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Full Length Research Paper

Effect of heat on the ascorbic acid content of dark green leafy vegetables and citrus fruits

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ABSTRACT

Ascorbic acid is the only major nutrient derived from citrus fruits and dark green leafy vegetables consumed by a large proportion of the populace.This study was aimed at examining the overall effect of heat on ascorbic acid in selected fruits and vegetables. Citrus fruits and dark green leafy vegetables were sampled from the fruit and vegetable Market inMakurdi, Benue State,Nigeria. Ascorbic acid content of the dark green leafy vegetables and fruits were also determined while in the fresh state at ambient temperature of 37℃. The dark green leafy vegetables (pumpkin and bitter leaf) and juice from the fruits (orange and grape) were subjected to high temperatures of 50℃ and 70℃ by placing them in a water bath set at the respective temperatures. The study showed that the citrus fruits contained more ascorbic acid(61.18mg/100ml; 45.24mg/100ml) as compared to that of dark green leafy vegetables(41.75 mg/100ml; 38.71mg/100ml) in their fresh state at ambient temperature (37℃). In their fresh state, oranges had the highest amount of ascorbic acid while bitter leaf had the least ascorbic acid content. They all lost some amount of ascorbic acid when subjected to higher temperatures of 50℃ and 70℃. However, the dark green vegetables lost more ascorbic acid than the citrus fruits when subjected to heat. Thus, it is advised that blanching should be the most appropriate means of cooking leafy vegetables and less heat applied to citrus fruits during processing especially while making fruit concentrates and juices. It is best to take citrus fruits raw in order to get maximum amount of the ascorbic acid content.

Keywords: Ascorbic acid, Heat, Citrus fruits and dark green leafy vegetables.

INTRODUCTION

Fruits and vegetables form an essential part of a balanced diet. Vegetables and fruits are valuable components of the daily diet contributing carbohydrate in form of dietary fiber,vitamins andminerals to the body. They are important to world agricultural food production, even though their production volumes are small compared with grains. In Nigeria, fruits and vegetables constitute a major part of the diet. Benue state, Nigeria also known as the food basket of the nation is a major producer of different varieties of fruit and vegetables.

The most important vitamin in fruits and vegetables for human nutrition is ascorbic acid (Vitamin C).Most animals are able to synthesize vitamin C from glucose and galactose. However, primates and guinea pigs are unable to do so. Foods of plant origin, particularly citrus and soft fruits and leafy green vegetables, are major sources of vitamin C. Kidney and liver are good animal-derived sources of vitamin C.

Ascorbic acid is widely found in many fruits and vegetables.Ascorbic acid is a water-soluble antioxidant known to be important to health and for proper functioning of the human body.Ascorbic acid is vital for the growth and maintenance of healthy bones, teeth, gums, ligaments and blood vessels. (Njoku*et al,*2011).It also helps in the formation of collagen which is the body's major building protein and it increases the body'sresistance to infections.More than 90% of the vitamin C in human diets is supplied by fruits and vegetables including potatoes. Vitamin C is defined as the generic form for all compounds exhibiting the biological activity of L- ascorbic acid (AA). AA is the principal biologically active form but L-dehydroascorbic

acid (DHA), an oxidation product also exhibits biological activity. DHA can be easily converted into AA in the human body (Lee *et al*., 2000). Ascorbic acid is water soluble micronutrient required for multiple biological functions. It is a strong reducing agent and it is readily oxidized reversibly to hydroascorbic acid (DHA).

Studies on the interactions of ascorbic acid with various chemicals and metal ions have indicated that ascorbic acid and its oxidation product, dehydroascorbic acid, as well as its intermediate monodehydroascorbic acid free radicals may function as cyclingredox couples in reactions involving electron transport and membrane electrochemical potentiation (Haciserki,2009). Ascorbic acid has been shown to participate in many different neurochemicalreactions involving electron transport. Neurons are known to use ascorbic acid for many different chemical and enzymatic reactions including the synthesis of neurotransmitters and hormones (Haciserki, 2009).

Factors affecting ascorbic acid content of citrus fruits and vegetables include production factors and climate conditions, maturity stage, handling, storage and type of container (Naggy,1980).Hot tropical areas produce fruits with lower levels of Vitamin C (Padayatti*et al*., 2003). The stability of ascorbic acid decreases with increase in temperature (Emese*et al*., 2008). A considerable quantity of ascorbic acid content of food is lost during processing, storage and preparation (Emese*et al.,* 2008) and Davey, *et al*., 2000). Ascorbic acid also decreases gradually during storage especially at temperature above 0°C (Ajibola*et al*., 2009). Various ways by which fruits and leafy vegetables containing ascorbic acid are administered decrease their ascorbic acid retention, for instance, bruising, peeling, cutting into pieces and exposure to air decreases ascorbic acid retention (Allen *et al*., 2006 and Maria *et al*., 2006). It is evident that the Vitamin C retention of fruits varies with the treatment but in general, fruits are valuable when they are used raw and have minimum of bruising, cutting, peeling and exposure to air and excessive heat.

According to Babalola*et al* (2010), heat mostly affected the vitamin C content of fruits and vegetables during a research conducted on the effect of processing on seven Nigerian green leafy vegetables. Temperature management after harvest is the most important factor to maintain vitamin C of fruits and vegetables; losses are accelerated at higher temperatures and with longer storage duration (Elsevier, 2000).

The study aims to determine the effect of heat and the duration of exposure to heat on ascorbic acid contentin citrus fruits and dark green leafy vegetablessold in Makurdi, Benue State, Nigeria as they are often over heated in the process of cooking.

MATERIALS AND METHOD

Sample Collection

Oranges (*Citrus sinesis*) and grapes (*Citrusparadisi*) from the citrus fruits andpumpkin leaves(*Telfaraoccidentalis*)andbitter leaf(*Vernoniaamygdalin)* from the dark greenleafy vegetables were bought from the fruits and vegetable market in Makurdi, Benue State of Nigeria.The samples were taken to the laboratory for analysis. The juices of the samples were squeezed out and separated from the seeds and fibers through a funnel and filter paper.The samples were analysed immediately they were brought into the laboratory.

Determination of Ascorbic Acid Content for fresh samples of citrus fruits and green leafy vegetables at ambient temperature (37°C)

The method described by Sadasivam and Manickam(1996) was employed. The vitamin C present in the samples was extracted with 20% trichloroaceticacid and thereafter determinedby titrimetric method using 2, 6-dichlorophenol indophenol dye. The method involved preparing a stock standard solution and a working standard solution.

The stock standardsolution was prepared by dissolving 100mg ascorbic acid into 100ml of 4% oxalic acid solution in a standard flask (1mg/ml).

The working standard solution was prepared by diluting 10ml of the stock solution to 100ml with 4% oxalic acid. The concentration of the working standard is equal to 100µg/ml.

5ml of the working sample was pipetted into a 100ml conical flask and 10ml of 4% oxalic acid was added. This was titrated against the dye and recorded as V_1mL; the end point was indicated by the appearance of a pink coloration thatpersisted for afew minutes. The amount of dye consumed is equivalent to the amount of ascorbic acid. Then, 5g of the sample was extracted and made up to 100ml volume using 4% oxalic acid and centrifuged. 5ml of the supernatant was pipetted and 10ml of 4% oxalic acid was added and titrated against the dye and the value was recorded as V_2mL.

Calculation was done thus;

$$\text{Ascorbic acid content(mg/100ml of sample)} = \frac{0.5\text{mg} \times V_2\text{mL} \times 100\text{ml} \times (100)}{V_1\text{mL} \times 5\text{mL} \times \text{Wt. of the sample}}$$

Table 1. Ascorbic Acid Content of the Citrus Fruits and Dark Green Leafy Vegetables at Ambient Temperature (Fresh State)

Sample	Ascorbic Acid (mg/100ml)
Orange	61.18
Grape	45.24
Bitter leaf	38.71
Pumpkin	41.75

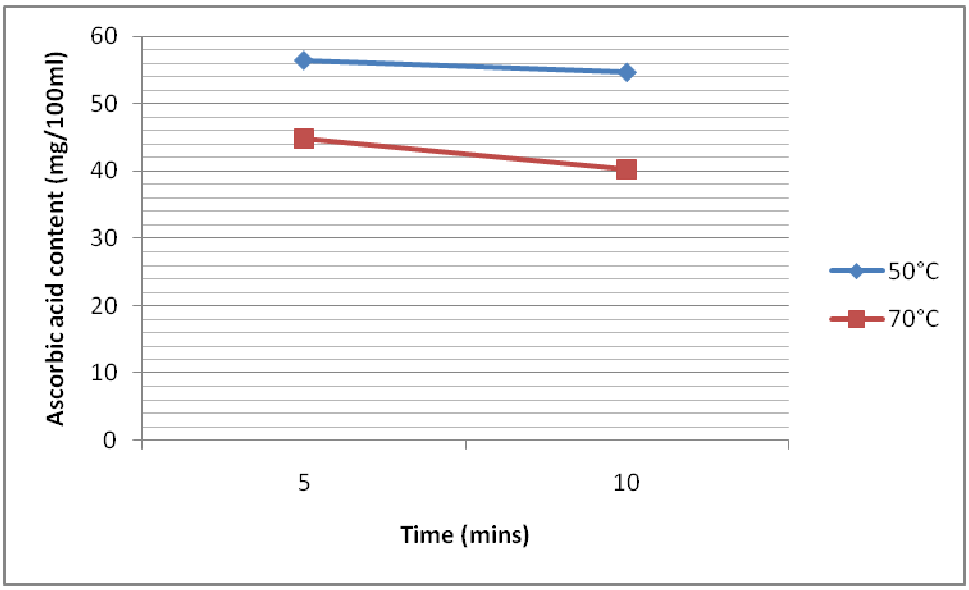

Figure 1. Ascorbic Acid Content of Orange at Various Temperatures and Times

Determination of Ascorbic Acid Content for fresh samples of citrus fruits and green leafy vegetables at 50℃ and 70℃.

The samples were subjected to heat for five (5) and ten (10) mins in a water bath at temperatures of 50℃ and 70℃ respectively. The tests were carried outin duplicate for each of the samples. The ascorbic acid content of the samples was also determined using the same method as above.

RESULTS AND DISCUSSION

It was found out that heat affected the ascorbic acid content of the citrus fruits and dark green leafy vegetables when subjected to temperatures of50℃ and 70℃ respectively; the more the heat, the less the ascorbic acid content as compared to the ones tested at ambient temperature which were in the fresh state.

Ascorbic acid Content of the Citrus Fruits and Dark Green Leafy Vegetables at Ambient Temperature(Fresh State)

The ascorbic acid content of the citrus fruits and dark green leafy vegetables was determined after extracting the juice from the samples. This was at ambient temperature in the fresh state of the samples. The following results in Table 1 were after calculation of the averages:-

The result showed that the ascorbic acid content of the citrus fruits was higher than that of the dark green leafy vegetables at ambient temperature which was their fresh state. For the citrus fruits,orange had higher ascorbic acid content than grape. Pumpkin had higher ascorbic acid content than bitter leaf under the dark green leafy vegetables. This result shows thatmore ascorbic acid is obtained from consumption of citrus fruits than in dark green leafy vegetables in their fresh state.

Effect of Heat on the Ascorbic Acid content in the Citrus Fruits and Green Leafy Vegetables

The effect of heat on the ascorbic acid content in citrus fruits and dark green leafy vegetables when subjected to 50℃ and 70℃ over periods of 5 and 10min respectively is shown in Figure 1, Figure 2, Figure 3 and Figure4. There were losses of ascorbic acid when the samples were subjected toheat at 50℃ and even higher losses at 70℃ than that of 50℃ under five minutes duration. Much higher losses were recorded when the samples were subjected to ten minutes duration at 50℃ and 70℃ respectively. The result shows that the higher the

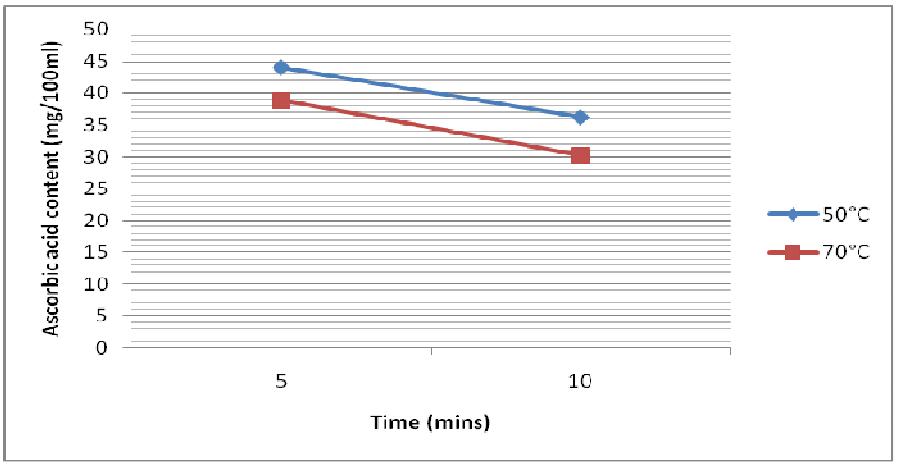

Figure 2. Ascorbic Acid Content of Grape at Various Temperatures and Times

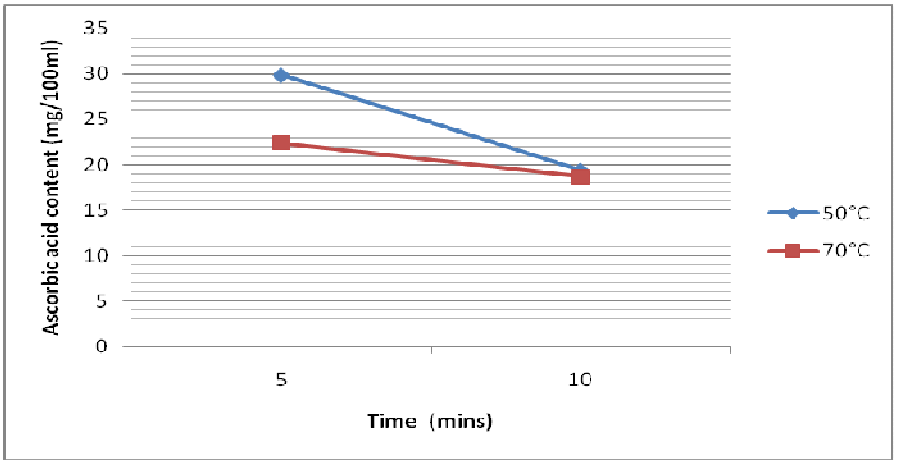

Figure 3. Ascorbic Acid Content of Bitter Leaf at Various Temperatures and Times

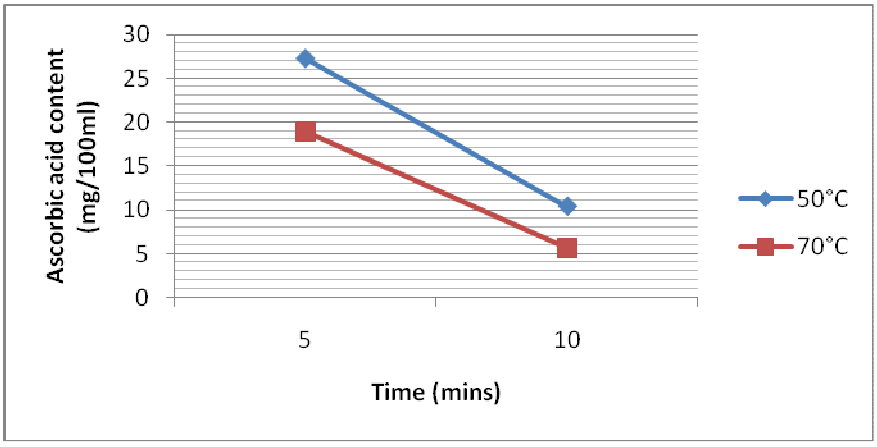

Figure 4. Ascorbic Acid Content of Pumpkin at Various Temperatures and Times

temperature the higher the loss of the ascorbic acid and the longer the duration of exposure to heat the more the loss of ascorbic acid.

The losses observed when the fruits and vegetables were subjected to heat are in agreement with the work of Babalola*et al*(2010)who confirmed that ascorbic acid

levels in green leafy vegetables are temperature dependent.

It therefore follows that subjection of citrus fruits and dark green leafy vegetables to boiling and excessive exposure to radiation will automatically destroy the ascorbic acid content.

CONCLUSION AND RECOMMENDATION

This work has confirmed that the higher the temperature and longer the time of exposure to heat, the more losses the ascorbic acid content of fruits and vegetables. It is therefore better to take fruits raw and add green leafy vegetables to soups and porridges and cook for few minutes using the blanching method.

Blanching is necessary to inactivate the oxidase enzyme that destroys ascorbic acidand also to destroy microorganisms present. A high recommendation of 100-200mg/day of ascorbic acid has been suggested since stress in modern life is known to increase the requirement for ascorbic acid (Lee *et al*., 2000).

Other factors that affect the ascorbic acid content of citrus fruits and green leafy vegetables like production factors, climate conditions, maturity stage, handling, and storage and preparation processshould be considered. Bruising, cutting, peeling and exposure to air should be minimized to avoid too much loss of ascorbic acid.

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