Effect Of Heating On Vitamin C Content Of Some Selected Vegetables

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ABSTRACT: The effect of heating on the vitamin C content of five choice vegetables was determined by redox titration with potassium iodate in the presence of potassium iodide. The results obtained in raw vegetables showed that pepper (61.56mg/100ml) has the highest vitamin C content while the least was in carrot (21.72mg/100ml). The vitamin C content of the vegetables analyzed were found to be in the order: Pepper > Green peas > Spinach > Pumpkin > Carrot. It was also observed that the heating time has significant effect on the vitamin C content of all the vegetables, as the heating time increases, the percentage loss of vitamin C increases too. The percentage loss of vitamin C in the vegetables ranged between (9.94-16.57%), (29.94-37.43%) and (49.91- 64.71%) at 5, 15 and 30 mins respectively. Of all the vegetables assayed pepper gave the highest percentage loss of 64.71% at 30 mins. Vitamin C is easily destroyed by excessive heat and water, as well as exposure to air. For retention of vitamin C in cooked foods, it is recommended that foods containing vitamin C be cooked as fast as possible with less heat and small amount of water.

KEY WORDS: Ascorbic acid, Human nutrition, Redox titration, Phytochemicals, Spinach, Vegetables, Pumpkin, Antioxidant,

INTRODUCTION

Vegetables and fruits are rich sources of essential vitamins, minerals, fibers and disease-fighting phytochemicals which the human body needs to maintain good health [1]. Some vegetables can be taken raw but most are commonly cooked before being consumed. Generally, preparations of vegetables at home are based on taste preference and convenience rather than retention of nutrient and health-promoting compounds [2]. Report has shown that consumption of diets rich in vegetables and fruits protect the human body from chronic degenerative diseases [3], [4], [5], [6], [7]. Vitamin C, also known as ascorbic acid, is a water-soluble vitamin found in fruits and vegetables. It is an antioxidant that is very essential for human nutrition and proper functioning of the body [8], [9]. The human body cannot synthesize vitamin C endogenously, so it is an essential dietary component [10]. Vitamin C is instrumental in neutralizing free radicals, which are harmful to the body, assimilation of iron, healing of wounds, helps to build collagen, which aids the skin, defense against bacterial and viral infection [11]. Deficiency of vitamin C in human can lead to a disease known as scurvy, whose symptoms include hemorrhaging especially in gums and skin, loosening of the teeth, joint pains and exhaustion [12], [13]. Many fruits and vegetables contain vitamin C, but excess amount of heat can destroy the vitamin completely. At high temperature, in the presence of sunlight and oxygen in air, vitamin C reacts and it is oxidized [14]. Cooking in high temperature also destroys vitamin C since it easily leaches into the cooking water being a water-soluble vitamin.

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The redox titration method was used in this research for the determination of vitamin C ($C_6H_8O_6$) in the vegetable samples, potassium iodate (KIO_3) was added to a vegetable solution that contains strong acid and potassium iodide (KI). Potassium iodate reacts with potassium iodide, liberating molecular iodine (I_2):

$$KIO_3 + 5KI + 6H^+ \rightarrow 3I_2 + 6K^+ + 3H_2O \quad \text{..... [1]}$$

The iodine (I_2) produced in equation [1] oxidizes the vitamin C to form dehydroascorbic acid ($C_6H_6O_6$) and iodide ion (I^-) equation [2].

$$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2I^- + 2H^+ \quad \text{..... [2]}$$

The purpose of this work is to determine the effect of heating on the vitamin C content of the selected vegetables.

MATERIALS AND METHOD

Sample Collection

Five vegetables commonly consumed in Nigeria were purchased from the Keffi market, Nasarawa State. The vegetable samples are Carrot (*Daucus Carota*), Pumpkin (*Cucurbita Maxima*), Green Peas (*Pisum Sativum*), Pepper (*Capsium Annum*) and Spinach (*Spinacia Oleracea*). Vitamin C tablet used for the analysis was purchased from a pharmaceutical store.

All the apparatus used were properly washed and rinsed with distilled water. Analar grade reagents were used in this study.

Preparation of Reagents

1% Starch Indicator Solution: A starch solution (1%) was prepared by weighing 1g of starch into a 250ml beaker and 100ml of distilled water was added. The mixture was boiled for 5 minutes with stirring until the starch dissolved, the resulting solution was allowed to cool.

Vitamin C Standard Solution: 0.4g of vitamin C tablet was weighed and dissolved in 100ml distilled water.

0.1M Hydrochloric Acid: 0.83ml of hydrochloric solution was measured into a 100ml conical flask and made up to the mark with distilled water.

Potassium iodate solution: 2g potassium iodate was weighed and dissolve in 1 L of distilled water in a volumetric flask.

Potassium iodide solution: 5g of solid potassium iodide was dissolved in about 50 ml of distilled water in a 200 ml volumetric flask and diluted to 200 ml with distilled water.

Sample Preparation

The vegetable samples were sorted and washed with distilled water to remove adhering dirty particles. 100g of each sample was weighed and blended with 100ml of water using an electric blender. The mixture was strained, and the clear filtrate collected in a 200ml volumetric flask and made up to the mark with distilled water for each sample.

Experimentals

25ml of Vitamin C standard solution was placed in a 250ml beaker, 5ml of each potassium iodide and 0.1M hydrochloric acid was added and also 1ml of the starch indicator solution. The potassium iodate solution was filled into the burette and titrated against the sample in the beaker until a blue black colour that persists was observed. Also 25ml of each of the vegetable solutions was titrated. The procedure was done in triplicate and the average titre value for each sample was obtained. The heating time was varied (i.e. 5, 15 and 30 mins respectively) while the temperature was kept constant (i.e. 60°C).
The percentage lost on the ascorbic acid due to cook heating was calculated using the formular:

$$\% \text{ lost} = \frac{AAF - AAH}{AAF} \times 100$$

Where, AAF = the ascorbic acid content in the raw sample

AAH = the ascorbic acid content of the heated sample

RESULTS AND DISCUSSION

The average titre values of iodate solution used up by the vitamin C tablet and the vegetable samples respectively are shown in table 1 below.

Table 1: Average titre values (ml) of Iodate solution for raw and heated samples

Vegetables	Raw samples	5 mins	15 mins	30 mins
Pepper	1.70	1.50	1.10	0.60
Green peas	1.20	1.10	0.80	0.50
Spinach	1.00	0.90	0.70	0.40
Pumpkin	0.80	0.70	0.50	0.30
Carrot	0.70	0.60	0.40	0.30
Vit. C tablet	44.20	-	-	-

The vitamin C concentration in mg/25ml and mg/100ml of the vegetables as affected by heating time are shown on tables 2 and 3 respectively. The results revealed that all the vegetables contain vitamin C but pepper gave the highest value of 61.56mg/100ml implying it is a good source of vitamin C while carrot gave the least of 6.43mg/100ml. The vitamin C content of the raw vegetables is generally high when compared with those of the heated. It was also observed that heating affected the vitamin C content of all the vegetables, as the heating time increases, the vitamin C content decreases, while the temperature was kept constant. Vitamin C is water-soluble as such easily leached into the water and then degraded by heat.

Table 2: The Vit. C (mg/25ml) content of vegetables as affected by heating time

Vegetables	Raw samples	5 mins	15 mins	30 mins
Pepper	15.39	13.58	9.96	5.43
Green peas	10.86	9.96	7.24	4.53
Spinach	9.05	8.15	6.34	3.62
Pumpkin	7.24	6.34	4.53	2.72
Carrot	6.43	5.43	3.62	2.72

Table 3: The Vit. C (mg/100ml) content of vegetables as affected by heating time

Vegetables	Raw samples	5 mins	15 mins	30 mins
Pepper	61.56	54.32	39.84	21.72
Green peas	43.44	38.84	28.96	18.12
Spinach	36.20	32.60	25.36	14.48
Pumpkin	28.96	25.36	18.12	10.88
Carrot	25.36	21.72	14.48	10.88

In table 4, the percentage loss in the vitamin C content was shown. The highest loss of vitamin C was seen in pepper (64.71%) at 30 mins while the least loss of vitamin C was found in spinach (9.94%) at 5mins. Loss as a result of boiling is justified since vitamin C is water-soluble and heat labile [15]. The loss observed in spinach (60.00%) in 30 mins of heating was in agreement with the work reported by Rumm-Kreuter and Demmel [16] for average losses of (60%) in spinach through boiling. Vitamin C loss can be induced by a number of factors these include cooking time, high temperature, and cooking method.

Table 4: % loss in concentration of Vitamin C as heating time varies

Vegetable samples	% lost in 5 mins	% lost in15 mins	% lost in 30 mins
Pepper	11.76	35.28	64.71
Green Peas	10.59	33.33	58.28
Spinach	9.94	29.94	60.00
Pumpkin	12.43	37.43	62.43
Carrot	16.57	33.33	49.91

CONCLUSION

Vitamin C is the very unstable vitamin which can easily be denatured. It was found in both the raw and heated vegetables samples analyzed in varying proportions. The percentage loss of vitamin C at different heating time was observed to be in the order - At 30 mins: Pepper > Pumpkin > Spinach > Green peas > carrot; at 15 mins: Pumpkin > Pepper > Green peas = Carrot > Spinach and at 5 mins: Carrot > Pumpkin > Green peas > Pepper > Spinach. Of all the vegetables, pepper gave the highest level of vitamin C (61.56mg/100ml) and also a 64.17% loss of vitamin C in 30 mins heating. This suggests that denaturation of vitamin C due to heating depends on its availability in the vegetable. Thus vitamin C being water soluble leaches into cooking water and gets degraded. Vitamin C is important to human health and a necessary dietary source. For high retention of vitamin C while cooking it is recommended that the vegetables are cooked in low heat and small amounts of water for short periods to minimize the loss of vitamin C.

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