate alone is not toxic, but its metabolism in the human body produces various toxic substances, which threaten human health. Excessive consumption of nitrate and nitrite can cause various diseases, including methemoglobinemia in the human body. Vegetables and plants, including potatoes, are beneficial foods, which are important for the health of the human body due to the presence of nutrients such as vitamins preventing many diseases in humans. However, it should be noted that they usually contain high contents of nitrate and nitrite (2 and 3). Hence, the objective of this research was to evaluate the nitrite and nitrate contents before and after applying different cooking methods of cooking in potatoes. The results of this research revealed that the nitrate and nitrite content in the samples is very high and variable. The maximum and minimum nitrate contents were 378.7 and 162.3 mg/kg, respectively, and nitrate content varied between minimum of 1.7 and maximum of 4.9.
Conflict of Interest

The authors disclose that they have no conflicts of interest.

References


