EVALUATION OF VITAMIN C CONTENT IN DIFFERENT VARIETIES OF MANGOES AND ORANGES GROWN IN KAPCHORWA

BY

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DECLARATION

I **CHEMONGES AGGREY**, declare that this research report is presented in its original form and has not been presented to any other University or Institution for any academic award whatsoever.

Sign.....

Date..31/01/2024.....

CHEMONGES AGGREY

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APPROVAL

This research entitled "Evaluation of vitamin C content in different varieties of mangoes and oranges grown in Kapchorwa" is submitted by my approval as a supervisor

Sign.....

Date.....31/01/2024.....

Dr. Kamoga Omar

DEDICATION

I dedicate this piece of work to my beloved father, Yesho Julius and my beloved mother, Judith Yesho, my beloved brothers; Joel, Walter, Alfas, Emmanuel, Mark and my beloved sisters; Mama Jonathan, Faith for giving me the opportunity to study and also supporting me morally and financially not forgetting relatives and my friends for any kind of support they have rendered to me.

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ABSTRACT

Vitamin C (ascorbic acid, AA) is a water-soluble vitamin essential in human nutrition, an antioxidant, a scavenger of free radicals in biological systems and a co-factor of several enzymes. The purpose of this study was to analyze the vitamin C content from three varieties of mangoes and oranges grown in Kapchorwa. The method used to determine vitamin C content was titration method. The varieties of mangoes used were; alfonso, palmer, keitt and oranges were; novel, washing tunava, and american tungerine. The results of the varieties were as follows; percentage weight of alfonso was 1.03×10^{-3}% of sample, palmer was $0.90\times10\times^{-3}$% of sample and keitt was 0.97×10^{-3}% of sample of vitamin C in mango varieties. This means that alfonso variety had the greatest percentage weight and palmer had the least percentage weight amongst the three mango varieties and this may be due to high degradation of vitamin C during ripening.

Also, for orange varieties; novel had a percentage weight of 1.31×10^{-3}% of sample, washing tunava had a percentage weight of 1.19×10^{-3}% of sample, american tungerine had a percentage weight of 1.54×10^{-3}% of sample. Therefore, american tungerine had the greatest percentage weight and washing tunava had the least percentage weight among orange varieties.

The above results show that about 55 fruits should be eaten per day and this number is very high as compared to what health experts recommend whereby, they say that about 3-5 fruits should be eaten per day (Hampl, Taylor et al. 2004).

All the three varieties of mangoes and oranges were rich in vitamin C and should be eaten when they are just ripening. Alfonso and american tungerine are among the mango and orange varieties that should be eaten to avoid some health problems like; cancer, coronary heart disease among others since they contain much of vitamin C compared to other varieties.

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CHAPTER ONE:

1.0 INTRODUCTION

1.1 Background

Vitamin C is defined as the generic term for all compounds exhibiting the biological activity of L-Ascorbic acid. Vitamin C is the most important vitamin in fruits and vegetables. It is a major water-soluble anti-oxidant within the body. Vitamin C plays a very important role in a number of organismic physiological processes such as collagen biosynthesis, iron absorption, immune response activation, wound healing and osteogenesis. Vitamin C is a valuable food component because of its oxidant and therapeutic properties (Khosroshahi and Razavi 2022). Vitamin C is the principle biologically active form but L-dehydroascorbic acid, an oxidation product also shows biological activity.

Vitamin C is required for the prevention of scurvy and maintenance of healthy skin, gums and blood vessels. It functions in collagen formation absorption of inorganic iron, reduction of plasma cholesterol level, enhancement of the immune system and reaction with singlet oxygen and other free radicals (Rekha, Poornima et al. 2012) as an antioxidant, it also reduces the risk of atherosclerosis and some forms of cancer. However, an excess of Vitamin C can lead to irritation. Further, oxalic acid which is the metabolic product of vitamin C can cause renal problems. It can easily be degraded by enzymes and even by atmospheric oxygen, making it a highly labile substance. Its oxidation can further be enhanced by excessive heat, light, and heavy metal cations. Thus, vitamin C contents of food and beverages act as indicators of their quality as it can vary during manufacturing, transport, and storage of this food items.

1.2 Problem statement

Vitamin C is usually present in fruits (mangoes and oranges) in varying concentrations depending on the state of ripening. Three varieties of mangoes and oranges will have different concentrations of vitamin C which need to be analyzed.

The body requires vitamin C in small amounts and its deficiency may result into scurvy which is a disease characterized by lose of teeth, anaemia, swollen joint, fragile blood vessels among others.

Since the varieties of mangoes and oranges have varying concentrations, Health experts recommend that people should eat fruits with much vitamin C such that diseases like; cancer, coronary heart disease, and other various age-related chronic diseases are avoided.

1.3 Objectives of the study

1.3.1 General objective of study

The general objective of this study is to analyze vitamin C content present in three varieties of mangoes and oranges grown in Kapchorwa.

1.3.2 Specific objectives

i) To identify the three varieties of mangoes and oranges grown in Kapchorwa

ii) To determine the concentration of vitamin C in each of the varieties.

ii) To compare the concentrations of the three varieties of mangoes and oranges

1.4 Research question

What are the concentrations of the different varieties of mangoes and oranges?

1.5 Scope

The study was done on the evaluation of vitamin C content on the varieties of three varieties of mangoes and oranges grown in Kapchorwa district. This was done using the sample extracts of mango varieties; alfonso, palmer, keitt and oranges varieties; novel, washing tunava, and American tungerine using titration method of evaluation of vitamin C. The study was limited on the determination and comparison of vitamin C on the three varieties of mangoes and oranges.

1.6 Significance of the study

The study was intended to evaluate the concentration content of vitamin C of the three varieties of mangoes and oranges that are grown in Kapchorwa. The varieties of mangoes include; Alfonso, Palmer, Keitt (Gangolly, Singh et al. 1957) and for oranges include; Novel, Washing tunava, and American tungerine and information to the public through the government official and health workers on the type of fruit with less harmful effects.

Since the fruits have different concentrations of vitamin C, determining their concentrations was intended to help avoid health problems like hemolysis, heart burns, diarrhea, nausea, dental decalcification, increased estrogen levels, and hence give information on which varieties on which varieties of mangoes and oranges contain suitable concentrations of vitamin C with less harmful effects.

1.7 Justification of the study

The research is intended to analyze the vitamin C content present in three varieties of mangoes and oranges grown in Kapchorwa district and give information to the public through the government officials and the health workers on the variety of fruits with less health effects

Since the three varieties of mangoes and oranges have varying concentrations of vitamin C, determining their concentrations will help to avoid health problems like cancer, coronary heart disease, heart burns, hemolysis, diarrhea, nausea, increased estrogen levels, dental decalcification and occult rectal bleeding and hence this research is to give information on which species of mangoes and oranges contains suitable concentration of vitamin C with less health effects (Chawla and Kvarnberg 2014).

CHAPTER TWO:

2.0 LITERATURE REVIEW

2.1 Fruit ripening

Ripening is the process by which fruits attain their desirable flavor, quality, colour, palatable nature and other textural properties.

An important factor of ripening is the natural plant hormone ethylene (C_2H_4), which is produced by the fruit itself and released as a gas into the surrounding atmosphere. The released ethylene accelerates the ripening and senescence processes, making the fruit react very strongly to it (autocatalytic ripening)(Mazonde, Mujuru et al. 2017).

Ethylene is a phytohormone that controls or influences many aspects of plant growth and development (Iqbal, Khan et al. 2017). Many of the development processes controlled by ethylene, such as senescence, organ abscission and fruit ripening, are critically important to agriculture. For example, fruits such as mangoes and oranges require an increase in ethylene biosynthesis at maturity in order to ripen.

Ethylene is a phytohormone that controls many aspects of plant growth and development such as senescence, organ abscission and fruit ripening are critically important to agriculture. For example, mangoes and oranges require an increase in ethylene biosynthesis at maturity in order to ripen (Chawla and Kvarnberg 2014). The atmosphere contains less than 0.005ppb of ethylene. The optimum composition of ethylene in the storage capacity depends on the type of the fruit. In general, the fruit becomes sweeter, less green and softer as it ripens.

Though the acidity as well as sweetness rises during ripening, the fruit still tastes sweeter. Fruits produce much larger quantities of ethylene, although the internal ethylene concentrations vary significantly between fruit types. For most fruits a sharp increase in the internal ethylene concentration precedes or is coincident with a dramatic increase in respiration rate (metabolic activity) and attendant biochemical and physiological transformations that occur during ripening.

Ethylene production in fruits is described as an ‘autocatalytic’ process that is; exposure to an initial small concentration of ethylene causes the fruit to produce greater quantities of ethylene until a peak concentration is achieved (Bazzano, Barolo et al. 2016).

Exposing immature fruit to ethylene can trigger this autocatalytic response, causing premature ripening and result in fruit with poor eating quality which may cause health problem.

The predominant pathway of vitamin C degradation in aqueous water systems (water activity higher than 0.980) entails the oxidation of ascorbic acid to dehydroascorbic acid, which itself promptly degrades to 2,3-diketogulonic acid (Herbig and Renard 2017) . Vitamin C degradation depends slightly on the temperature in a range of 27-36℃ for mangoes and 20-30℃ for oranges. Above this temperature there is a high rate of loss in vitamin C concentration.

2.2 Functions of vitamin C

Vitamin C also known as ascorbic acid (AA), is important in the formation and repair of bones, teeth, and collagen; the body's major building protein (Devaki and Raveendran 2017).

It is an essential vitamin needed by humans to prevent scurvy and to increase the body's resistance to infections.

Vitamin C acts as an oxidant, a nutrient that chemically binds and neutralizes the tissue-damaging effects of substances in the environment known as free radicals (Akbari 2016). Vitamins help to heal wounds.

Vitamin C also helps the body absorb iron from plant foods.

In addition, vitamin C is required for the synthesis of carnitine, a small molecule that is essential for the transport of fat into cellular organelles called mitochondria, where the fat is converted to energy.

Research also suggests that vitamin C is involved in the metabolism of cholesterol to bile acid. Vitamin C is also a highly effective antioxidant, even small amounts of vitamin C can protect indispensable molecules in the body such as proteins, lipids (fats), carbohydrates and nucleic acids (DNA and RNA), from damage of free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants like cigarette smoke.

Vitamin C is generally non-toxic for maintaining a good and sound health and common cold, therefore human body should be kept saturated with vitamin C (Rahman, Khan et al. 2007)

2.3 Deficiency symptoms of vitamin C

Severe vitamin C deficiency has been known for many centuries as the potentially fatal disease, scurvy. Symptoms of scurvy include bleeding and bruising easily, hair and tooth loss, joint pain and swelling. Such symptoms appear to be related to the weakening of blood vessels, connective tissue and bone, which also contain collagen (Olmedo, Yiannias et al. 2006) .

A shortage of ascorbic acid may also result in hemorrhages under the skin and a tendency to bruise easily, poor wound healing and weakness. Lack of energy, poor digestion, bronchial infection and colds also indicative of an under supply of ascorbic acid. Many of the deficiency symptoms can be explain by a deficiency in the hydroxylation of collagen, resulting in defective connective tissues (Pinnell, Krane et al. 1972).

2.4 Diseases associated with vitamin C

2.4.1 Cardiovascular disease

Its until recently that the results of most prospective studies indicated that deficient intake of vitamin C were associated with an increased risk of cardiovascular diseases, and that modest dietary intakes of about 100mg per day were sufficient for maximal reduction of risk of this disease among nonsmoking people (Resnikoff, Pascolini et al. 2004) .

2.4.2 Cataracts

Cataracts are a leading cause of visual impairment throughout the world. It occurs more frequently and become more severe as people age. Decreased vitamin C levels in the lens of the eye have been associated with increased severity of cataracts in humans. Some studies have observed that increased dietary vitamin C intake and increased blood levels of vitamin C can lead to decreased risk of cataracts. In general, those studies that have found the relationship, suggest that, vitamin C intake may have to be higher than 300mg per day for a number of years before a protective effect can be detected (Sauberlich 1994) .

2.4.3 Lead Toxicity

People who are chronically exposed to lead are more likely to develop learning diseases, behavioral problems. Lead toxicity continues to be a significant health problem, especially in children living in urban areas. Abnormal growth and development have been observed in infants

of women exposed to lead during pregnancy, while children have a low IQ (Hanson and Smith 1975). In adults, lead toxicity may result to kidney damage, high blood pressure, and anemia (Riess and Halm 2007). In the study of 747 older men, blood lead levels were significantly higher in those reported total dietary vitamin C intakes averaging less than 109mg per day compared to those who reported higher vitamin C intake.

2.4.4 Cancer

A large number of studies have shown that increased consumption of fruits and vegetables is associated with reduced risk for most types of cancer (Key 2011). Such studies were the basis for dietary guidelines endorsed by the U.S. Department of Agriculture and the National Cancer Institute, which recommended at least five serving of fruits and vegetables per day. The recommended serving number depends by age, gender, body composition and physical activity level (Chatindiara, Williams et al. 2019). Laboratory experiments indicate that vitamin C inhibits the formation of carcinogenic compounds in the stomach (Zhang, Wakisaka et al. 1997).

2.4.5 Hypertension

Individuals with high blood pressure are at increased risk of developing cardiovascular diseases, several but not all studies have demonstrated a blood pressure lowering effect of vitamin C supplementation (Abrams 2017). A small study in individuals with hypertension found that vitamin C supplementation with 500gm per day for six weeks slightly decreased systolic blood pressure (1.8mmHg reduction) compared to a placebo (Glandt and Raz 2011)

2.5 Methods that are normally used for determining the concentration of vitamin C

Many analytical methods have been reported for the determination of vitamin C content and these include; conventional titration method, fluorimetry, spectrometry, chemiluminescence, enzymatic methods, capillary electrophoresis, electrochemical methods, amperometry, HPLC are the most common (Klimczak and Gliszczyńska-Świgło 2015).

Use of titration method determines the concentration of vitamin C content in solution by redox titration using iodine. Vitamin C commonly called ascorbic acid, is an essential antioxidant needed by the human body. As iodine is added during the titration, ascorbic acid is oxidized to dehydroascorbic acid, while the iodine is reduced to iodide ions.

In spectrometric method, the total amount of vitamin C (Ascorbic acid + Dehydroascorbic acid) is determined in fruits by using UV spectrophometer. Here bromine water is used which oxidizes the ascorbic acid to dehydroascorbic acid in the presence acetic acid (Desai and Desai 2019). Spectrophometer is mostly used to determine ascorbic acid because it is a simple method and vitamin C is able to absorb UV rays (Desai and Desai 2019).

Another method is simple fluorimetric method, for determination of AA which is base d on the condensation reaction between AA and O-phenylenediamine (OPDA) (Wu, Diao et al. 2003). For the oxidation of AA to DHA and reaction with OPDA, the oxidant (DCPIP, N-bro mosuccinimide and iodone) is used. The sensitivity of common OPDA method is low due to blank effect of the oxidant. Wu and his co-workers (Wu et al, 2003) develop OPDA method when AA can react with OPDA in the absence of the oxidant at PH 9.4, so the sensitivity of the determination is better and the detection limit is lower. Fluorimetric method with 2,3-Diamynonaphthalene (DAN) at PH 10.2 to 10.5 and cyanoacetamide at PH 12.9 to 13.3 could be used for AA analysis.

Ascorbic acid could also be evaluated by flow injection analysis (FIA). There are many modifications of this technique (Denet et al, 2000). Its versatility, simplicity, and reasonable costs, and possible combination of the FIA method with spectrophometry, chemiluminescence, electrochemical methods, potentiometry, are advantageous parameters for many different analytical measurements.

Electrochemical determination of ascorbic acid using electrodes as quite long continuation. For the evaluation of AA by direct electro-oxidation some convectional electrodes such as Hg (Tsang, Hui et al. 2014), platinum, and glassy electrode (GCE) has been used.

CHAPTER THREE:

3.0 MATERIALS AND METHODS

3.1 Overview

This chapter details the methods and procedures used to achieve the research objectives. Specifically, it explores how the concentrations of vitamin C were determined by titration method.

3.2 Apparatus

The following apparatus were used and include; conical flasks, measuring cylinders, mortar and pestle, a 100 ml volumetric flask, plastic beakers.

3.3 Materials and reagents

Three varieties of mangoes which include; alfonso, palmer, and keitt and that of oranges include; novel, washing tunava, american tangerine, vitamin C standardized solution, standard iodine solution, starch indicator solution, deionized water

3.4 Reagent preparations

Vitamin C standard solution

0.25g of vitamin C (ascorbic acid) was dissolved in 100ml of water in a beaker.

0.005molL^{-1} standard iodine solution

2g of potassium iodide grate reagent was carefully weighed into a 100ml beaker, 1.3g of potassium iodate was weighed and added into the same beaker and the contents dissolved in a few ml of water, swirled for a few minutes until the iodine was dissolved and raised to the marked volume of 100mL with distilled water. 3M sulphuric acid was added and the solution was transferred into a 1000ml volumetric flask and diluted up to the mark.

Starch indicator solution

This solution was prepared by dissolving 1g of starch powder in 10ml of distilled water, it was then stirred well and transferred to 100 ml of boiling water. The content was stirred thoroughly and boiled for a minute and then allowed to cool at room temperature. This was to enable the

formation of a precipitate once it becomes cool. The precipitate was left to decant and then used as an indicator solution.

3.5 Sample collection

Three varieties of mangoes; alfonso, palmer, keitt and of oranges; novel, washing tunava, american tangerine were purchased from different places in Kapchorwa district and brought into the chemistry laboratory. The choices of the varieties of mangoes and oranges were based on the availability and cost effectiveness.

3.6 Sample preparation

The fresh collected variety of mangoes and oranges were washed thoroughly with tapped water and their juices were extracted by normal squeezing of the fruit varieties. 100g sample of the varieties was cut into small pieces and grinded in a mortar and a pestle. 10ml portions of distilled water was added several times while granting the sample, each time decanting off the liquid into a 100ml volumetric flask.

3.7 Procedure

20ml vitamin C standard solution was pipetted into a 250ml conical flask. 3drops of 0.5% starch solution was added into the flask. The burette was rinsed with a small volume of iodine solution and then filled up to the mark and the initial volume was noted. The vitamin C standard solution was the titrated against iodine solution until the endpoint was reached (dark blue- green colour) that persists after 20seconds of swirling the solution. The final volume of iodine solution was noted and recorded. The titration was repeated twice more to obtain consistent results. The same procedure was then followed for the samples of the three varieties of mangoes and oranges.

CHAPTER FOUR:

4.0 RESULTS AND DISCUSSION

4.1 Data about selection of varieties

In the determination of vitamin C content of mango and orange varieties by titration method using iodine solution, iodine is a weak oxidizing agent it would only oxidize vitamin C as far as desired. But iodine is almost insoluble in water (Winger, König et al. 2008). Vitamin C reacts with iodine according to the following equation;

$$C_6H_8O_{6(aq)} + I_{2(aq)} \rightarrow C_6H_6O_{6(aq)} + 2H^+{}_{(aq)} + 2I^-{}_{(aq)}$$

The concentration of vitamin C and the findings of the study were then presented in the table below.

Table 4.1: Percentage weight of vitamin C

Sample		Weight of vitamin C (mg/100g of sample)	Weight percent (%)
Mango variety	Alfonso	1.03	1.03×10^{-3}
	Palmer	0.90	0.90×10^{-3}
	Keitt	0.97	0.97×10^{-3}
Orange variety	Novel	1.31	1.30×10^{-3}
	Washing tunava	1.19	1.19×10^{-3}
	American tungerine	1.54	1.54×10^{-3}

The results of the study were then presented on the graph of weight percent against sample as shown in the figure below.

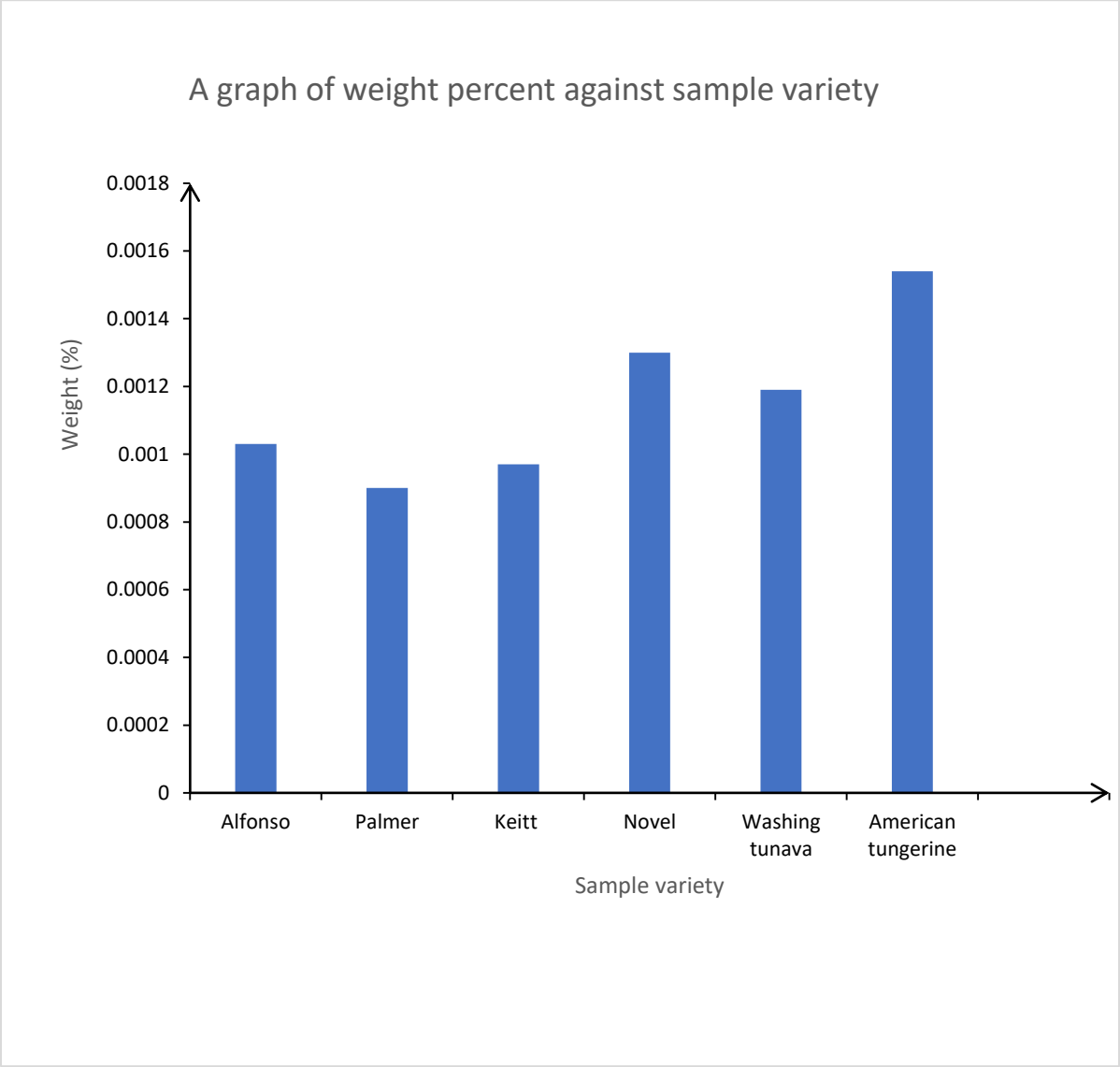

Figure 4.1.A graph of percentage weight against sample variety

The concentrations in grams per 100g of vitamin C of the varieties were then converted to percentage weights and they were as follows; percentage weight of alfonso was 1.03×10^{-3}% of sample, palmer was 0.90×10^{-3}% of sample and keitt was 0.97×10^{-3}% of sample of vitamin C in

mango varieties. This means that alfonso variety had the greatest percentage weight and palmer had the least percentage weight amongst the three mango varieties and this may be due to high degradation of vitamin C during ripening.

Also, for orange varieties; novel had a percentage of 1.31×10^{-3}% of sample, washing tunava had a percentage weight of 1.19×10^{-3}% of sample, American tungerine had a percentage weight of 1.54×10^{-3}% of sample. Therefore, american tungerine had the greatest percentage weight and washing tunava had the least percentage weight among orange varieties.

Most people can get enough vitamin C for the day in their food. An orange provides enough vitamin C for the day. The recommended daily amount for vitamin C is 15-75mg for children, 75mg per day for women and 90mg a day for men. This implies that approximately 3-5 fruits should be eaten per day (Hampl, Taylor et al. 2004).

Usually, the concentration of vitamin C decreases with ripening because of oxidation of vitamin C to dehydrovitamin C (Galgano, Favati et al. 2002) and therefore vitamin C is highly unstable and has short shelf-life while unripe fruits have high concentrations of vitamin C , and this diminishes as the fruit ripens. As ripe fruits age, the vitamin C continues to disappear.

CHAPTER FIVE:

5.0 CONCLUSION, CHALLENGES, AND RECOMMENDATIONS

5.1 Conclusion

Vitamin C is important in health of humans and many people need a dietary source to stay healthy. The results of the varieties were as follows; percentage weight of alfonso was 1.03×10^{-3}% of sample, palmer was $0.90\times10\times^{-3}$% of sample and keitt was 0.97×10^{-3}% of sample of vitamin C in mango varieties. This means that alfonso variety had the greatest percentage weight and palmer had the least percentage weight amongst the three mango varieties and this may be due to high degradation of vitamin C during ripening.

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The above results show that about 55 fruits should be eaten per day and this number is very high as compared to what health experts recommend whereby, they say that about 3-5 fruits should be eaten per day (Hampl, Taylor et al. 2004).

5.1.1 Challenges faced

- Collecting samples at the same ripening stage for analysis was a big problem since samples were collected from different areas in Kapchorwa district at different times.
- I also faced a challenge in preparation of vitamin C samples whereby I prepared the samples and left them until the following day and found no vitamin C present in the samples. This made me to prepare fresh sample solutions again.

5.1.2 Solutions to the above challenges

- Samples should be collected at the same stage and kept in same conditions of temperature in order to improve on the accuracy of results.
- Vitamin C sample extracts should be prepared and used immediately to avoid oxidation of vitamin C to dehydrovitamin C which can easily take place.

5.2 Recommendations

- All the three varieties of mangoes and oranges were rich in vitamin C and should be eaten when they are just ripening. Alfonso and american tungerine are among the mango and orange varieties that should be eaten to avoid some health problems like; cancer, coronary heart disease among others since they contain much of vitamin C compared to other varieties.
- Further research can be done on the factors that affect the vitamin C content in fruits

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