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Effects of Sunlight on the Ascorbic Acid (Vitamin C) Content of Some Selected Oranges in Kasoa, Ghana

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Abstract:
Standard Indophenols Method was used to determine vitamin C content of selected oranges kept at different locations in Kasoa, through an experimental study. Data were also collected from 80 purposively sampled university students in Kasoa, using pre-tested questionnaires with both open and close-ended items in across-sectional survey. The items for the data collection included a four-point Likert scale, which were analyzed using Statistical Package for Social Sciences version 17 and results presented by tables of frequencies, percentages and means.
The results of the experiment proved that sunlight certainly has a negative effect on vitamin C in oranges, in bringing about losses of the vitamin. Again vitamin C loss is greater when the orange is peeled and with long storage time. Respondents reported of careless handling and unhygienic storage practices by traders although their knowledge on vitamin C was quite poor. It is recommended that education of farmers and consumers can help conserve vitamin C in oranges.

Keywords: *Oranges, sunlight, Ascorbic acid, vitamin C, poor storage*

1. Introduction

1.1. Background of the Study

The problem of proper nutrition has always been a concern throughout the world. The foods people consist primarily of carbohydrates, fats, proteins minerals, vitamins and water and these help the functioning of the body. Some environmental and conditions which are toxic can find their way into these foods and cause nutrient loss, which subsequently cause problems in the body. Type of food people eat depends on the environment they live in but recent industrial and technological developments have contributed to mobility of food as well as its contamination. Many foods have also been exposed to some levels of chemicals and environmental conditions which may be toxic or carcinogenic.

Human beings get their nutrients (carbohydrates, proteins, fats and oils, minerals and vitamins) mainly from food commodities available. The nutrients function in body building, energy- giving and protection of the body. The vitamins are mostly paramount in fruits, but by casual observation, Ghanaians are not good consumers of fruits and even those who consume do not get maximum benefits from their nutrients due to poor handling practices from the farm gates to market places. The method of preparation of particular fruits, production factors, climate, temperature, oxygen and even sunlight can cause considerable loss of nutrients in fruit.

The World Health Organization's (WHO) October1999 report revealed that five common conditions, namely; acute respiratory infections, diarrhoea, measles, malnutrition and pneumonia caused over 70% mortality rates. According to Iloveinda, (2010) the consumption of oranges can help individuals to deal with some of these ailments.

According to Odum (2006), fruit is a term that has different meanings, depending on the context in which it is being used. In cuisines, when discussing fruits as foods the phrase usually refers the fleshy seed associated with certain plants that are sweet and edible in the raw state (Free encyclopaedia; Khander, 2004). Citrus fruits, which compose of oranges, lemons, grape fruits and tangerines, form a major group of common tropical fruits.

1.1.1. Composition of Fruits

According, to Khader (2004), fresh fruits contain carbohydrates, protein, fats and oils, minerals and vitamins. The carbohydrates in fruitsare made up of fructose, glucose, sucrose, starch as well as some fibres. Most of the energy from fruits (80-96%) is provided by the sugars present, therefore fruits or fruit juices are given when quick source of energy is needed for example as appetizers and as refreshing drinks for athletes. Water constitutes about 80% of fruits and come more near the water percentage of human body.

Fruits are important sources of pro-vitamins A and C. Some dry fruits are rich sources of minerals such as calcium and iron. Fruits contain pigments which are responsible for their colour. The orange yellow fruits contain beta carotene, which is converted to vitamin A, when absorbed from the digestive tract. Most fruits contain edible parts combined with some inedible parts. There are some fruits which are wholly edible such as berries and guava; while apples, pear, peaches, cherries have 85 to 90% edible portion. Other fruits such as banana, sweet lime, oranges and pineapple contain more roughage(Khader, 2004; Wardlaw&Insel, 1995),

Decuyprere's (2000) studies showed that fruits are generally acidic and sweet. There are a number of other flavour components, which give distinctive flavour and taste to each variety of fruits. Fruits have protective tissues which take the form as peels, skin and rinds. Surfaces of these protective structures are waxy, which helps in retaining the moisture which is necessary to retain the freshness of fruits. He found out that fruits contain vitamin A,B (niacin, thiamine, riboflavin, pantothemic acid) C,E and K (Decuyprere, 2000)

1.1.2. Nutritional Contribution of Fruits

Nevo Foundation Netherlands Nutrition Centre (N.F.N.N.C), (1996), stated that energy is present in fruits like banana and strawberries. Proteins, fats, and sugars are present in fruits and they are able to digest within 30 minutes because they produce non-toxic waste products. Rather, the type of proteins, fats, and sugars help in stimulating the removal of waste and waste products, and toxic elements from the body. Fibres are another remarkable nutrient in fruits. They help in removal of waste products from the body and even help in lowering blood cholesterol levels (N.F.N.N.C., 1996). According to Solar Energy Charity (2000), fruits and fruit juices contain many vitamins and minerals and they are also low in fat except avocados. United Nations Development Agency (USDA) as cited by Solar Energy Charity (2000), nutritionist recommends two to four servings from the fruits group each day. They also recommend eating of whole fruits rather than peeled fruits or fruit juices in order to get the maximum nutrients.

The soft texture of most fruits permits their use in infant diets, diets for the aged and the sick. Fruits with lower carbohydrate content find place in energy restricted diets (Sumati&Rao, 1993) cited in Khander (2007). In India, there are fruits such as alma, guava, cashew fruits which are extremely good sources of vitamin C providing 135-600g of vitamin C per 100g edibleportion. The quantities of fruits eaten may have to be increased, if a source containing medium or low vitamin C is used. Fruits such as papaya, orange, mango, which contain yellow orange pigment called carotene is a precursor of vitamin A. The World Health Organization (WHO) (2004) reveals that fruits are important components of healthy diets. Sufficient consumption could help prevent major diseases such as cardiovascular disease and certain cancers. Over all, it is estimated that up to 2.7 million lives could be saved each year if the consumption of fruits were sufficiently increased. Anarticle published by WHO and Food and Agriculture Organization (FAO) (2004) recommends the intake of minimum of 400g of fruits per day for prevention of diseases such as cancers, heart diseases, obesity, diabetes, as well as prevention and alleviation of several micro deficiencies especially in less developed countries. It is scientifically proven that low intake of fruits is a key risk factor for several non communicable diseases. WHO has initiated a policy to promote the consumption of fruits. A joint workshop by WHO/FAO in Japan in 2004 at Kobe Centre for Health Development also addressed the need for consumption of fruits because of their nutritional benefits (WHO/FAO, 2004).

1.1.3. Oranges

An orange is a citrus fruit considered to be hybrid of the ancient cultivated origin between pomelo*(Citrus maxima)* and tangerine *(Citrus reticulate).*The name originated in Latin, where it is specifically referred to the plant now known as citron which is derived from the ancient Greek word cedar. Cultivated citrus like orange may be derived from a few as four ancestral species (Iloveindia, 2010).

Oranges contain several vitamins like vitamin A, B, C, Copper, potassium, protein, calcium and iron Nutritional Benefit. According, to (Iloveindia, 2010) an orange that weights 100grams contain the following nutrients.

Nutrient	Mass
Vitamin A	190IU
Vitamin B (Thiamine)	0.8mg
Vitamin C	49mg
Calcium	33mg
Phosphorus	23mg
Potassium	300mg
Calories	60mg

Table 1: Nutrients in Oranges
Source: I1oveindia.com (2010)

Apart from above nutrients, oranges contain fat, copper, iron, sulphur, folic acid and magnesium. According to a publication by Plants and Food Research (2008), oranges are well and widely grown in areas with cool night time temperatures and in the tropics of which Ghana is no exception. Oranges are recommended for everybody but also for people with special medical conditions recommended like scurvy, weak bones, sore throat, catarrh and those with, hypertension.

1.1.4. Vitamin C (Ascorbic Acid)

Vitamin C also known as ascorbic acid is one of the most important vitamin found in citrus juices. Vitamin C is a water soluble vitamin. It is closely related to hexode's sugar. It is readily oxidized initially to dehydro-ascorbic acid. The two forms are inter-convertible and those that are collectively referred to as "vitamin C". In the body, vitamin C is present in small amounts in blood plasma and all tissues. It is concentrated in white blood cells and in adrenal glands and to a smaller extent in the liver and kidneys. Its major known metabolic roles is in the connective tissues formation particularly after injuries, fractures, or bums when the blood concentration and urinary excretion both fall drastically. In addition vitamin C is believed to be involved in the formation of some neurotransmitters in the brain, drug detoxification and iron metabolism in the body. It may also, along with selenium and vitamin E,

exert a protective role in preventing the accumulation of active radicals formed by the spontaneous oxidation of fatty acids in the body. Oranges contain vitamin C (Barasi&Mottram, 1993; Fox & Cameron, 2003),

1.1.5. Factors that Cause Depletion of Vitamin C in Fruits

According to Stevens (1980), oxygen is the most destructive ingredient in oranges causing degradation of vitamin C. However the major sugar (fructose) found in fruits also cause vitamin C depletion. The higher the fructose content the greater the loss of vitamin C. Conversely higher levels of citric acid and malic acid stabilize vitamin C. Oranges must be stored at proper cool temperature with oxygen banners for best retention of vitamin C level. When fresh citrus is stored at 38°F for 12weeks, there was no loss of vitamin C but when stored at high temperatures the loss was great. Production practices such as the use of fertilizers can affect the vitamin C levels in oranges. Proper potassium levels are also needed in retention of vitamin C in fruits. Climate, total available heat also affects vitamin C levels in oranges.

Areas with cool temperatures produce oranges and watermelons with high vitamin C levels while hot tropical areas produce oranges with low vitamin C levels. Ripening is another factor that causes vitamin C depletion in orange and should be avoided. Addition of sodium bicarbonate greatly increases the destruction of vitamin C and should be avoided (Mullick, 2007).

1.1.6. The Effect of Sunlight on Vitamin C in Oranges

It has been claimed that even a single day's lapse between harvesting and eating fresh fruits significantly lowers vitamin C content. This is almost certainly untrue (Barasi & Mottram, 1993).Wilting; bruising and exposure of cut surfaces do decrease vitamin C levels in oranges. According to Barasi & Mottram (1993) sunlight destroys vitamin C also known as ascorbic acid. If given time, temperature, above 85°C and inactivating the oxidizing enzymes can also destroy the vitamin C. Keeping fruits under the sun for sometime is very destructive to vitamin C (Barasi & Mottram 1993). When kept under the sun for 15 minutes, a quarter of the original amount is lost and after 90 minutes three quarters is lost. The problem is greater still when fruits are transported from farm gates under the sun to distance markets. In this case the lost is inevitable. Colloidal materials in fruits, which contain vitamin C, usually coagulate when it exposed to sunlight and adds substances which would otherwise precipitate during pasteurization of the juice (source). As stated by Khader (2004), sunlight decreases the jellying power of pectin; that

is, degradation of pectin found in the walls of fruits may occur if the fruits are kept in sun above 80°C. This makes jelly tough due to over concentration. A study by Mateljan Foundation (2006 and 2011), showed that sun drying of fruits result in loss of vitamins. For example, when mongo sun dried it resulted in loss of94% beta carotene and 84% of vitamin C. They therefore recommend that, whenever possible fresh fruits should be chosen over dried fruits.

For over thousand years, sunlight has been used in the drying of foods which serve as means of preservation. However, this has led to depletion or escape of certain nutrients especially vitamins if not done well. One such nutrient that has received much scientific and media attention is vitamin C. Central Region is one of the regions in Ghana where most people are into the cultivation of oranges. Oranges are one of the fruits that contain Vitamin C.

Kasoa is a fast growing municipal town. It is a market centre as well as an agricultural town. Many people have settled in Kasoa based on its nearness to Accra, the capital. Several self-employed as well as those in wage-employment have moved to Kasoa as a result of comparatively cheaper rents in Accra although their work places are in Accra. A lot of schools of all levels are in Kasoa and West End is the first university in Kasoa, although it is private. West End University College was established in the year 2000 and has three faculties; Business Administration, ICT/Computer Studies and Allied Nursing. At the time of the study the student population was 335 students. Most of the students, both foreign and Ghanaians live in hostels around the university college.

There are several traders who sell fruits but the commonest and cheapest are oranges. They are grown in and all around Kasoa. They sold in all markets and at all fruit stands at every corner in Kasoa. The oranges are cheap when in season and are often seen heaped in the sun, in the rain and at any available space. People eat oranges but they are not much concerned about how they are handled and so they buy oranges from any outlet available. One keeps wondering whether consumers know what they are buying.

This study was motivated by the fact that a similar study on vitamin C content of watermelons was found to have results of concern in terms of practices of consumers that seemed to suggest that consumers do not seem to care much about vitamin losses in fruits. This present study was carried out to find out the level of vitamin C losses in oranges and how the West End university students view the way oranges are handled in Kasoa and to find out if they are aware of the possible losses of vitamin C.

1.2. Statement of the Problem

Fruits are valued for their contribution as a source of energy for the development of the body Khader (2004). According to the World Health Organization (2004), the human body needs a substantial amount of fruits in order to prevent diseases such as cardiovascular disorders, and cancers that affect the development and growth in human beings. Iloveidia (2010), also observed that the consumption of oranges provide vitamin C to the human body. George and Pamplona-Reger, (2009) indicated that oranges are undoubtedly the most consumed fresh fruits in the world.

It is generally observed in Ghana that harvesting of oranges in Ghana is mostly carried out manually. The harvesters usually climb or either stand by the trees and are later picked into baskets or bowls. The few plantations do not have combined harvester force the oranges down using long sticks. The orange fruits drop to the ground and machines or any better ways have better methods that can be used to harvest orange fruits. The crude harvested fruits are often bruised even before they are transported.

The methods of transportation of the oranges to the marketing centres have nothing to write home about. The oranges are just poured into truck and transported from long distances without any temperature control. At the marketing centres also the oranges are dumped

by roadsides, with the spoilt and good ones mixed together, under the scorching sun. All these practices do bring about the loss of vitamin C with the microbial deterioration further increasing the loss of vitamin Cas well as other unstable vitamins. There are no proper storage facilities either. Studies have established that high temperatures and storage time affect the amount of vitamins, particularly vitamin C in orange fruits and orange juices (Barasi&Mottram, 1993; Nagy &Smoot, 2006). Mullick (2007) also stressed that proper storage of fresh fruits help in conserving their food values with regards to its vitamin retention. There is therefore a high possibility that the oranges in the study area might have lost the necessary vitamin C content before they are even sold to consumers. The reason for considering oranges is that they are much cheaper and more common in several communities in Ghana than the other fruits.

A common observation of the practices in the sale of oranges in markets and cities reveal that some oranges are sold whole, while others are peeled and both peeled and unpeeled oranges are either sold by traders who are at permanent spots or peddled by hawkers in and around Kasoa under the sun. Also consumers in the study do not often seem to be worried about the state in which fruits are handled. No one seems to complain openly. Fruits are purchased and consumed without any comments, regardless of the consequences. This study is therefore designed to investigate the effect of sunlight on vitamin C in oranges and consumers' views on the manner oranges are handled by traders in Kasoa.

1.3. Purpose of the Study

The purpose of the study was to investigate the effect of sunlight and handling practices on the vitamin C content of oranges.

Specifically, the objectives of the study are to:

a. assess the vitamin C content of peeled and unpeeled oranges kept at room temperature;
b. assess the vitamin C content of peeled and unpeeled oranges kept in the sun for periods between 4 and 48 hours;
c. find out views of students on the handling of oranges in by traders in Kasoa and its environs that are likely to affect the vitamin C content; and
d. offer suggestions for improvement in the handling of oranges in order to minimize the losses of vitamin C.

1.4. Significance of the Study

The study will be beneficial to orange farmers, traders, and consumers to improve on their handling practices in order to retain the vitamin C content in oranges. The study will again be helpful as it will make both traders and consumers become aware of the destructive effects of sunlight on vitamin C in oranges. Consumers will benefit greatly from the findings in that it will help them to take maximum care in the choice of oranges so as to get the greatest maximum benefit of vitamin C from them. Other researchers will benefit from the study on similar topics on vitamin C in oranges.

1.5. Delimitations and Limitations of the Study

The oranges selected for study were harvested from an orange tree in Kasoa. A lot of nutrients can be found in them but this study is concentrated on the vitamin C content in oranges harvested from a tree in someone's backyard in Kasoa.

The limitations of this study include the following: Human errors are likely to occur during the experiment and that there could also be some losses of vitamin C between the time of harvest and the laboratory experiment. Also vitamin C levels in oranges used were likely to vary due the positions of orange on the tree (Barasi&Mottram, 1993; Nagy &Smoot, 2006; Mullick, 2007).To make sure that errors are kept to the barest minimum, fruits used for the experiment were harvested from backyard orange trees at Kasoa. The harvesting was done at 5.00am before sunrise and then they were put in an ice chest to protect them from sunlight until the fruits got to the laboratory in Accra. Care was taken to make sure the oranges were harvested from the same tree, at the same level from the ground, from the same side of the plant and at the same degree of ripening. The reasons behind these actions were to follow the guidelines given by (Barasi&Mottram, 1993; Nagy &Smoot, 2006; Mullick, 2007) so as to lessen the loss of vitamin C before the determination.

At the laboratory, they were washed and care was taken to ensure that accurate measurements of chemicals and equal sizes of fruits were used. This study involved experiment as well as human opinions which are both subject to errors. The experiment was therefore replicated three times to ensure validity and reduction in the error terms.

2. Methodology

2.1. Research Design

The study was conducted in two parts; first the determination of the effect of sunlight on the vitamin C (Ascorbic Acid) content of the oranges and then views of students on how oranges are handled in Kasoa by both producers and traders.

2.2. Population, Sample Collection Transportation and Preparation of the Oranges

The first part of the study involved the determination of vitamin C content in the selected oranges. The target population was all the oranges in Kasoa municipality but the population of oranges in Kasoa could not be obtained because there are no records on the quantities of Agricultural produced in Kasoa. Since this is somehow a baseline study, the oranges were picked from a tree at the backyard of a citizen close to the West End University College.

Twelve oranges were picked from an orange tree and put in a big ice chest, which were transported to Accra in a private car the same day so that the oranges would not be bruised. At the laboratory, the oranges were first washed to take off all dirt. Some of the oranges

were peeled and left under the sun where the temperature ranged between 35^0C and 38^0Cand at the laboratory temperature ranging from 25^0C and 26^0C. The oranges, both peeled and unpeeled, were left under the sun for periods between four and 16 hours.
The target population for the survey consisted of students of West End University College who ate oranges, at least, once a week. It was impossible to get the number of oranges in Kasoa at any given time. Although the population of the students was estimated at 350, it was not possible to obtain the population of the students who ate oranges at least once a week.

2.2.1. Sample and Sampling Techniques
Out of the total number of 350 students of the university only 80 of them were selected because they were those who ate oranges at least once a week, through the purposive sampling techniques, The purposive sampling was used, being an exploratory study and the fact that it sought to identify particular cases for the investigation (Neuwman, 2007).This type of sampling was employed also because it sought to address the students who consumed watermelons at least once a week, being the respondents whose opinions were thought to be relevant to the study (Amedahe, 2002).

2.3. Instruments
The materials used for the determination of vitamin C were:

1. Funnel
2. Orange squeezer
3. 150ml volumetric flask
4. 10ml pipette
5. 50ml burette
6. 250ml round bottom flask
7. Pipette filler
8. Mercury in glass thermometer (laboratory thermometer)
9. Distilled water
10. 2, 6 dichlorophenolindophenol
11. Metaphosphoric acid
12. Orange juice
13. Acetone

2.3.1. Instruments for the Survey Data Collection
The aim of this part of the study was to examine their viewson factors which affect vitamin C and also on how producers and traders in Kasoa handled oranges generally. A cross-sectional survey research design was employed for the study. The design is a descriptive survey design in which data are collected at one point in time for a sample selected to represent a larger population. An attempt was made in this survey to capture the attitudes of different groups in a sample at specific time frames and this timeline is vital in collecting bit by bit relevant results for the study (Owens, 2002). In this study, the cross-sectional survey design sought to investigate the knowledge of students who ate oranges, at least, once a week.
The items for the students (consumers) were divided in sections. Section A focused on biographic characteristics of the respondents. Section B dwelt on consumption and sources of oranges they ate, while section C had items on the storage of purchased. Items in section D was based on the views of respondents on the factors that affect the level of vitamin C of watermelons. Respondents were provided with a four-point Likert (Strongly Agree = 4. Agree = 3; Disagree = 2 and Strongly Disagree = 1), consisting of statements on vitamin C content in watermelons and some environmental conditions that affect the vitamin. Means were computed for the Likert scale and compared with the mean for the statement which was 2.5 (10/4 = 2.5). The respondents were made to select from each of the statements which represented their knowledge.

2.4. Pre-testing of the vitamin C determination
In the determination of vitamin C, one of the oranges was arbitrarily selected and the experiment carried out on trial basis to give a rough estimate of the vitamin C in the orange. The questionnaire was pre-tested by administering 20 questionnaires to check for clarity. For the determination of vitamin C, the experiment was duplicated to make sure the results were accurate.

2.5. Data Collection Technique
To determine the Vitamins C content in oranges (Standard Indophenols Method).The Comparative Titration method was employed as follows:

a. Squeeze orange to get an orange juice
b. Pipette 10mls of orange juice into 150mls volumetric flask
c. Add 5mls of 20% metaphosphoric acid as stabilizing agent and make up to the maven with 100mls of distilled water.
d. Add 2mls of acetone to the solution
e. Titrate with 2, 6- dichlorophenolindophenol solution until a faint pink colour persists for 15 seconds.
f. Calculate the vitamin C content in the sample as mg per 100mls.

NB: The acetone may be omitted if sulphur dioxide is known to be absent. All the determinations were done in triplicate so as get the average figures.

As indicated already, 80 students of the university who satisfied the needed criteria and were willing and ready to answer the questionnaires were used. The questionnaires were given to the respondents at the lecture halls and they filled and returned them within 10 minutes. Few of them, however, took the questionnaires home but all of them returned them within three days. The whole data collection started in January 2nd to 20th 2017.

2.6. Data Analysis

The Statistical Package for Social Sciences (SPSS) version 17 was used to compute the mass of vitamin C. The second part of the study was the use of a cross-sectional descriptive survey to solicit responses from selected West End University College students who consumed oranges.

The survey data were edited, coded and entered into the computer. The computation of the mass of vitamin C and the analyses of the data collected were done using Statistical Package for Social Sciences (SPSS) version 17. Tables of pie charts, frequencies, percentages and mean scores were used to present the results.

3. Results and Discussion

3.1. Mass of Vitamin C in the Samples per 100mls of Orange Juice

The vitamin C content of the oranges was calculated following the formula below after the titration.

Test Samples	Titration	Initial burette	Final burette	Difference/Mean
Control (10ml of orange juice)	1	17.0ml	30.5ml	13.5ml
	2	30.5ml	44.0ml	13.5ml
	3	10.0ml	22.5ml	12.5ml
				Mean = 13.5ml
Pure vitamin C	1	24.0ml	33.2ml	9.2ml
(Ascorbic acid)	2	35.0ml	44.2ml	9.2ml
in 10mls	3	33.1ml	42.5ml	9.4ml Mean = 9.3ml

Table 2: Titration Table

3.1.1. Computation of Vitamin C in the Control Orange

Pure vitamin C (Ascorbic acid) = 0.02g/100ml, therefore 10ml has 2mg pure vitamin C

93.0ml

Titre. Pure Vitamin C = Titre of Juice (control)

Titre. Pure Vitamin C = Titre of Juice (control)

2mg Xmg

Xmg = 2 x Titer of Orange Juice (control)

Xmg = 2 x 13.5

9.3

10 mls of control has 2.967mg of vitamin C

100ml = 29.67mg/100ml

X = 29.7mg/l00ml

Tables 3a and 3b present the mass of vitamin C in the various samples of peeled and unpeeled oranges and the total times (in hours)the samples were left at the different experimental locations/(conditions) and the mean loss of vitamin C. The mass of vitamin C in the peeled and unpeeled oranges were calculated using the results of the vitamin C in Table 2.

Treatment	A	B	C	Mean (mg).
Peeledorange in the sun (4hrs)	17.5	17.6	17.6	17.6
Unpeeled in the sun(4hrs)	22.9	22.7	22.9	22.8
Peeled in the sun (16hrs)	20.0	19.4	19.4	19.8
Unpeeled in the sun(16hrs)	24.0	20.6	20.8	21.8
Peeled room temperature (48hrs)	11.2	11.0	10.6	10.9
Unpeeled room temperature(48hrs)	13.0	13.3	12.9	13.1

Table 3a: Mass of Vitamin C in the Samples per 100mls of Orange Juice

It can be observed from Table 3a that the oranges were left at the various locations for periods between 4 and 48 hours (2 days). The mean mass of vitamin C obtained ranges from 17.6 to 20.8 mls. The results of the orange juice used as the control served as basis for comparisons.

Table 3b shows the total time (in hours) that the oranges were left at the various locations (in the sun and at the laboratory).Mass of vitamin C per 100ml, amount lost and their percentages has been tabulated in Table 3b.

Treatment	Time Intervals in hours	Mass of Vit. C (mg/100 ml) in sample	% of Vit. C (mg/100 ml) in sample	Vitamin C lost (mg/100ml)	Percentage Vitamin C losses
Orange control	-	29.7	100	-	-
Peeled orange in the sun	4	17.5	58.9	12.3	41.1
Unpeeled orange in the sun	4	22.8	76.7	6.9	23.3
Peeled orange in the sun	16	19.5	65.7	10.2	34.3
Unpeeled orange in the sun	16	20.8	70.0	8.9	30.0
Peeled orange at room temperature	48	10.9	36.7	18.8	63.3
Unpeeled orange at room temperature	48	13.1	44.1	16.7	55.9

Table 3b: Vitamin C Levels in the Various Samples of Oranges

The results shown in Table 3b indicate that the mean mass of the juice from peeled orange samples kept in the sun for 4, 16 and 48 hours were: 17.5mg, 19.5mg and 10.9mg/l00ml respectively. The results also show that mean mass of the juice from unpeeled orange samples kept in the sun for 4, 16 and 48 hours were: 22.8mg, 20.8mg and 13.1mg/l00ml respectively. The percentage losses from the samples after 4, 16, and 48 hours were as follows:i). Peeled orange samples had 41.1%, 34.3% and 63.3% respectively. The results of the percentage losses for the unpeeled oranges were 23.3%, 30.0% and 55.9% respectively.

The loss of vitamin C in the juice from the peeled orange kept in the sun for four hours lost 12.0mg/100ml while the unpeeled one kept at the same time of four hours was 6.8%/100ml. the peeled orange kept in the sun for 16.6mg/100mls when kept in the sun for the same 16 hours.

Juices from peeled and unpeeled oranges were kept at room temperature for 48 hours and there were also losses of vitamin C. The peeled juice lost 9.8mg/100mls while the unpeeled one lost 8.

It can be clearly deduced from the results of the experiment that sunlight certainly has a negative effect on vitamin C in oranges, in bringing about losses of vitamin C. Again the loss is greater when the orange is peeled as compared to the unpeeled oranges and also the losses increase with time, meaning, when the period of warm exposure to the sun or when kept in warm temperatures for long hours the vitamin losses increase.

The results confirm the assertion by Barasi and Mottram (1993) who stressed that even a single day's lapse between harvesting and eating of fresh fruits can significantly lower the vitamin C content of fruits. According to Nagy and Smoot (2006), high temperature and storage time affects the amount of vitamin C in orange fruits and orange juices. Mullick (2007) also found that proper storage of fresh fruits help in conserving their food values with regards to its vitamin retention. The results from this study thus emphasize the vulnerability of vitamin C. Many Ghanaians buy oranges from the market without being aware of how long the oranges had been harvested. Oranges are often sold under the scorching sun in most locations in Ghana.

According to Iloveindia (2010) an orange which weights 100grams contains 49 mg of vitamin C. However, the results of this study showed that the weight of the orange for the control was 170 grams and it had 29.7mg/100 ml vitamin C, which is far lower than the vitamin C in 100gms of an orange used by Iloveindia for the study. Several reasons can be attributed to this difference in values, based assertions on made by on Mullkick's (2007) and Barasi and Mattram's (1993) that:

i. The locality and the soils for the cultivation were different;
ii. The variety (species) of the oranges used;
iii. The trees from which the oranges were obtained and even the position of the orange on the tree can account for the difference.
iv. The level of maturity of the oranges used in the two studies.

3.2. Views of Students on How Oranges are Handled in Kasoa

In order to find out whether consumers were aware of the factors that affect the vitamin C content of oranges, 80 students of West End University were selected for the study. Table 4 represents the gender and ages of the students of the respondents because it helped to know the background characteristics of the respondents. However, before the views were sought, other questions were asked, the results of which are found in the proceeding section.

Sex	Frequency	Percentages (%)
Female	49	61.2
Male	31	38.8
Total	80	100

Age in years		
Below 21	16	20.0
21 -25	37	46.3
26 -30	23	28.7
31-35	2	2.5
36 above	2	2.5
Total	80	100

Table 4: Gender and Age of Respondents

Out of the 80 students in the contacted for the study, 49 were females representing 61.2% while the rest were males representing 38.8%. There were obviously more females than males in the sample as seen in the table. In all, 16, representing 20.0% of them were below the ages of 21years 60(75.0%) of them were between the ages 21 and 30, while the remaining 5.0% were above 31 years. Table 5 shows the weekly consumption pattern of oranges among respondents.

Consumption per week	Frequency	Percentage (%)
Once	28	35.0
Twice	18	22.5
Thrice	12	15.0
Four times	10	12.5
More than four times	12	15.0
Total	80	Total

Table 5: Frequency of Orange Consumption in a Week

The results, as presented in Table 5, show that as high as 57.5% of respondents ate oranges once or twice a week. Those who ate oranges thrice or four times formed 27.5% and 15.0% ate oranges more than four times a week. Forty-six (57.5%) bought peeled oranges, 20 (25.0%) bought the unpeeled oranges, while 14(17.5%) bought oranges both peeled and unpeeled forms. Some of the reasons given by those who bought the peeled oranges were convenience, time, attractiveness, better taste, prevention of odour on hands. Those given by people who responded to the unpeeled as a form of orange bought were hygiene, case of storage, better taste, attractiveness and nutrient maximization.

It is clear that more than half of the consumers preferred the peeled to oranges. From the results of the experiment on the loss of vitamin C increased with time and temperature, i.e. high temperatures and long time ofstoring the fruits outside cold environments increases loss of vitamin C.

3.3. Sources from Which Oranges were Obtained

Table 6 illustrates the sources from which the students obtain oranges for consumption. The reason for the enquiry is because it gives some idea on whether of factors that might contribute to loss of vitamin C.

Sources	Frequency	Percentage (%)
From peddlers	45	59.0
From market	26	32.9
From fruit stands	8	10.0
Total	80	100

Table 6: Where Respondents Obtained their Oranges

Data in Table 6 indicate that 45(59.9%) of the students bought their oranges from the peddlers, 26(32.9%) bought them from the market and the remaining 8(10.0%) got their oranges from the fruit stands. Oranges from all these sources were not stored in a way that would help to conserve the vitamin C content.

The next enquiry concentrated on the views of respondents on factors that affect the level of Vitamin C in oranges. Table 7 presents the views and the assumption was that it would reveal the knowledge they had on the factors which affect vitamin C. The mean for each statement which was computed before any comment was made.

Statements	No.				Mean	
		SA	A	D	SD	
Orange contains vitamin C	80	2(2.5)	2(2.5)	3(3.8)	73(92.2)	1.2
Vitamin C is easily destroyed by sunlight	80	2(2.5)	1(1.3)	29(36.2)	48(60.0)	1.5
Vitamin C can be destroyed when exposed to heat and oxygen	80	1(1.3)	4(5.0)	40(50.0)	35(43.7)	1.1
Vitamin C is unstable to humidity	80	2(2.5)	8(10.0)	60(75.0)	10(12.5)	2.0
Long period of orange stored at room temperature destroys vitamin C	80	8(10.0)	8(10.0)	51(63.8)	13(16.2)	2.3

Table 7: Respondents' Views on Factors that Affect the Level of Vitamin C in Oranges

Data in Table 7 reveal the respondents' views on statements relating to the factors that influence the level of vitamin C in oranges. The means of all the statements were below 3.0, none of the means of the statements was up to 3, meaning they disagreed with all the statements on factors which affect vitamin C content of oranges. It can be assumed that the students did not know much about vitamin C.

3.4. Respondents' Views on Handling of Oranges

Respondents were asked to give their views on how oranges they had been buying are handled by the traders and whether the practices can help to conserve vitamin C. Their views were grouped into four main categories namely harvesting, packaging and storage, transportation, and marketing. Figures 1a to 1dpresent respondents' views on how oranges are handled during harvesting, packaging and storage, transportation and marketing.

Respondents' Views on Handling of Oranges in Kasoa(n = 80)

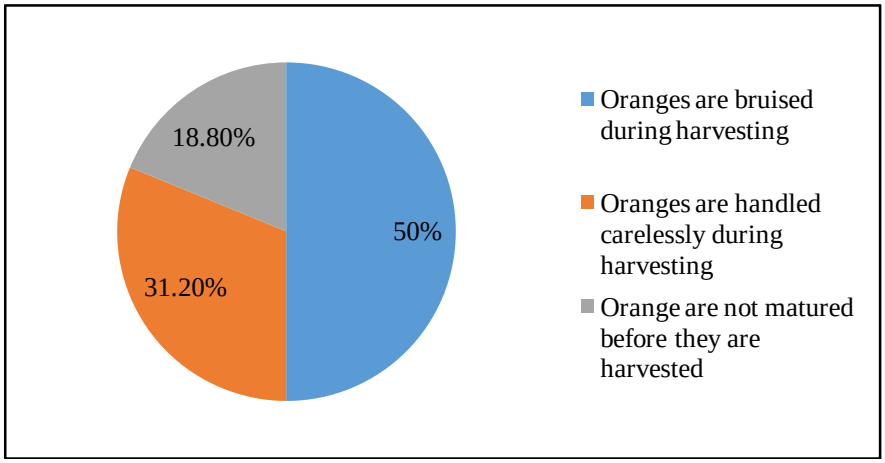

Figure 1a: Respondents' Views on Harvesting of Oranges in Kasoa

On harvesting, 50.0% of the respondents were of the view that the oranges are bruised, 31.2% claimed the oranges are handled anyhow in a careless manner and 18.8% felt the oranges are not allowed to mature.

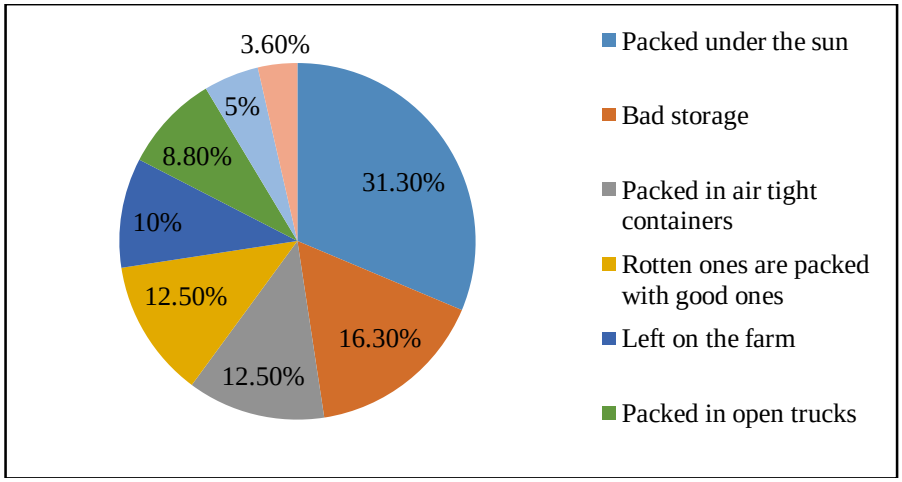

Figure 1b: Respondents' Views on Packaging and Storage of Oranges in Kasoa

Respondents' views on packaging and storage, as seen in Figure 1b, show 72.6% were of the view that oranges are packed under the sun, in unhygienic and airtight containers, with both rotten and good ones packed together.

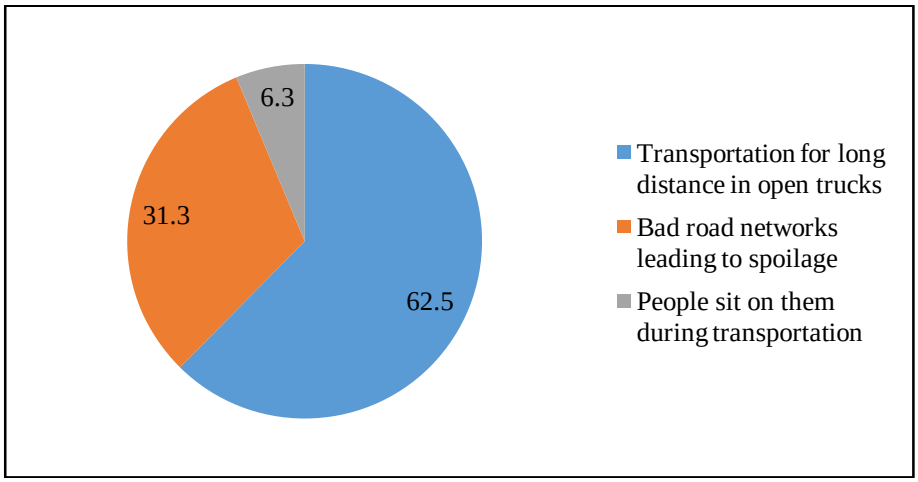

Figure 1c: Respondents' Views on Transportation of Oranges in Kasoa

An overwhelming majority, 93.8% of the respondents were of the view that the long distances of transportation and bad roads caused delays. The remaining 6.3% also responded that traders sat on the oranges

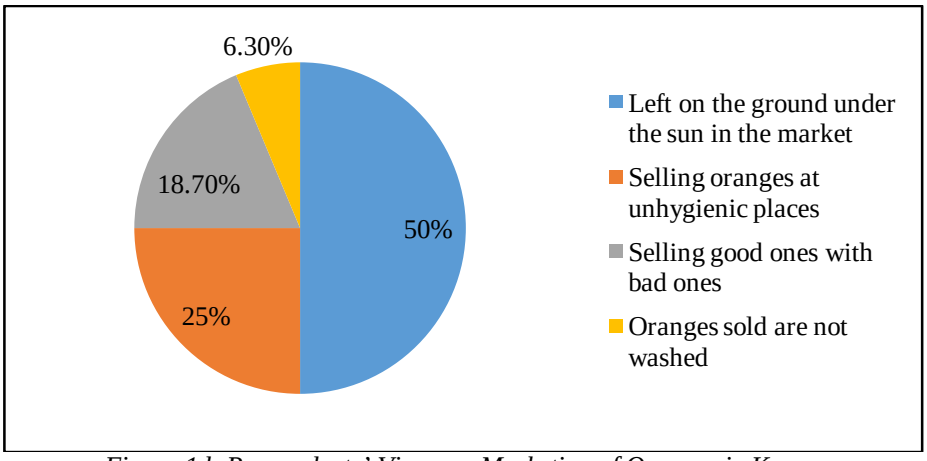

Figure 1d: Respondents' Views on Marketing of Oranges in Kasoa

The responses on marketing practices indicate that 93.7% of them complained about oranges left on the ground along the roadside, inside the markets and any open space. Also there were views that oranges are piled in unhygienic places, with good ones mixed up with spoilt ones. A few, 6.3%, added that the oranges are not washed and even those who sell them on stands store them without washing them.

Several views were expressed on bruises caused during harvesting due to how they harvested them. Ghanaian farmers pluck oranges from trees by using long sticks hit them so that they fall on the ground, thus causing bruises. Other comments they gave included careless handling during harvesting and harvesting immature oranges. In terms of transportation, the major comment made by the respondents was the fact that oranges were transported to the marketing points using open trucks which make them vulnerable to sunlight and prolong heat due to the fact that they were transported from long distances to the marketing centres without making sure they were in cool temperatures. Sitting on oranges in the trucks as they are being transported to the marketing centres is a very bad practice. It causes bruises and cuts to the oranges causing losses of vitamin C.

From the literature, it is clear that all these practices observed by the students, who are also consumers, are likely to result in losses of vitamin C. The results of the experiment to determine the effect of sunlight on the vitamin C content of oranges (Tables 3a and 3b) revealed that sunlight and long exposure have detrimental effects on the vitamin C content of oranges in that it caused considerable the losses of the vitamin. Even at room temperature, there were still losses of the vitamin. Barasi and Mottram (1993), Nagy and Smoot (2006), and Mullick (2007) proved that vitamin C levels in oranges vary due the positions of orange on the tree and the degree of maturity.

The same authors again argued that unhygienic storage and display contaminate the quality of oranges consumed by the respondents and for that matter reduces their nutritive value. The results revealed that though the students were not aware of the effect of sunlight or heat on vitamin C in orange, their views and comments showed that they perceived these factors had effects on the quality of the oranges, especially vitamin C.

4. Summary, Conclusions and Recommendations

i. The mean mass of the juice from peeled orange samples kept in the sun for 4, 16 and 48 hours were: 17.5mg, 19.5mg and 10.9mg/l00ml respectively. The percentage losses from the samples after 4, 16, and 48 hours were as follows: i). Peeled orange samples had 41.1%, 34.3% and 63.3% respectively.

ii. The mean mass of the juice from unpeeled orange samples kept in the sun for 4, 16 and 48 hours were: 22.8mg, 20.8mg and 13.1mg/l00ml respectively. The results of the percentage losses for the unpeeled oranges were 23.3%, 30.0% and 55.9% respectively.

iii. The loss of vitamin C in the juice from the peeled orange kept in the sun for four hours lost 12.0mg/100ml while the unpeeled one kept at the same time of four hours was 6.8%/100ml. the peeled orange kept in the sun for 16.6mg/100mls when kept in the sun for the same 16 hours.

4.1.1. Views of students on how oranges are handled in Kasoa

i. There were 38.8% and 61.2% females and 95.0% of them were aged between 21 and 30 years, while the remaining 5.0% were above 31 years.

ii. As high as 57.5% of respondents ate oranges once or twice a week and the rest ate oranges more than thrice a week. Forty-six (57.5%) bought peeled oranges, 20 (25.0%) bought the unpeeled oranges, while 14(17.5%) bought oranges both peeled and unpeeled forms. It was clear that more than half of the consumers preferred the peeled to oranges.

iii. The means of all the statements on respondents' views relating to the factors that influence the level of vitamin C in oranges were below 3.0, meaning they disagreed with all the statements on factors which affect vitamin C content of oranges.

iv. On harvesting, 50.0% were of the respondents were of the view that oranges are bruised,

v. About a third, representing 31.2% of students felt oranges were handled in a careless manner and 15.0% felt the oranges are not allowed to mature.

vi. On packaging and storage, 72.6% were of the view that oranges are packed under the sun, in unhygienic and airtight containers, with both rotten and good ones packed together.

vii. An overwhelming majority, 93.8% of the respondents were of the view that the long distances of transportation, bad roads causing delays and the remaining 6.3% also responded that traders sit on the oranges, which is a very bad practice.

viii. The responses on marketing practices indicate that 93.7% of them complained about oranges left on the ground along the roadside, inside the markets and any open space.

4.2. Conclusions

Based on the findings from the experimental and survey research, the following conclusions were deduced:

i. It can be clearly deduced from the results of the experiment that sunlight certainly has a negative effect on vitamin C in oranges, in bringing about losses of vitamin C. Again the loss is greater when the orange is peeled as compared to the unpeeled oranges and also the losses increase with time, meaning, when the period of warm exposure to the sun or when kept in warm temperatures for long hours the vitamin losses increase.

ii. To the students, Ghanaian farmers pluck oranges from trees by using long sticks hit them so that they fall on the ground, and careless handling thus causing bruises. Unhygienic storage and display contaminate the quality of oranges consumed by the respondents and for that matter reduces their nutritive value.

iii. The results revealed that though the students were not aware of the effect of sunlight or heat on vitamin C in orange, their views and comments showed that they perceived these factors had effects on the quality of the oranges, especially vitamin C.

4.3. Recommendations

Based on the findings and the conclusions made, the following recommendations are made:

i. As much as possible, all individuals and institutions that are involved in the production and marketing of oranges should make it a point to prevent the oranges from sunlight and higher temperatures,

ii. The Ministries of Education, Health and Agriculture should help consumers be aware of the benefits of vitamin C to the human body and also how to handle oranges in order to conserve the vitamin C.

iii. The Ministry of Health and Agriculture should enact laws that will prevent fruits from being piled up in unhygienic.

iv. The universities should make Nutrition a part of the Liberal courses so that students will be aware of vitamin and its health benefits.

v. The Ministry of Agriculture should help conduct course on how to harvest and transport fruits in order to help farmers know how to harvest fruits so as to conserve the vitamin C.

vi. The Ministry of Agriculture should help farmers to secure combined harvesters to harvest fruits so as to conserve the vitamin C.

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