ANALYSIS OF THREE VARIETIES OF PEPPER FOR ASCORBIC ACID AND SOME ESSENTIAL MINERALS

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DECLARATION

I hereby declare that all the work reported in this thesis is my own research work. It has not been submitted in any form elsewhere for the award of any other degree or certification.



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CERTIFICATION

This thesis entitled "ANALYSIS OF THREE VARIETIES OF PEPPER FOR ASCORBIC ACID AND SOME ESSENTIAL MINERALS CONTENT". By Sule Zakari Kazaure, meets the regulations governing the award of the degree of M.Sc. ANALYTICAL CHEMISTRY of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to my late parents;

Mallam Zakari Kuda Kazaure and Madam Khadija Zakari Kazaure.

May their Souls rest in Perfect peace.

AMEN.

ABSTRACT

Three local varieties of pepper readily available namely: *Capsicum annum* L Tattasai (Hausa), tatase (Yoruba) *Capsicum annum* G. Attarugu (Hausa), Atarodo (Yoruba) and *Capsicum frutencens,* Barkono (Hausa), Ata wewe (Yoruba) were analysed for some essential mineral and ascorbic acid contents. Flame ehiission and atomic absorption spectroscopy were used for essential minerals determination and AOAC indophenol method for ascorbic acid. The effect of drying on ascorbic acid content of the freshly harvested pepper was also studied. In addition the relationship between the source soil mineral content and that of the peppers grown on it was investigated.

It was found that the fresh samples from the farm contained more ascorbic acid than the samples from the market. The samples from the farm and market follow the pattern: Barkono > Attarugu > Tattasai.

About 50 to 60% of the ascorbic acid content was observed to be lost as a result of drying. In all the three varieties of peppers, potassium was observed to be the most abundant element and calcium the least.

TABLE OF CONTENTS

PAGE

Title Page i

Declaration ii

Certification iii

Dedication iv

Acknowledgement v

Abstract vi

Table of Contents vii

List of Tables x

List of Appendix xi

CHAPTER ONE

1.0 INTRODUCTION 1

1.1 Peppers and their consumption 1

1.2 Ascorbic acid and essential mineral content of peppers 2

1.3 Physiological importance of Ascorbic acid and essential minerals .2

1.4 Aim and justification of research 5

CHAPTER TWO

2.0 Literature review 7

2.1 Varieties of Pepper 7

2.2 Review of methods of Analysis 8

2.2.1 Ascorbic acid in fruits 8

2.2.2 Methods of quantification of essential mineral elements 10

2.3 Previous studies 11

2.4 Relation of minerals in soil and plant. 12

CHAPTER THREE

3.0 Materials and Methods 14

3.1 Materials 14

3.1.1 Chemicals 14

3.1.2 Collection of pepper and soil samples 14

3.1.3 Soil sampling 15

3.1.4 Pre-treatment of samples 15

3.2 Experimental 16

3.2.1 Determination of Moisture and Dry matter 16

3.2.2 Determination of Ash 16

3.2.3 Preparation of standard solutions of metal ions 17

3.2.4 Preparation of pepper sample solutions 20

3.2.5 Preparation of soil sample solutions 20

3.2.6 Leaching (partial digestion) 21

3.2.7 Mineral elements determination 21

3.2.7.1 Determination of Na and K in pepper and the soil sample 22

3.2.7.2 Determination of Ni, Cr, Mn and Ca in pepper and soil samples . 24

3.2.7.3 Background correction 26

3.2.8 Determination of Ascorbic acid 27

3.2.8.1 Preparation of solutions 27

3.2.8.2 Preliminary test 28

3.2.8.3 Standardisation of indophenol solution 29

3.2.8.4 Preparation of sample solutions. 29

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CHAPTER FOUR

4.0 Results and Discussion 31

4.1 Moisture and ash content 31

4.2 Some essential mineral content of pepper samples 35

4.2.1 Fresh pepper samples 35

4.2.2 Sun-dried pepper samples 39

4.3 Mineral content of the source soils 43

4.4 Ascorbic acid content of pepper 47

CHAPTER FIVE

5.0 Summary and Conclusion 51

5.1 Recommendation 52

REFERENCES 53

APPENDIX 56

LIST OF TABLES

TABALE	TITLE	PAGE
1.1	The daily requirement of some essential minerals in food for an adult human being	4
3.0	AAS Operating parameters for elements determined	26
3.1	Moisture and ash content of fresh pepper samples	33
3.2	Moisture and ash content of sun-dried pepper samples	34
3.3	Element composition of fresh flesh pepper (mg100g of fresh pepper)	37
3.4	Element composition of fresh seed peppers (mg100g of fresh pepper)	38
3.5	Element composition of the seed of sun-dried peppers (mg/100 g of dried pepper)	41
3.6	Element composition of the seed of sun-dried pepper (mg100g of dried pepper)	42
3.7	Elemental composition of leeched source soil (mg/100 g)	46
3.8	Elemental composition of Digested source soil (mg/100 g)	46
3.9	Ascorbic acid content of fresh pepper samples (mg/100 g)	50
3.10	Ascorbic acid content of sun-dried pepper samples (mg /100g)	50

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LIST OF APPENDIX

APPENDIX	TITLE	PAGE
I	Calibration curve for the determination of sodium	56
II	Calibration curve for the determination of potassium	57
III	Calibration curve for the determination of nickel	58
IV	Calibration curve for the determination of chromium	59
V	Calibration curve for the determination of Manganese	60
VI	Calibration curve for the determination of calcium	61

CHAPTER ONE

1.0 INTRODUCTION

1.1 Peppers and their Consumption

Different varieties of peppers are grown and eaten in different parts of the world. *Piper nigrum* is the native of East Indies and is cultivated in Indonesia, India and Brazil, *Capsicum annum* is grown throughout the world *while Capsicum frustecens* is native to tropical regions.

Most human being eat pepper in one form or another with their meals, perhaps more as spices. An alkaloid responsible for the hot taste of pepper in for example *Piper nigrum* is piperine. Different varieties of pepper have differing degree of pungency, apparently suggesting that different variety of peppers contain different amount of what ever alkaloids are responsible for the pungent taste. Since people tend to eat peppers because of their fungency, some variety of peppers may have to be consumed in larger amount to bring about the pungent taste required for example *Capsicum annum* Longum, "tattase" (Hausa), "tatase" (Yoruba) is not as pungent as *Capsicum annum* grossum, "Attarugu" (Hausa), "Atarodo" (Yoruba) by implication, what ever "tattase" contains apart from the piperine content is taken in by the consumer in larger amounts.

Eventhough peppers are taken in little quantities at a time they are nutritionally unimportant because they are eaten in almost every meal.

1.2 Ascorbic Acid and Essential Mineral Element Content of Peppers.

Ascorbic acid or vitamin C is commonly presumed to exist only in fresh foods. Due to the fact that it is easily destroyed by heat, little attention appears to be given to the amounts in cooked food (Peterson, 1973). The presence of ascorbic acid in pepper has long been established. Wimalasari and Wills (1983) found that *Capsicum annum* L. (Tattase) has 186.7 mg ascorbic acid per 100 g of dry sample.

Floyd and Fraps (1939) found that the peppers they studied contained 280 mg of ascorbic acid in 100g of the fresh peppers .

The presence of minerals in peppers also has been established in countries like Egypt and United States of America (Nicol, 1956). But in Nigeria little appears to be known about how much of vitamin C and essential mineral elements the local varieties of pepper contain (Nicol, 1956).

1.3 Physiological Importance of Ascorbic Acid and Essential Minerals.

Ascorbic acid is found widely distributed in vegetables, certain tubers and acidic fruits among others. It is also normally found in certain animal tissues, especially the grandular tissues (Krishiman, 1979). The mechanism of ascorbic acid formation in plants and animals remains obscure (Krishman, 1979).

The richest natural source of ascorbic acid are rose hips, peppers, lemons, limes, orange and grapefruit (Williams, 1992). Ascorbic acid is an essential food substance. Most animals are able to produce it from sugars within

their own bodies. But man must depend on his food for his supply of ascorbic acid (Williams, 1992)

The most important function of ascorbic acid is the control it has on the ability of the body cells to produce collagen (Sastry, 1942). This is a substance that binds cells together and keeps them in proper relation to each other. The maintenance of the capillary blood vessels, the dentine of the teeth, the bones and the connective tissues of the body are dependent on this function.

A deficiency of ascorbic acid leads to a disease known as scurvy (Kondo, 1941). It develops occasionally in infants and in adults who have been deprived of ascorbic acid in their diets for several months. (Altenburgar 1941).

Symptoms of scurvy include general weakness, loss of appetite, tenderness of the legs, anemia, hemorrhages in body tissue, and swelling, infection, and bleeding of the gums. If condition goes on untreated, death may result. (Cutforth, 1958).

The estimated daily requirement lie within fairly wide limits but the amounts considered minimal for good nutrition are about 20 mg for infants 40 mg for children and 50 - 60 mg for adults (Smith, 1938). Women in pregnancy state and those lactating may require more.

Nutritionally essential minerals are the inorganic elements required by man and animals for normal body operations.

Each of the element manganese, calcium, sodium, potassium, zinc, nickel, iron, copper and chromium are considered to be essential to animal and human physiology.

TABLE 1.1: The Daily Requirement of Essential Mineral in Food and Water (Schroeder, 1976).

ELEMENT	AMOUNT (g)
Sodium	4.400
Potassium	3.300
Manganese	0.013
Nickel	0.013

All forms of living matter require minerals for their life process. Many elements act alone or in conjunction with other catalyst for essential enzymic processes in the body (Osborne, 1978).

Potassium and sodium play crucial roles in the body by helping to maintain equilibrium between extra and intra-cellular fluids, influence any contractility of smooth, skeletal and cardiac muscles, affecting the excitability of nerve and muscle tissue and controlling the optimum acid - base balance as well as intracellular metabolism (Stare and Mcwilliams, 1973).

Calcium is essential for the formation of teeth, bones and blood clots. It is the main component of the structural developments, in both plants and animals. It is also important in nerve tissue regulation, cardiac control, regulation of muscular activity and regulation of body fluids (Stare, and McWilliams, 1973).

Manganese deficient animals have diminished testes weight and tubular degenerations they lack sex derive and are sterile (Ovent and McCoilum, 1931).

Recovery in nature animals concides with the time required for sperm production. Manganese is involved in spermatogenesis (Gunn and Gould, 1976), but a specific role has not been identified. Sexual impotence is a common early complaint in industrial manganese poisoning, but direct effects on human sperm characteristics have not been reported (Pendver, 1955), but has been accidentally induced through the feeding of a synthetic ration. The manifestation of manganese deficiency include growth retardation, reduced fertility, skeletal abnormalities and disorders of the central nervous system. (Dossy, 1974).

Nickel is found in large amount in the body. Nickel catalyst are involved in the hydrogenation of edible vegetable oils. This is one reason for large amount of nickel being present in the human body. Nickel is an essential mineral, but its role status in human nutrition is unknown

Nickel appears to be essential for animals and Pathology consistent with nickel deficiency has been produced in chicks, rats and swine. Nickel deficiency in these animals causes metabolic abnormalities in the liver, increased liver lipids, increased phospholipid and cholesterol fraction (Nielsen, 1974).

1.4 Scope and Justification of Research

Peppers are eaten almost daily but in small quantity by human beings Ascorbic acid and essential mineral elements are known to be of vital physiological importance to the human body. This project was embarked upon in a bid to asses the ascorbic acid and some mineral element contents of three

local varieties of pepper readily available, namely. *Capsicum annum* L tattasai (Hausa). "tatase" (Yoruba), *capsicum annum* g. "attarugu" (Hausa), "atarodo" (Yoruba), and *capsicum frustencens*, "barkono" (Hausa), "ata we-we" (Yoruba). The effect of drying on the ascorbic acid content of the freshly harvested pepper was also studied. In addition the relationship between the source soil mineral content and that of the peppers grown on it was investigated.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Varieties of Peppers

There are two major species, each containing a number of cultivars.. The first major specie is capsicum annum which is widely grown through the America and the tropics.

These are small, bushy, and sometimes woody, annuals growing 0.3 -1.5 m tall. The leaves are simple, variable a size and shape, and 6 - 12 cm long. The carrying single fruits are 1 - 30 cm long. Varying in colour from yellow, orange, red brown to purple. These fruits vary in their pungency and sweetness. The second major species is *Capsicum frustescene*. These are short-lived shrubby perennials which bear their flowers in clusters. The fruits are usually red and 2 - 3 cm long. In general, there are "not' pepper. *Capsicum frustescens*. (Williams, 1992).

Peppers of the genus *Capsicum* comprise a number of varieties and sub-species, and their uses reflect thus diversity. All forms are used as spices in ways which depend on how pungent or "hot" they are. The pungency itself depends on the amount of Capscacin (an organic compound) within the plant. Sweet peppers are mild and are often stuffed, pickled or used in salads. The more pungent Paprika pepper are dried and used in powdered form in stews and other dishes.

Africa and Indian chillies are particularly hot and are used most notably in curies when dried and ground into powder. This spices are generally used in

the manufacture of hot sauce, pickles and curry powders and they have a traditional use, as medicine or stimulant. (Williams, 1992).

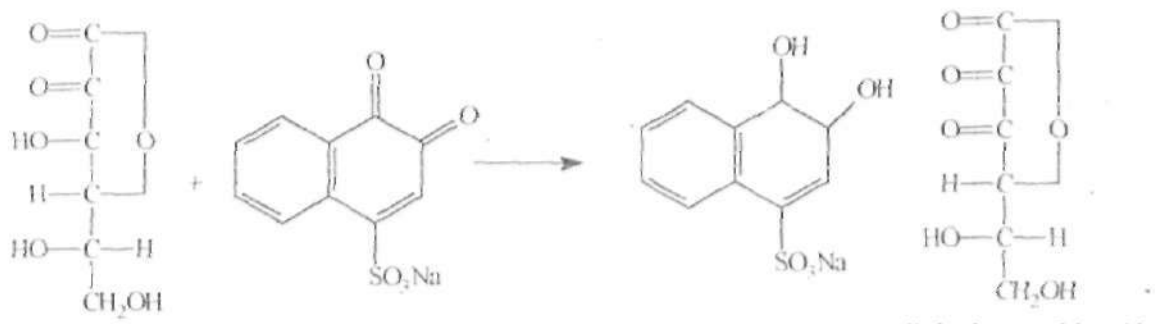
2.2 Review of Methods of Analysis.

2.2.1 Methods of Quantification of Ascorbic Acid in Fruits.

There are many methods for determination of ascorbic acid in fruits. The most common approach for the determination of ascorbic acid content in fruits is by indophenol titration method. This method involves extraction with metaphosphoric acid and titrating with indophenol.

Floyd *et al.*, (1939) used indophenol titration to determine the ascorbic acid content of some texas fruits and vegetables, and described the method as the best for determination of ascorbic acid in fruits and vegetables.

Barakat *et al.*, (1955) proposed a new titrimetric method involving the selective oxidation of ascorbic acid by *N*-bromosuccininimide. The method is based on the fact that the orange - colours reagent solution (*N*-bromosuccinimide) it quantitatively and rapidly reduced by ascorbic acid in acid solution to colourless compound. Sodium 1,2-naphthoquinone-4-sulphonate is analogous to 2,6 - dichlorophenolindophenol, acting as a self - indicator, but it is better because it is definitely crystalline compound that dissolves readily in cold distilled water, it does not require frequent standardisation as does 2,6-dichlorophenolindophenol. It is quantitatively and rapidly reduced by ascorbic acid as represented in the equation. (Barakat, *et al.*, 1955).



Sodium 1,2-naphthoquinone-4-sulphonate Dehydroascorbic acid

A thorough investigation was made of the use of indophenol titration for estimation of ascorbic acid in Parika. No evidence was obtained for the presence of interfering reducing substances or for the existence of complex protein containing bound ascorbic acid which would vitiate the titration (Patka *et al.*, 1942).

Melvin *et al.*, (1943) described the photometric method as another method for determination of ascorbic acid in fruits. The. Rapid titration of an acid extract with standardized solution of sodium salt of 2,6-dichloroindophenol yield accurate values for product rich in ascorbic acid. This procedure involves measurement in a photoelectric calorimetric of the progressive reduction of an excess of the dye.

The micro method for determining reduction ascorbic acid by titration with 2,6-dichlorophenolindophenol, developed by Harris, Ray and Birch (1933) has found wide application in the study of plant tissue.

The method is simple and numerous investigators have comparison with animal tests that is reliable. When applying the micro method of estimating ascorbic acid to plant tissue, it is recommended that not more than 20 g of

material should be taken, complete extraction is difficult if the concentration of material is high and in addition, some oxidation of ascorbic acid may occur during the extra time required for grinding a larger sample.

Wang *et al.*, (1988) determined the value of ascorbic acid in food materials using HPLC on a Zorbax ODS column with electrochemical detection. The influence of mobile phase, pH and methanol on capacity ratios were studied. Electrochemical detection was more selective than absorbance detection. The capsicum studied has an average value of 1912 mg of ascorbic acid per 100 g of dry sample.

Han (1987) used - Reverse phase HPLC to determine ascorbic acid content in food products. A micro pack CN-10 column (4 x 300 mm) and UV - detection (260 nm) were used. The elution solvent contained methanol - water (5:95). The column temperature was 40 °C. The lower detection limits were 1.5 - 50 mg.

2.2.2 **Method of Quantification of Essential Mineral Elements**.

When determining the level of inorganic nutrients in food, the objective is to obtain the minerals in a concentrated form separated from as many sources of interferences as possible. This is a achieved by the destruction of the organic matrix by wet digestion or dry ashing. A wide range of analytical techniques are available for the determination of these elements viz: electrochemical (Polarographic, coulometric, conductometric, potentiometric, amperometric analysis), atomic spectroscopy (emission absorption, flourescence), colorimetric

spectrophotometric, chromatographic, complexometric, volumetric and gravimetric techniques (Vincent, 1981). Piper (1947) described the classical colometric procedures that have been adapted as AOAC official methods (AOAC, 1980). Johnson and Virich (1959) have described various colometric methods for the determination of a number of micro-nutrients in plants tissue.

Nitrous-oxide-acetylene flame emission spectrophotometry looks promising (Pickett and Koirtyohann, 1969). Atomic absorption spectrometry has been used for food analysis. An excellent service of this technique for the analysis of plant tissue has been made by Isaac and Kerbe (1971).

2.3 Previous Studies.

Report on analysis of peppers are scanty and most of these are only proximate composition. A number of analysis on red peppers for Carbohydrate, protein, fat, vitamin C and calcium was carried out by Krischman *et al.*, (1979). The following result was obtained. Carbohydrate (7.1 g per 100 g of pepper), protein (1.4 g per 100 g of pepper), fat (0.3 g per 100 g of pepper), vitamin C (204 mg per 100 g on dry weight basis) and Calcium (13.0 mg per 100 g).

Floyd *et al.*, (1939) from their studies, found that the peppers studied contained 280mg of ascorbic acid in 100 g of fresh pepper samples. Sprugt (1939) estimated the ascorbic acid content of (East) Indian fruits and found that *Capsicum annum* (pepper) had very high values three to five time those of average citrus fruits (280 - 330 mg per 100 g of fresh pepper sample). Mohammed *et al.*, (1938) estimated the ascorbic acid content of several varieties

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of Indian chilies (*Capsicum*) *Capsicum grossun* contained from 43.10 - 57.20 mg of ascorbic acid in 100 g of dry sample while *Capsicum annum* was found to contain 24.8 mg per 100 g of dry pepper.

Wimalasiri *et al.*, (1982) found the capsicum studied to have an average value of 186.7 mg of ascorbic acid in 100 g of dry sample.

Sosa-bourdoul (1940) estimated the ascorbic acid content of some varieties of sweet pepper and their hybrids. They were found to contain an average value of 300 mg of ascorbic acid per 100 g of fresh samples.

2.4 **Relation of Minerals in Soil and Plant**.

The factor that affects the availability of a mineral nutrient in soil for plant absorption is the solubility of inorganic compounds. An element has to be in soil solution before it can be absorbed. This makes it clear that water will be necessary for the dissolution of the mineral elements in the soil before the plants can take them up for onward 'transmission to man. Schroeder (1976) has suggested that elemental variations in soil might be reflected in fruits grown on soils with very low amount of one or more elements.

Low soil temperatures are important limiting factor in the uptake of minerals by the plant. (Kenneth, 1976). Chemical analysis of a soil must however remain of limited use until some reasonable technique for determining 'plant available' mineral nutrients can be introduced. For not all the elements in the soil solution are available to the plant and certain other ones which are not in

solution can be obtained by the intimate contact of the root with soil particles (Schutte, 1959).

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 MATERIALS

3.1.1 Chemicals

All solutions were prepared with AnalaR grade chemicals and distilled water used as diluent except otherwise stated. The glassware and other apparatus used in this work were cleaned and dried before use.

3.1.2 Collection of Pepper and Soil Samples.

Sampling is a process of obtaining a suitable sample whose components and their amounts reflect that of the bulk of material from which it was taken.

The pepper samples used for this research work were collected from Institute of Agricultural Research (IAR) farm site in Samaru Zaria, Kaduna State, Nigeria. These are *Capsicum annum* L and *Capsicum annum grossum* (Tattase and Attarugu) and *Capsicum frutescens* L. (Barkono). These three local varieties were used in this study. In addition some pepper samples were bought randomly from Samaru market.

Pepper samples were picked randomly from the farm and market with out particular points of interest except that it should be visually fit for human consumption. Every pepper fruit in the farm or market had an equal chance of being harvested or bought. The random sampling may help to reduce or lower the errors due to sampling.

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All pepper samples were collected between November 1994 and February 1995.

3.1.3 *Soil Sampling*.

It is impossible to analyse every square millimeter of a farm land and find exactly the same composition. Therefore a method that would give a representative sample is most appropriate.

A soil auger was used to collect soil samples from five different points. These five samples were then resolved using cone and quarter system to obtain the soil sample used as representative of the source soil from each farm. Soil samples were collected from the attarugu farm, tattasai farm and barkono farm

3.1.4 **Pretreatment of Samples.**

The pepper samples from the market and the farm were randomly divided into two portion. A portion was separated into flesh and seeds and analysed fresh. The other portion was sun-dried for one week and then separated into flesh and seeds.

The pepper flesh and seed samples were then ground into powder using a small porcelein mortar and pestle. The ground samples were stored in dry polyethene bottles and kept in a dessicator.

The soil samples were dried at 105 ± 0.5 °C for twelve hours. They were then cooled, bottled and kept in a dessicator

3.2 EXPERIMENTAL

3.2.1 Determination of Moisture and Dry Matter (AOAC, 1980)

Procedure

One gram of sample was weighed in a pre-weighed watch glass and dried at 105 + 0.5 °C to constant weight. Five determinations were carried out for each sample.

Calculation

The moisture and dry matter content of the sample were calculated as shown below.

$$\text{Moisture content (\%)} = \frac{100(W_2 - W_3)}{W_2 - W_1}$$

where: W_1 = weight of watch glass

W_2 = weight of watch glass plus sample before drying

W_3 = weight of watch glass plus sample after drying.

3.2.2 Determination of Ash. (AOAC 1980)

The crucible was pre-heated in a muffle furnace at 550 °C + 1 °C for one hour, cooled in a dessicator and weighed. About 0.5g of pepper samples was then accurately weighed into the crucible and was placed in a cold muffle furnace. The temperature was allowed to rise to 550 °C + 1 °C and maintained at that temperature for 3 hours. The crucible with its residue was allowed to cool to about 200 °C + 1 °C in air before transferring it into a dessicator to cool to

room temperature (29 °C - 32 °C) and then weighed. Five determinations were carried out for each sample.

Calculation

$$\text{Ash (\%)} = \frac{100(W_3 - W_1)}{(W_2 - W_1)}$$

where: Wi = weight of crucible

W_2 = weight of crucible plus sample

W_3 = weight of crucible plus ash.

3.2.3 **Preparation of Standard Solutions of The Metal Ions (Vogel, 1969).**

Reagents preparation.

0.1 M EDTA - This solutions was prepared by dissolving 37.225 g of EDTA in water and made up to 1000 cm^3 volumetric flask. 0.05 M and 0.01 M EDTA solution were prepared by diluting appropriate volumes of the 0.1 M EDTA Solutions.

Variamine Blue B indicator (1.0% aqueous solution was prepared).

1.0% Eriochrome Black T indicator - 0.2 g of the dyestuff was dissolved in 15 cm^3 of triethanolamine and 5.0 cm^3 of absolute ethanol.

0.5% Murexide indicator (0.5 g of powdered murexide was suspended in 100 cm^3 of distilled water, shaken thoroughly and allowed to settle. The supernatant was used).

0.5% Fast sulphon Black F indicator - 0.5 g of the fast sulphon Black F was dissolved in 20.0 cm^3 of water and then diluted to 100 cm^3.

0.5% xylenol orange indicator - prepared by dissolving 0.5 g of xylenol orange in water and the solution was made to the mark in a 100 cm^3 volunetric flask.

Preparation of standard solution.

1000 ppm sodium - This was prepared by dissolving 2.542 g of dried sodium chloride in 50 cm^3 of water and made to the mark in a 1000 cm^3 volumetric flask. From this stock solution, working standard solution of 10, 20, 30 and 50 ppm sodium ions were prepared by appropriate dilution.

1000 ppm potassium - was prepared by dissolving 1.907 g of dried potassium chloride in 50 cm^3 of water and made up to the mark in a 1000 cm^3 volumetric flask. From this stock solution, working standard solutions of 10, 20, 30 and 50 ppm potassium ions were prepared by appropriate dilution.

1000 ppm calcium - The stock solution of calcium ions was prepared by dissolving 2.497 g of anhydrous calcium carbonate with 200 cm^3 of distilled water and 5 cm^3 of concentrated hydrochloric acid. The mixture was warmed to drive off carbon dioxide, allowed to cool after effervescence had ceased and diluted to the mark in a 1000 cm^3 volumetric flask.

The stock solution was then standardized by titrating with 0.01 M EDTA solution using eriochrome Black T indicator. An intermediate stock solution of 100 ppm calcium ions was prepared by appropriate dilution of the standardized stock solution. From this intermediate solution, working standard solution, of 1, 3, 6 and 9 ppm calcium ions were prepared by appropriate dilution.

1000 ppm Manganese - A stock solution of manganese was prepared by dissolving 1.583 g of manganese dioxide in 2.0 cm^3 concentrated hydrochloric acid and then evaporated to dryness. The residue was dissolved in distilled water and then transferred into a 1000 cm^3 volumetric flask. The solution, having been made up to the mark contained 1000 ppm manganese ions.

Standardization was by titration with 0.05 M EDTA solution using variamine Blue B indicator. From the prepared 100ppm intermediate standard, working standards 1, 3, 6 and 9ppm manganese ions were prepared.

1000ppm Nickel - A stock solution of nickel was prepared by dissolving 4.049 g of nickel chloride hexahydrate in 50 cm^3 of distilled water and then made up to the mark in a 1000 cm^3 volumetric flask. This was standardized by titrating with 0.1 M EDTA solution using murexide indicator. An intermediate stock solution of 100ppm nickel ions was prepared by appropriate dilution of the standardized stock solution. Also by appropriate dilution, 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 ppm working standard solutions of nickel were prepared from the intermediate stock solution.

1000 ppm - This was prepared by dissolving 1 g of high purity chromium metal in 50 cm^3 of concentrated hydrochloric acid and 2 cm^3 of nitric acid. The resulting solution obtained was made up with deionised water to the mark in a 1000 cm^3 volumetric flask. From this stock a set of standard solution of 0.5, 1.0, 1.5 to 5 ppm chromium concentration were prepared by appropriate dilutions.

3.2.4 Preparation of solutions of the pepper sample (Vogel, 1969).

The pepper samples were put into solution by wet digestion. Accurately weighed dried sample (0.5 g) was put in a 50 cm^3 Kjedahl flask. 1.0 cm^3 of 60% perchloric acid, 5.0 cm^3 of concentrated (69.71%) nitric acid and 0.5 cm^3 concentrated (98%) sulphuric acid were added. Digestion was carried out at low heat while swirling the flask. Heating was then increased after the initial vigorous fuming. Digestion was continued for 10 minutes after the evolution of the brown fumes of nitrogen dioxide had ceased. The clear, colourless digest was set aside to cool, transferred into 100cm^3 volumetric flask and made up to the mark with distilled water. A blank digestion was carried out without the sample. The samples solutions prepared were kept in a refrigeration (2 °C ± 0.5 °C) till required.

3.2.5 Preparation of Solution of The Soil Sample: (Vogel 1969).

Accurately weight dried soil sample (0.1 g) was placed in a polypropylene beaker and moistened with a little distilled water., 1.0 cm^3 of 60% perchloric and 7.0 cm^3 of 40% hydrofluoric acid were added to the moist soil in the polypropylene beaker. The beaker was swirled gently, covered with a polypropylene lid and then digested for three hours on a boiling water bath. The beaker was then allowed to cool, the lid was washed into the beaker with distilled water and the content of the beaker was slowly evaporated to dryness on the boiling water bath. The breaker was allowed to cool followed by the addition of 3.0 cm^3 nitric acid (60.71%) and 1.0 cm^3 of 98% sulphuric acid and

heated until the evolution of brown fumes of nitrogen dioxide ceased. The beaker was allowed to cool and the clear digest was made up to the mark in a 100 cm^3 volumetric flask with distilled water.

A blank was carried out in the same way as above excluding the soil sample.

In this study the acid mixture used was HF - $HClO_4$ - HNO_3 - H_2SO_4 (7.1:3:1 v/v), the hydrofluoric acid was to destroy the silicates, perchloric and nitric acids were to volatilize the silicon tetrafluoride formed (when silicate react with HF) and oxidize organic matter and sulphuric acid was to prevent the beaker from drying out.

3.2.6 **Leaching (Partial digestion) of The Soil Sample.**

The oven dried ground soil sample was leached with 1 M NH_4NO_3 in distilled water by soaking 10.0 g of the soil sample in 20 cm^3 of ammonia nitrate (NH_4NO_3) solution and stirring at intervals for 6 hours. The mixture was then filtered through a filter paper and the residue was washed with 50 cm^3 NH_4NO_3 solution. The filtrate plus washings were made up to 100 cm^3 with distilled water.

NH_4NO_3 solution served as the blank.

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3.2.7 **Determination of Mineral Elements.**

The analytical methods for the determination of these elements are based on flame photometry and atomic spectrophotometry. Potassium and

sodium were determined by flame photometry while calcium, manganese, Nickel, and chromium were determined by atomic absorption spectrophotometry.

In flame photometry, the atoms of the element are excited by flame and on returning to the ground state, they emit radiations characteristic of the element concerned. The intensity of the radiation emitted is directly proportional to the concentration of the element present. A calibration curve is normally plotted and the concentration of the element in the sample, corresponding to its intensity is read from the curve.

In atomic absorption spectroscopy, a solution of the element of interest is passed into a cool flame where the bulk of the atoms remain in the ground state. Radiation of a characteristic wavelength from a hollow cathode lamp is passed through the flame. The atoms absorb some of this radiation and become excited. The decrease in intensity of the radiation is then measured using a monochromator and a detector system. The atoms in the ground state, and the decrease in intensity is therefore related to the concentration of the element in solution.

3.2.7.1 **Sodium and Potassium in Pepper and Soil Samples (Allen *et al* ., 1974)**

Procedure

A flame photometer (corning - EEL model 866150) was allowed to stabilize for about 15 minutes, after it had been switched on. The flame was then lit and adjusted to give a colourless flame. The instrument was then thoroughly

flushed with distilled water. The blank was aspirated and the scale adjusted to read zero.

The sodium working standard with highest concentration of 20 ppm was introduced and the meter was adjusted to maximum scale deflection (100%). The procedure was repeated several times until constant zero reading for blank and 100% for 20 ppm sodium ions were obtained each time without adjusting the knobs. The working standard between 0ppm and 20 ppm sodium ions were aspirated starting from the least concentrated solution - Each time the corresponding scale deflection were note. With these results, a calibration of each sodium standard solution was then plotted Appendix I.

Care was taken to flush the nebulizer, atomizer and burner with distilled water after each sample solution was aspirated before the next. At intervals, the working standard solutions of highest concentration and blank were introduced to check the instruments ability.

The concentration of sodium in each sample solution was then determined from the calibration curve after subtracting reading for the blank where necessary. The instrument was again flushed with distilled water until the flame was colourless. The next filter was inserted and the appropriate working standard solution for potassium were aspirated as described above. The same samples solutions were aspirated after the set of standards. Calibration curve was then obtained from potassium (Appendix 2) and from this the concentration of potassium in the sample solutions was determined. In the determination of the sample solution, it is necessary to dilute the sample solutions if the pointer of

the instrument was deflected off scale. The dilution factor in each case was noted.

Calculation.

Using the equation below, the amount of sodium and potassium in mg/g

$$\text{Element (mg/g)} = \frac{Std. \times \%E \times Volume\ of\ sample\ solution \times DF}{\%E_{Std} \times Weight\ of\ sample\ (g)}$$

where:

Std = the concentration of the element standard solution (ppm)

$\%E_{std}$ = the corresponding % emission of the standard solution above.

%E = percentage emission of the sample solution

DF = Dilution factor.

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3.2.7.2 **Determination of Calcium, Nickel, Manganese and Chromium in The Pepper and Soil Samples.**

Apparatus

- A pye unicam , model SP 192, atomic - absorption flame emission spectrophotometer equipped with automatic background corrector.
- specific hollow cathode discharge lamps.

Procedure

The instrument was switched on and allowed to warm up for at least 15 minutes. In each case, the analytes hollow cathode lamp was allowed to stabilize for 10 minutes. The operating parameters in table 3.0 on page 26 were used to calibrate the instrument for each element determined.

Calibrates curve of absorbance against analyte ions concentration for each analyte was obtained by setting the top working standard to a suitable scale deflection and the 0ppm standard to zero and then aspirating the intermediate working standard solutions prepared as described in section 3.2.3 and for the analyte being determined.

For each analyte determined, the sample solutions was aspirated under the same conditions in which the standard solutions were aspirated. The sample prepared as 3.2.4 and 3.2.5 were used in the determination of nickel, manganese and chromium. The calcium was not determined directly from the sample solutions prepared, because of the interference from other elements until after their inferring activity is removed (described below). Blank determination were carried out and subtracted where necessary.

The spray chamber and burner were flushed with distilled water after each run. The analyte content in each sample was analysed using the equation given in 3.2.7.1.

TABLE 3.0: Atomic Absorption Spectrophotometer Operating Parameters For Elements Determined.

ELEMENT	WAVELENGTH	FLAME	BAND PASS
CALCIUM	422.7 nm	AA (R)	0.02 nm
MANGANESE	279.4 nm	AA(L)	"
NICKEL	232.0 nm	AA(L)	"
CHROMIUM	257.9 nm	AA(R)	"

Key

L = fuel lean

AA = Air/Acetylene

R = fuel rich.

3.2.7.3 **Background Correction.**

Introduction

The greater draw back in the application of flame methods for determination of calcium has been the interference from other elements (Allen, *et al.*, 1974). The most important in biological materials particularly vegetation and soil are phosphorus and aluminum both of which depress the absorption or emission of the analytes by forming stable complexes with the analytes. The procedure for a wide variety of biological materials involves using a releasing agent as suggested by Yofe and Finklestein (1958) who reported that strontium and Lanthanum gave full release from the effects of aluminum, phosphorus and sulphur.

Thompson and Reynolds (1978) stated that if significant chemical interferences are taking place, addition of Lanthanum to the digests should minimize this interference. Omojola (1986) suggested the addition of 2000 ppm Lanthanum to be an optimal concentration for the determination of calcium in plant materials. This was adapted in this work. Also Lanthanum was adapted because strontium precipitates with H_2SO_4 (Allen *et al.*,1974).

Procedure

13.36 g ±0.001 g of lanthanum chloride heptahydrate was dissolved in water containing 2.0 cm^3 of 2M hydrochloric acid and then made to the mark in a 1000 cm^3 volumetric flask with water.

25 cm^3 each of the sample solutions prepared as described in 3.2.4 and 3.2.5 were pipetted into separate 50 cm^3 volumetric flasks. 20 cm^3 of the Lanthanum ions solution prepared above was added to each.

3.2.8 Determination of ascorbic acid (AOAC, 1980).

3.2.8.1 Preparation of solutions.

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Extracting solution

Glacial metaphosphoric acid (15 g) was dissolved with shaking into 40 cm^3 of acetic acid and 200 cm^3 distilled water, then made up to 500 cm^3. The solution was then rapidly filtered into a glass bottle and stored in refrigerator where it remained stable for 7 - 10 days.

Ascorbic acid standard solution (1 mg/cm^3)

Accurately weight (50 g) ascorbic acid (that has been stored in dessicator away from direct sunlight) was transferred into 50 cm^3 volumetric flask, and made up to volume immediately.

Indophenol standard solution

Accurately weighed (50 g) 2,6-dichloroindophenol sodium salt, into 50 cm^3 distilled water to which 42 mg of sodium bicarbonate has been added, the mixture was shaken vigorously, to make sure the dye dissolved completely, then made up to the mark in 200 cm^3 volumetric flask with distilled water. The solution was then filtered into glass bottle.

50 mg of extracting solution containing excess ascorbic was added to 15 cm^3 dye reagent. If the reduced solution was not practically colourless, then new stock solution has to be prepared.

3.2.8.2 **Preliminary Test**.

Accurately 10 cm^3 sample solution was added to 10 cm^3 HCl (1 + 3), then followed by 5 drops of 0.05% aqueous solution of indigo carmine, The dye disappeared, after 15 to 20 seconds which indicates the absence of interfering substances in a quantity that can invalidate the test. The test was carried out three times everyday.

3.2.8.3 Standardisation of Indophenol solution

Three 2.0 cm^3 aliquots of the ascorbic acid solution was transferred into each of three 50 cm^3 Erlenmeyer flask containing 5.0 cm^3 of the HPO3 - HOAc reagent. They were titrated rapidly with the indophenol solution from 50 cm^3 burette until rose-pink colouriation persists for at least 5 seconds. Average titrations required an average value of 30.1 cm^3 of the indophenol solution. Similarly titrations of three blanks composed of 7.0 cm^3 of the HPO_3 - HOAc reagent plus 30 cm^3 of distilled water.

Average blank was 0.1cm^3.

Concentration of indophenol solution as mg of ascorbic acid equivalent to 1.0 cm^3 reagent.

30 cm^3 indophenol = 2mg

1 cm^3 indophenol - $\frac{2\ mg}{30}$

1 cm^3 indophenol = 0.0667 mg.

Standardization of indophenol was carried out daily with freshly prepared standard ascorbic acid solution.

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3.2.8.4 Preparation of Pepper Solutions

Accurately weighed sample (0.5 g) was crushed in a mortar with a pestle. After grinding the sample solution was prepared using equal amount of HPO_3 - HOAc reagent and water (1 + 1). The sample solutions were prepared in 25ml volumetric flasks and made up to the volume after filtration, using (1 + 1)

reagent of HPO_3 - HOAc and water. 10 cm^3 of aliquots, were titrated against 2,6-dichloro indophenol. Each titration was carried out five times. A blank determination for correction of titrations was determined. Each titration was carried out five times. Average for blank titration was 0.1 cm^3.

Calculations:

Ascorbic acid content in mg/g.

mg Ascorbic acid/g = $(\mu - B) \times (F/E) \times (V/Y)$

μ = Average cm^3 for sample titration

B = Average cm^3 for sample correction = 0.1cm^3

F = mg - of ascorbic acid equivalent to 1.0 cm^3 of indophenol standard solution = 0.0667 mg.

E = number of g assayed = 0.5 g

V = Volume initial assay solution = 25 cm^3

Y = volume aliquots titrated = 10 cm^3.

4.0 RESULTS AND DISCUSSION

4.1 Moisture and Ash Content.

The moisture and ash content of fresh pepper samples are shown in Table 3.1 It can be observed that the moisture content of the flesh is in the range of 85.56 to 93.22%, while the ash is in the range of 1.46 to 2.74%. The seed has the moisture content of 54.72 to 64.20% while the ash is in the range of 0.92 to 1.78%.

From Table 3.1 it can be generally observed that the flesh samples from the farm contains more moisture than the samples obtained from the market. "Tatasai" (farm) has the highest value of 93.22% while "barkono" (farm) has the lowest value of 86.62%. But the ash content of the flesh is reversed . The flesh samples from market contains more ash than the samples from the farm. "Barkono" (market) has the highest ash content of 2.74% while "tatasai" has the lowest value of 1.46%. Similarly the seed samples from the farm contains more moisture than those from the market. "Tatasai" seed (farm) has the highest moisture content 64.20% while "barkono" seed (farm) has the lowest value of 58.58%. Seed samples from the market contains more ash value than the seed sample from the farm. "Barkono" seed (market) has the highest ash content of 1.78% white "tatasai" has the lowest value of 1.02%.

Siemonsma and Kasem (1993) reported the moisture content of capsicum frustence (Barkono) to be 86 g/100 g of fresh sample and capsicum annum has

the value of 92 g/100 g of fresh sample.

The moisture and ash content of sun-dried pepper samples are shown in Table 3.2. It can be observed that the moisture content of the flesh is in the range of 13.14% to 22.8% white the ash content of the flesh is in the range of 5.38 to 8.46%. The moisture content of the seed sample is in the range 7.50% to 8.80% and the ash content of the seed is in the range of 2.46 to 5.18%. From Table 3.2, it can be observed that the flesh samples from the farm contains more moisture than the samples obtained from the market. "Tatasai" (farm) has the highest value of 22.28% while "barkono" (farm) has the lowest value of 13.24%. But in the case of ash content the samples from the market contain more ash content than samples from the farms. "Barkono" (market) flesh sample has the highest value of 8.46% while "tatasai" has the lowest value of 5.54%. The seed samples from the market generally contain more ash content than those from the farm. "Tatasai" seed (Market) has the highest ash content of 5.18% while "attarugu" seed (Market) has the lowest ash content of 2.46%. From table 3.1. and 3.2, it can generally be observed that samples from the farm contains more moisture than the samples obtained from the market. The samples from the farm were analysed within 24 hours after harvesting, while the ones obtained from the market are likely to have spent more time before the analysis.

TABLE 3.1 Moisture and Ash Content of Fresh Samples (g/100 g Wet Basis)

	FLESH		SEED	
SAMPLE	MOISTURE CONTENT	ASH CONTENT	MOISTURE CONTENT	ASH CONTENT
ATTARUGU (FARM)	90.72 ± 0.08	1.84 ± 0.09	60.98 ± 0.08	1.46 ± 0.16
ATTARUGU (Markel)	90.68 ± 0.08	1.88 ± 0.09	60.82 ± 0.08	1.48 ± 0.11
TATASAI (FARM)	93.22 ± 0.19	1.30 ± 0.16	64.20 ± 0.16	0.92 ± 0.13
TATASAI (MARKET)	92.72 ± 0.11	1.46 ± 0.11	63.42 ± 0.19	1.02 ± 0.11
BARKONO (FARM)	86.62 ± 0.13	2.64 ± 0.18	58.58 ± 0.13	1.64 ± 0.17
BARKONO (MARKET)	85.56 ± 0.09	2.74 ± 0.18	54.72 ± 0.08	1.78 ± 0.13

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TABLE 3.2: Moisture and Ash Content of Sun-dried Pepper Samples (g /100g Dry Basis)

	FLESH		SEED	
SAMPLE	MOISTURE CONTENT	ASH CONTENT	MOSITURE CONTENT	ASH CONTENT
ATTARUGU (FARM)	14.28 ± 0.08	6.14 ± 0.08	8.76 ± 0.11	2.30 ± 0.10
ATTARUGU (MARKET)	14.20 ± 0.08	6.21 ± 0.08	8.70 ± 0.11	2.46 ± 0.06
TATASAI (FARM)	22.28 ± 0.08	5.38 ± 0.32	8.80 ± 0.07	5.14 ± 0.06
TATASAI (MARKET)	22.14 ± 0.11	5.54 ± 0.15	8.76 ± 0.11	5.18 ± 0.08
BARKONO (FARM)	13.24 ± 0.11	8.34 ± 0.11	7.58 ± 0.08	3.26 ±0.11
BARKONO (MARKET)	13.14 ± 0.09	0.46 ± 0.11	7.50 ±0.08	3.40 ± 0.16

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4.2 SOME ESSENTIAL MINERAL CONTENT OF PEPPER SAMPLES

4.2.1 Some Essential Mineral Content of Fresh Pepper Samples.

The essential mineral contents in fresh pepper are shown in Tables 3.3 and 3.4.

Table 3.3 shows the essential mineral content in the flesh samples, while Table 3.4 shows some of the essential mineral in the seed. Potassium is the most abundant element and calcium is the least. The pattern was observed in all the samples analysed.

The flesh has generally higher mineral content, but the value of Chromium and Mangenese is higher in the seed samples. From Table 3.3. the fresh flesh samples from the farm contains more mineral nutrients than the samples from the market. However the sample from the market contains more Chromium and Mangenese than the samples from the farm.

From table 3.3. Attarugu (farm) fresh flesh samples has higher potassium content of 3903 mg 100g and barkono (farm) has the lowest value of 2603 mg/ 100 g. Barkono (farm) has the highest sodium content of 195 mg/100 g while tatasai (farm) has the lowest value of 170mg/100 g. Attarugu (farm) has the highest nickel content of 12.44 mg/100 g and Barkono (farm) has the highest chromium content of 21.mg/100 g and tatasai (farm) has the lowest value of 8.60 mg/100 g. Barkono (market) has the highest manganese value of 6.08 mg/100 g and tatasai (farm) has the lowest value of 3.18 mg/100 g. Barkono (Market) has the highest calcium content of 1.15 mg/100 g and attarugu (farm) has the lowest value of 0.33 mg/100 g.

Table 3.4 shows some of the essential mineral elements in fresh seed samples. Generally the seeds samples from the farms contain more mineral content than seed samples from the market. However, the seed samples from the market contain more manganese and calcium.

In fresh seed samples, potassium is also the most abundant element, with calcium as the least abundant. Barkono (farm) has the highest potassium content, while tattasai (farm) has the lowest value of 1100.00 mg /100 g. Barkono (farm) has the highest sodium value, while attarugu (farm) has the lowest value. Attarugu (farm) has the nickel highest value of 6.28 mg/100 g while Barkono (farm) has lowest value of 1.84 mg/100 g. Attarugu (farm) has the highest chromium content of 28.54 mg/100 g while tattasaai (farm) has the lowest value of 13.12 mg/100 g. Barkono (market) has the highest manganese content of 6.26 mg /100 g while attarugu (farm) has lowest value of 4.14 mg/100g, Barkono (market) has the highest calcium content of 0.59 mg/100g while attarugu (farm) has the lowest value of 0.25 mg/100g.

The result obtained in Table 3.3. and 3.4 is close to the result obtained by Siemonsma and Kasem (1993).

TABLE 3.3: Elemental Composition (mg/100g of fresh pepper) of Fresh Flesh Peppers.

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU (FARM)	3903.60 ± 2.0	186. ± 0.55	12.44 ± 0.11	18.44 ± 0.11	3.64 ± 0.11	0.33 ± 0.03
ATTARUGU (MARKET)	3802.20 ± 1.92	181.00 ± 1.00	9.52 ± 0.13	14.34 ± 0.20	3.84 ± 0.11	0.65 ± 0.02
TATASAI (FARM)	2903.40 ± 2.41	170.80 ± 0.84	7.32 ± 0.13	8.60 ± 0.16	3.18 ± 0.08	0.50 ± 0.01
TATASAI (MARKET)	2806.2 ± 1.92	135.60 ± 1.50	7.08 ± 0.13	7.10 ± 0.16	3.68 ± 0.08	0.93 ± 0.02
BARKONO (FARM)	2603.60 ± 2.35	195.80 ± 0.84	2.58 ± 0.08	21.80 ± 0.16	5.88 ± 0.08	0.64 ± 0.02
BARKONO (MARKET)	2503.20 ± 2.39	188.40 ± 2.07	2.92 ± 0.08	17.86 ± 0.11	6.08 ± 0.06	1.15 ± 0.04

TABLE 3.4: Elemental Composition (mg /100g of fresh pepper) of Fresh Seed Peppers.

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU	1101.60	75.80 ±	6.28 ±	28.54 ±	4.14 ±	0.25 ±
(FARM)	± 1.14	0.84	0.13	0.11	0.11	0.01
ATTARUGU	1002.60	61.40	6.08+0.0	20.00 ±	4.54 ±	0.34 ±
(MARKET)	± 2.70	±1.14	8	0.16	0.08	0.03
TATASAI	1100.20	90.80 ±	5.04 ±	13.12 ±	4.18 ±	0.39 ±
(FARM)	±1.92	0.84	0.11	0.13	0.13	0.01
TATASAI	1003.40	77.00 ±	4.98 ±	11.08 ±	4.80 ±	0.53 ±
(MARKET)	± 1.92	1.60	0.08	0.16	0.07	0.02
BARKONO	1153.60	91.00 ±	1.84 ±	22.64 ±	6.26 ±	0.47 ±
(FARM)	± 2.30	1.00	0.11	0.38	0.11	0.01
BARKONO	1114.00	75.80 ±	1.22 ±	20.10 ±	6.42 ±	0.59 ±
(MARKET)	± 2.92	0.59	0.08	0.16	0.08	0.02

4.2.2 Some Essential Mineral Content of Sun-dried Pepper Samples.

The essential mineral contents in sun-dried pepper samples analysed are summarised in Tables 3.5 and 3.6.

Table 3.5 show the essential mineral content in the flesh samples while table 3.6 show the essential mineral content of seed samples. It has been observed from the elements studied that potassium was the most abundant element and calcium the least. This highlights the importance of potassium in the successful cultivation of peppers studies. From the two tables, it can be observed that, the flesh generally has higher mineral content than the seed, but with the exception of Chromium and Manganese in which the seed has higher values.

From tables 3.5 and 3.6 the samples from the farm contains more mineral content than the samples from the market. However the samples from the market contain more Chromium and Manganese than the samples from the farm.

From table 3.5 attarugu (farm) has the highest potassium content of 3804 mg/100 g and barkono (farm) has the lowest value of 2503 mg/10g. Barkono (farm) has the highest sodium content of 184 mg/100 g while tatasai (farm) has the lowest value of 155.20 mg/100 g. Attarugu (farm) has the highest nickel content of 10.20 mg/100 g and barkono (farm) has lowest value of 2.18 mg/100 g. Barkono (farm) has the highest chromium content of 20.08 mg/100 g while attarugu (farm) has the lowest value of 5.10 mg/100 g. Generally the samples from the market contain more Manganese and calcium content than samples from the farm.

Barkono (market) has the highest manganese content of 4.28 mg/100 g while attarugu (market) has the lowest value of 2.88 mg/100 g. Barkono (market) has the highest calcium content of 0.83 mg/100 g and attarugu (market) has the least value of 0.26mg/100g. From table 3.6, the sun-dried seed samples follow the same pattern as the flesh. The seed samples from the (farm) contains more mineral content than the seed samples from the market. However the seed samples from the market contain more Manganese and Calcium content than those samples from the farm. Attarugu (farm) has the highest potassium content of 3804.00 mg/100 g while barkono (farm) has the least value of 2503.20 mg/100 g. Barkono (farm) has the highest sodium content of 184.80 mg/100g and tatasai (farm) has the least value of 155.20 mg/100 g. Attarugu (farm) has the highest content of nickel 10.20 mg/100 g while barkono (farm) has the lowest value of 2.18 mg/100 g. Barkono (farm) has the highest chromium content of 20.08 mg/100 g and tatasai (farm) has the lowest value of 5.68 mg/100 g . . Generally the seed samples from the market contains more Manganese and Calcium content than samples from the farm. The dried barkono seed sample from the market has the highest manganese content of 4.28 mg/100 g while attarugu (market) has the lowest value of 2.88 mg/100 g. Similarly barkono (market) has highest calcium content 0.83 mg/100 g and attarugu (market) has lowest value of 0.26 mg/100 g.

The results obtained are comparable to those reported by Siemonsma and Kasem (1993). However these workers did not report the value for the seed sample used.

The concentration of all the essential elements were not significantly different in both dry and fresh samples.

TABLE 3.5: Elemental Composition (mg/100g of dried pepper) of the Flesh of the Sun-Dried Peppers.

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU (FARM)	3804.00 ± 2.92	170.80 ±1.00	10.20 ± 0.16	5.10 ± 0.16	2.54 ± 0.08	0.12 ± 0.01
ATTARUGU (MARKET)	3700.60 ± 1.58	163.00 ± 1.58	8.76 ± 0.11	3.72 ± 0.13	2.88 ± 0.08	0.26 ± 0.01
TATASAI (FARM)	2804.60 ± 2.91	155.20 ± 0.84	6.82 ± 0.08	5.68 ± 0.16	3.08 ± 0.08	0.20 ± 0.02
TATASAI (MARKET)	2752.00 ± 1.58	130.6 ± 1.14	5.64 ± 0.11	4.80 ± 0.16	3.52 ± 0.08	0.43 ± 0.02
BARKONO (FARM)	2503.20 ± 2.39	184.80 ± 1.48	2.18 ± 0.09	20.08 ± 0.53	3.98 ± 0.03	0.40 ± 0.02
BARKONO (MARKET)	2404.00 ±1.58	164.00 ±1.94	2.10 ± 0.13	16.44 ± 6.21	4.28 ± 0.08	0.83 ± 0.02

TABLE 3.6: Elemental Composition (mg 100g of dried Pepper) of the Seed of the Sun-Dried Pepper.

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU	900.80 ±	60.80 ±	6.80 ±	9.56 ±	2.84 ±	0.08 ±
(FARM)	0.84	0.84	0.16	0.09	0.11	0.01
ATTARUGU	897.00 ±	46.40 ±	6.70 ±	7.18 ±	3.14 ±	0.11 ±
(MARKET)	1.58	0.14	0.16	0.13	0.11	0.01
TATASAI	953.20 ±	70.80 ±	5.14 ±	13.38 ±	3.76 ±	0.10 ±
(FARM)	2.39	0.84	0.11	0.16	0.11	0.01
TATASAI	902.20 ±	66.20 ±	5.08 ±	10.10 ±	34.94 ±	0.30 ±
(MARKET)	1.97	1.30	0.08	0.16	0.06	0.01
BARKONO	952.92 ±	75.80 ±	1.84 ±	21.10 ±	5.14 ±	0.27 ±
(FARM)	1.52	0.84	0.11	0.16	0.11	0.01
BARKONO	902.60 ±	62.20 ±	1.30 ±	18.84 ±	5.52 ±	0.48 ±
(MARKET)	2.70	1.60	0.16	0.11	0.08	0.01

4.3 Mineral content of the source soils.

The elemental composition of the leached soil samples are summarised in table 3.7. The leached soil determine the amount of absorbable mineral in the source soil. (Bonire *et al.*, 1990).

The mineral contents of the source soils determined from acid digestion are summerised in table 3.8. The concentration of all the minerals determined in the mixed acid digested sample solution were relatively higher than those obtained from leached sample solutions.

For the acid digested samples, the concentration of potassium was highest in tattasai source soil (5400 mg/100 g dry weight), while the lowest value was observed in barkono source soil. However for the leached soil sample, the highest concentration was in tattasai source soil (10.60 mg/100 g dry weight) while the lowest value was in attarugu source soil (7.40 mg/100 g) dry weight).

Sodium was the second most abundant mineral in the source soil as observed in the pepper samples. The lowest concentration of chromium was observed in all the digested soil samples. Tattasai source soil has the lowest value of 48.40mg/100 g while attarugu source soil has the highest value of 54.50 mg/100 g. The highest level of potassium, sodium and calcium in the leeched samples are 10.60, 2.80, and 2.50 mg/100 g respectively and were obtained in tattasai source soil.

The levels of these metal determined from the acid digested solutions were higher as expected, with highest level being 5.40×10^3, 3.00×10^3 and 942.20 mg/100 g for potassium, sodium and calcium respectively and these were

observed in tattasai soil samples, attarugu soil samples and barkono soil samples respectively. Nickel has the lowest value in all the acid digested soil samples. Attarugu soil samples were observed to have the highest value of 15.00 mg/100 g while barkono source soil was observed to have the lowest value of 13.80 mg/100 g.

The levels of manganese and chromium in the acid digested samples are represented in Table 3.8. the highest level being 132.00 mg/100 g from tattasai source and 54.50 mg/100 g from attarugu source soil respectively. From table 3.7, nickel was found to be in a very low concentration, in the leached samples. This may be due to low level of nickel in the source soils or the insolubility of forms in which it exists in these soils.

From the results of this work, it can be seen that there is a lot more of each mineral in the source soil than available to the plant (leached soil) perhaps for reasons of solubility.

In all the three varieties of peppers, both flesh and seed samples contains much higher concentrations of each mineral studied than the amount of the mineral available to the plant for absorption at a time. The flesh samples contain more of each mineral nutrient determined when compared to the seeds. However the seeds contain more manganese and chromium than the flesh.

Obviously, the plant can discriminate in its selection of the mineral elements to satisfy its peculiar needs and hence the proportion of the nutrients ions in the plant may bear no relationship to their proportion in the soil.

Climate factors, especially rainfall and temperature, play important roles in the absorption and uptake of the mineral nutrients from the soil. Rainfall is essential as a source of water for the solution of the elements in the soil and their migration in the xylem of the plant. Climate is importantly but indirectly influential in determining the nature of the vegetation in any region that, in turn, has a marked effect on the kind of soil development that occurs.

Low soil temperatures are important limiting factor in the uptake of minerals by the plant (Kenneth, 1976). Fundamentally important aspects of absorption and uptake of mineral elements by the plant are the mechanism of entry of mineral elements into the protoplasm of the root and the transfer of the element across the membrane barrier to the xylem. Hoagland (1944) suggested that some forces in addition to simple diffusion must account for uptake, since solution movement in living cells is so intimately related to and dependent on processes of metabolism.

TABLE 3. 7: Elemental Composition Of Leached Source Soil (mg /00g)

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU	7.40 ±	1.90 ±	0.09 ±	1.50 ±	1.10 ±	1.90 ±
SOIL	0.16	0.10	0.01	0.10	0.08	0.15
TATASAI	10.60+0.	2.80 +	0.09 ±	1.30 ±	0.90 ±	2.50 ±
SOIL	26	0.08	0.01	0.08	0.08	0.08
BARKONO	8.40 ±	1.60 ±	0.08 ±	1.10 ±	1.10 ±	1.80 ±
SOIL	0.10	0.12	0.01	0.08	0.08	0.13

TABLE 3.8: Elemental Composition Of Digested Source Soil (mg /100 g)

SAMPLE	K	Na	Ni	Cr	Mn	Ca
ATTARUGU	5100 ±	3000.00	15.00 ±	54.50 ±	112.00 ±	940.10 ±
SOIL	0.08	± 0.52	0.15	0.11	1.00	0.12
TATASAI	5400 ±	2800.00	14.20 ±	48.40 ±	132.00 ±	937.10 ±
SOIL	0.06	± 0.32	0.16	0.17	2.10	0.08
BARKONO	5000.00	2810 ±	13.80 ±	50.00 ±	120.00 ±	942.20 ±
SOIL	± 0.05	0.56	0.05	0.20	2.20	0.41

4.4. Ascorbic acid content of pepper.

The ascorbic acid content of fresh and sun-dried pepper samples are given in Table 3.9 and 3.10. It is observed from the tables that the fleshy part of the peppers contains more ascorbic acid than the seed. The ascorbic acid content of all the pepper samples from the farm were found to be higher than those form the market. This suggests the deterioration of peppers in their ascorbic acid content, once harvested. Fresh flesh barkono contained the highest ascorbic acid value of 280.84 mg/100 g while attarugu has 204.74 mg/100 g . Tattase contained the lowest value of 138.14 mg/100.g. The pepper samples from the market, also follow the same trend. Barkono contained the highest value of 179.52 mg/100 g, followed by attarugu with 141.42 mg/100 g and tattase has the lowest value of 130.32 mg/100g.

Citrus fruits are good source of ascorbic acid especially orange which contained about 50.0 ± 1.2 mg/100 g (Wimalasiri and Wills, 1982).

The pepper flesh contained three to five times more ascorbic acid than orange juice. The results obtained from the three samples are comparable to those reported by Sprugt (1939), Randall (1975), Wimalasiri and Wills (1982) and Siemonsma and Kasem (1993) as *Capsicum annum* L (280.0 mg/100 g) *Capsicum frustence* (180.0 mg/100 g), *Capsicum annum* L (186.7 mg/100 g) and hot capsicum pepper (242 mg/100 g) respectively.

Comparing the results in Tables 3.9 and 3.10 it is observed that about 50 to 60% of the ascorbic acid content has been lost as a result of drying. The flesh of Barkono has the highest ascorbic acid content, which dropped from

280.84 mg/100 g fresh flesh to 132.74 mg/100 g dry flesh, followed by atarugu which dropped from 204.76 mg/100 g fresh flesh to 108.18 mg/100 g sun-dried flesh. Tattasai has the lowest value which dropped from 138.14 mg/100 g fresh flesh to 89.48 mg/100 g sun dried flesh. The ascorbic acid content of the sun-dried pepper flesh samples was almost twice that of lemon/orange juice (Redgrove, 1938).

The ascorbic acid value of dried pepper obtained from the farm and the market were almost equal. From table 3.9 the fresh attarugu seed from the farm was found to have the highest ascorbic acid value of 9.34 mg/100 g seed followed by barkono to be 7.40 mg/100 g and tatase contained the lowest value of 6.03 mg/100 g seed. From table 3.10. the dried attarugu seed from the farm was found to contain the highest ascorbic acid value of 8.68 mg/100 g seed followed by barkono with 6.54 mg/100 g seed, tattase has the lowest value of 3.40 mg/100 g seed.

The dried seed samples from the market also follow the same trend. Attarugu has the highest value of 8.70 mg/100 g , followed by barkono with 6.42 mg/100 g while tattase has the lowest value of 4.01 mg/100 g. Generally Attarugu seed sample has the highest ascorbic acid value, while tattase has the lowest value.

The loss of ascorbic acid in seed during drying is less pronounced than in the flesh samples. The ascorbic acid value in the case of attarugu seed samples dropped by 7 to 8%, while it dropped by 11 to 12% in the case of barkono. The

loss is more pronounced in the case of tattase seed samples, which dropped by almost 30 to 40%.

Generally, the fleshy part of samples were found to contain more ascorbic acid than the seed. The fleshy part contains 11 to 20 times more ascorbic acid than the seed sample while tattase contained 13 to 15 times more than the seed sample. The loss of ascorbic acid value in seed during drying is less pronounced than the flesh. Crystalline ascorbic acid in dry form is stable in air but in an aqueous solution it is attacked by atmospheric oxygen.

Heat alone, in the absence of oxygen does not destroy ascorbic acid. In the presence of oxygen, the vitamin is readily oxidized, at a rate increasing with increase in temperature. The resultant dehydroascorbic acid is oxidized further both rapidly and irreversibly. Natural ascorbic acid in food is easily destroyed by enzymic oxidation and by undue exposure to oxygen. Prolonged cooking at high temperatures in the presence of oxygen should be avoided.

In plant materials the vitamin is also fairly easily oxidized, and when this happens, as in foods that are exposed too long to the air, it cannot be changed back to the active reduced form. Such foods are consequently no longer effective source of the vitamin. Moreover in the body itself some of the vitamin C taken in foods or even as pure ascorbic acid may be destroyed before it can be used. All this means that vitamin C is quite unstable and easily lost. (Siemonsma and Kasen, 1993).

TABLE 3.9: Ascorbic Acid Content Of Fresh Pepper Samples (mg/100 g)

SAMPLE	FLESH Ascorbic Acid (mg/100g of fresh flesh)	SEED Ascorbic Acid (mg/100g of fresh seed)
ATTARUGU (farm)	204.76 ± 1.86	9.34 ± 1.48
ATTARUGU (Market)	141.42 ± 1.81	9.44 ± 1.56
TATASAI (Farm)	138.14 ± 3.00	6.03 ± 1.50
TATASAI (Market)	130.32 ± 1.50	6.10 ± 1.40
BARKONO (FARM)	280.84 ± 2.24	7.40 ± 1.43
BARKONO (Market)	179.52 ± 2.66	7.20 ± 1.21

TABLE 3.10: Ascorbic Acid Content Of Sun - Dried Pepper Samples

(mg/100 g)

SAMPLE	FLESH Ascorbic Acid (mg/100g of sun - dried flesh)	SEED Ascorbic Acid (mg 100g of sun-dried Seed)
ATTARUGU (FARM)	108.18 ± 3.76	8.68 ± 1.81
ATTARUGU (MARKET)	100.60 ± 1.57	8.70 ± 1.82
TATTASAI (FARM)	89.49 ± 2.66	3.40 ±1.50
TATTASAI (MARKET)	81.36 ± 1.86	4.01 ± 1.50
BARKONO (FARM)	132.74 ± 2.76	6.53 ± 1.23
BARKONO (MARKET)	125.50 ± 2.12	6.43 ± 1.20

CHAPTER FIVE

5.0 SUMMRY AND CONCLUSION

Some essential mineral elements in three local varieties of pepper have been determined. The peppers analysed are: Capsicum annum L. (tattasai) *Capsicum annum* g (attarugu) and *Capsicum frutecens* (barkono). Sodium and potassium were analysed by FES while nickel, chromium, manganese and calcium were analysed by AAS.

The concentration of mineral elements in the flesh were found to be relatively higher than the concentrations in the seed samples, except for chromium and manganese which were found to be higher in the seed samples.

Potassium was found to be highest and calcium lowest among all the mineral elements determined.

The source soils were analysed so as to study the mineral uptake of the plant vis-a-vis the abundant minerals in the source soils. It was observed from the results of this work that the proportion of mineral elements in the peppers are independent of their relative amounts, in the source soil.

The ascorbic acid content was analysed using AOAC indophenol method. The results showed that the fresh peppers contained more ascorbic acid than the dried pepper, and the fleshy part of pepper contains about 80 to 90% ascorbic acid more than the seedy part,

About 50 to 60% of the ascorbic acid is destroyed as a result of ordinary sun-drying. Fresh barkono is the best source of ascorbic acid followed by attarugu and tattase is the least.

5.1 RECOMMENDATION

The results showed that the fresh peppers contained three to five times more ascorbic acid than orange juice. 50 g of fresh pepper can provide the ascorbic acid daily required by an adult (human being).

About 50 to 60% of the ascorbic use to be destroyed as a result of sun-drying. So it is advisable to take fresh pepper in form of salad as source of ascorbic acid; since cooking the peppers at higher temperature can destroy up to 90% of the acid.

There is a need to determine, the amount of ascorbic lost with time, right from harvesting.

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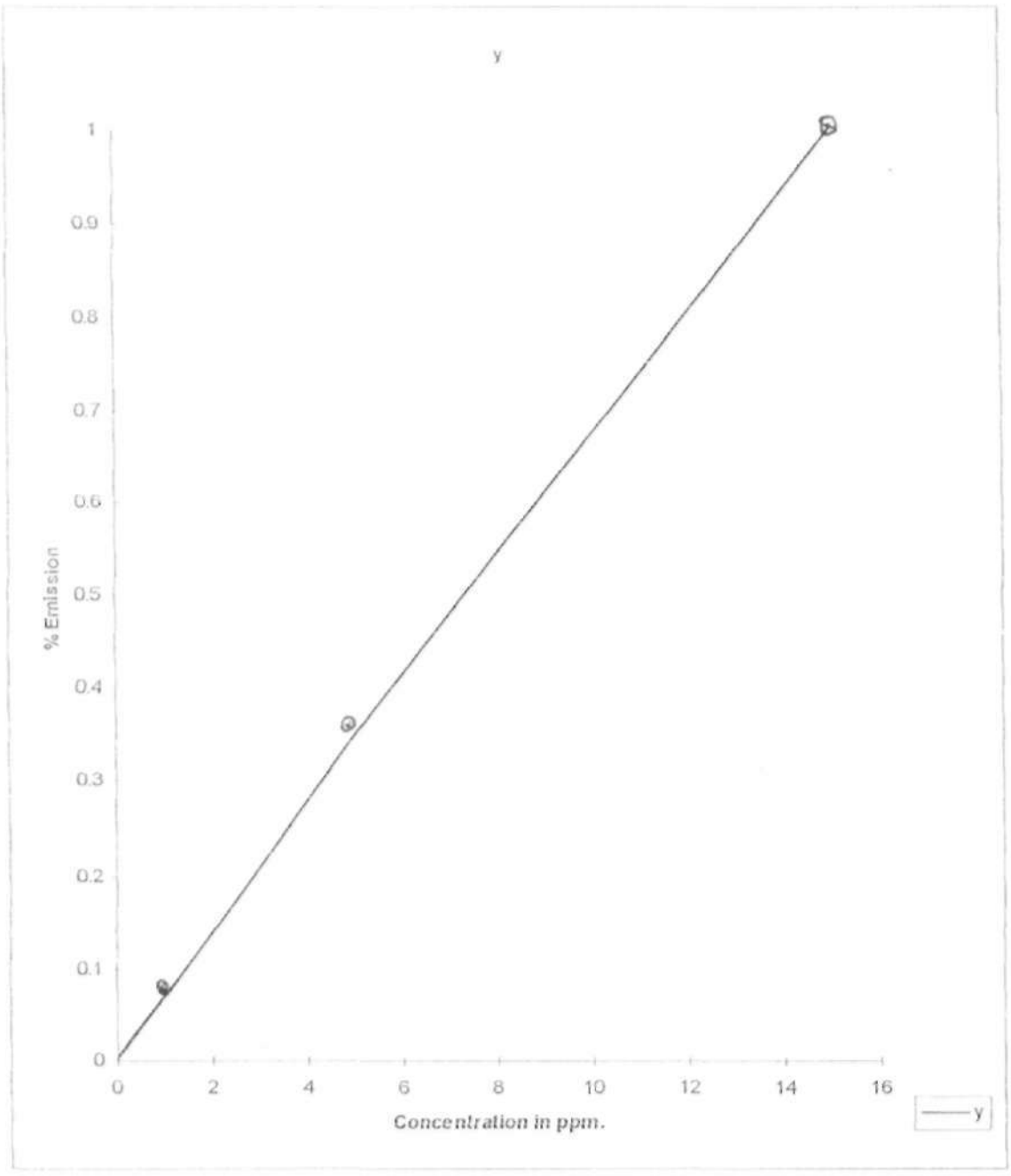
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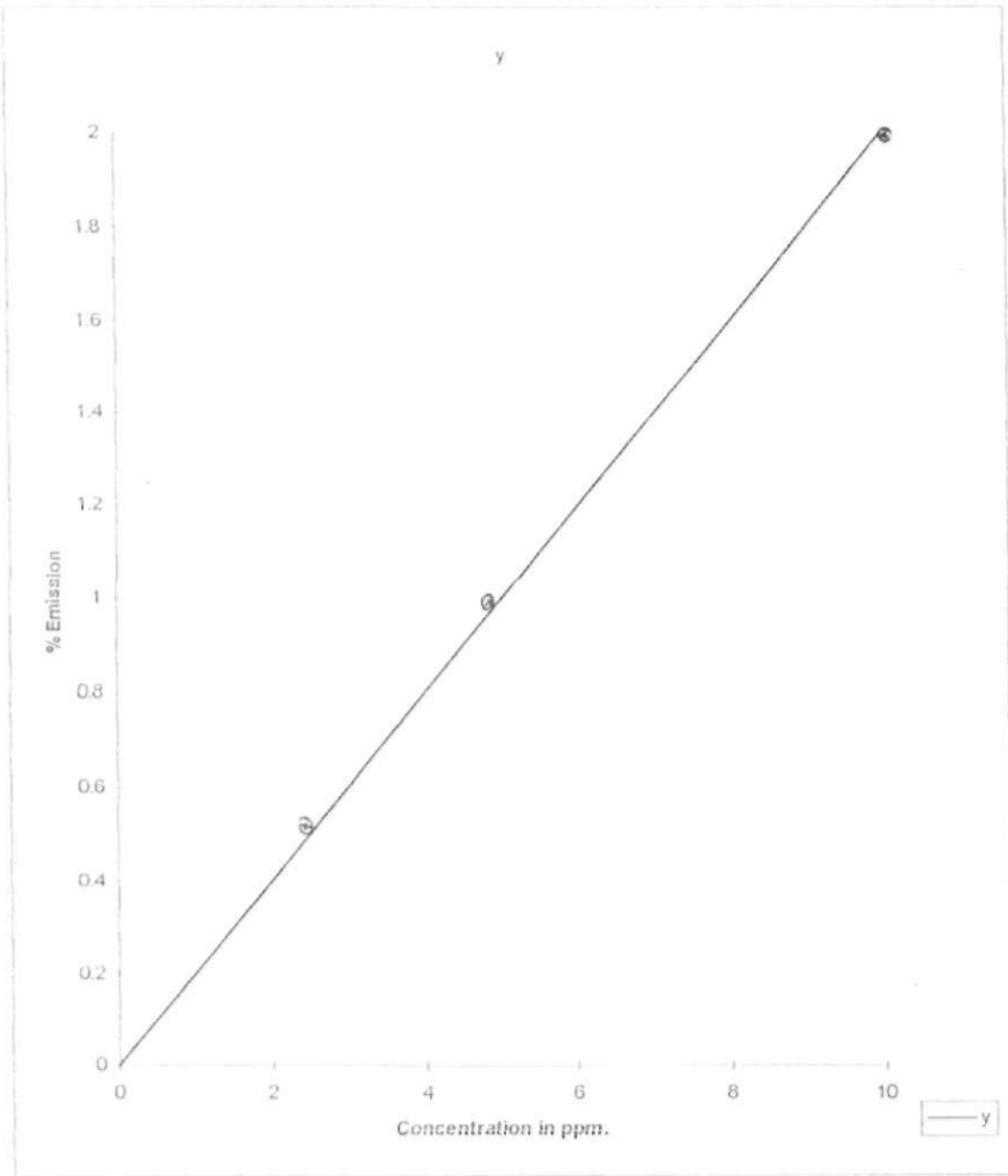
APPENDIX I

Calibration Curve for the determination of sodium



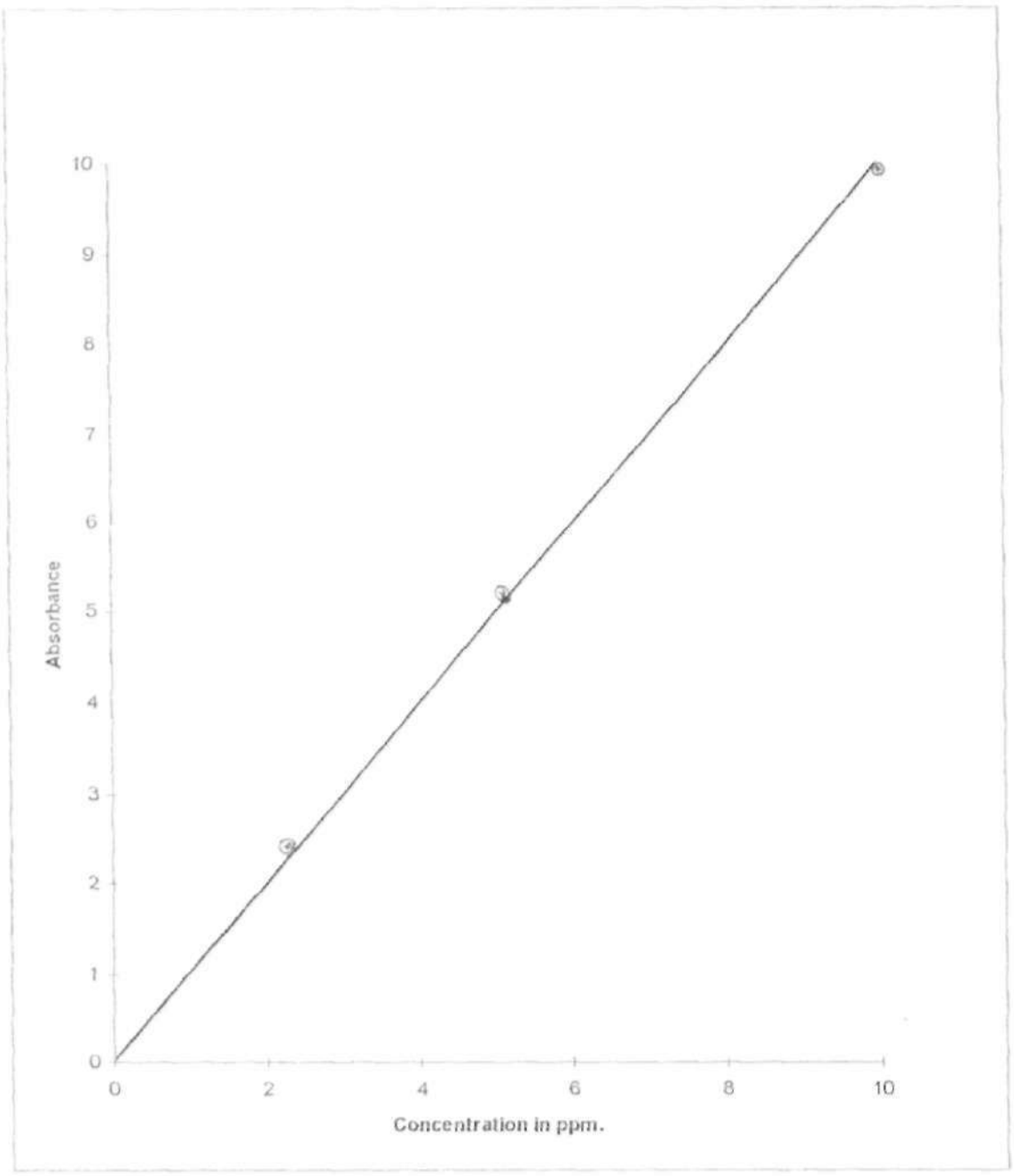
APPENDIX II

Calibration Curve for the determination of potassium



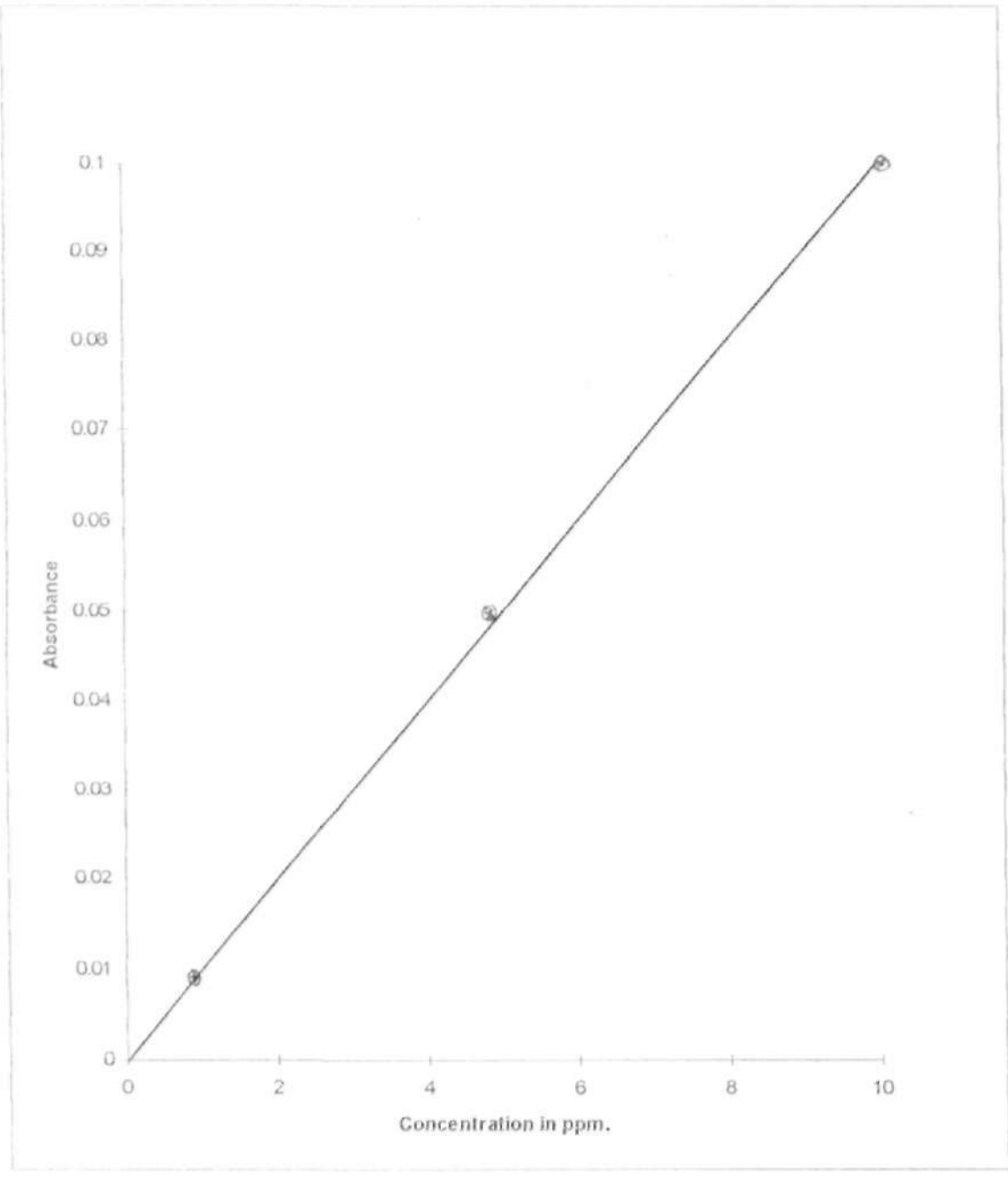
APPENDIX III

Calibration curve for nickel



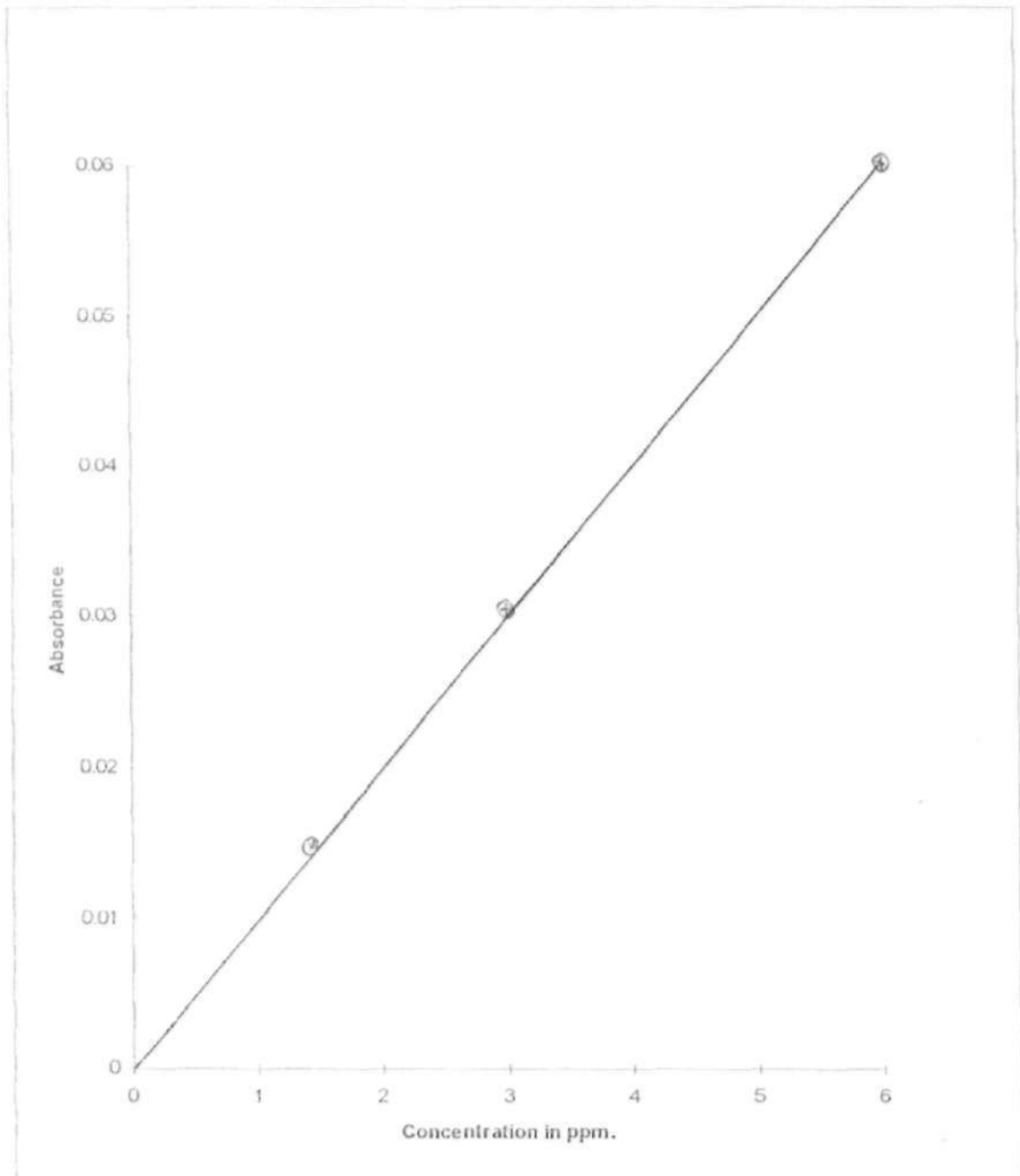
APPENDIX IV

Calibration curve for chromium



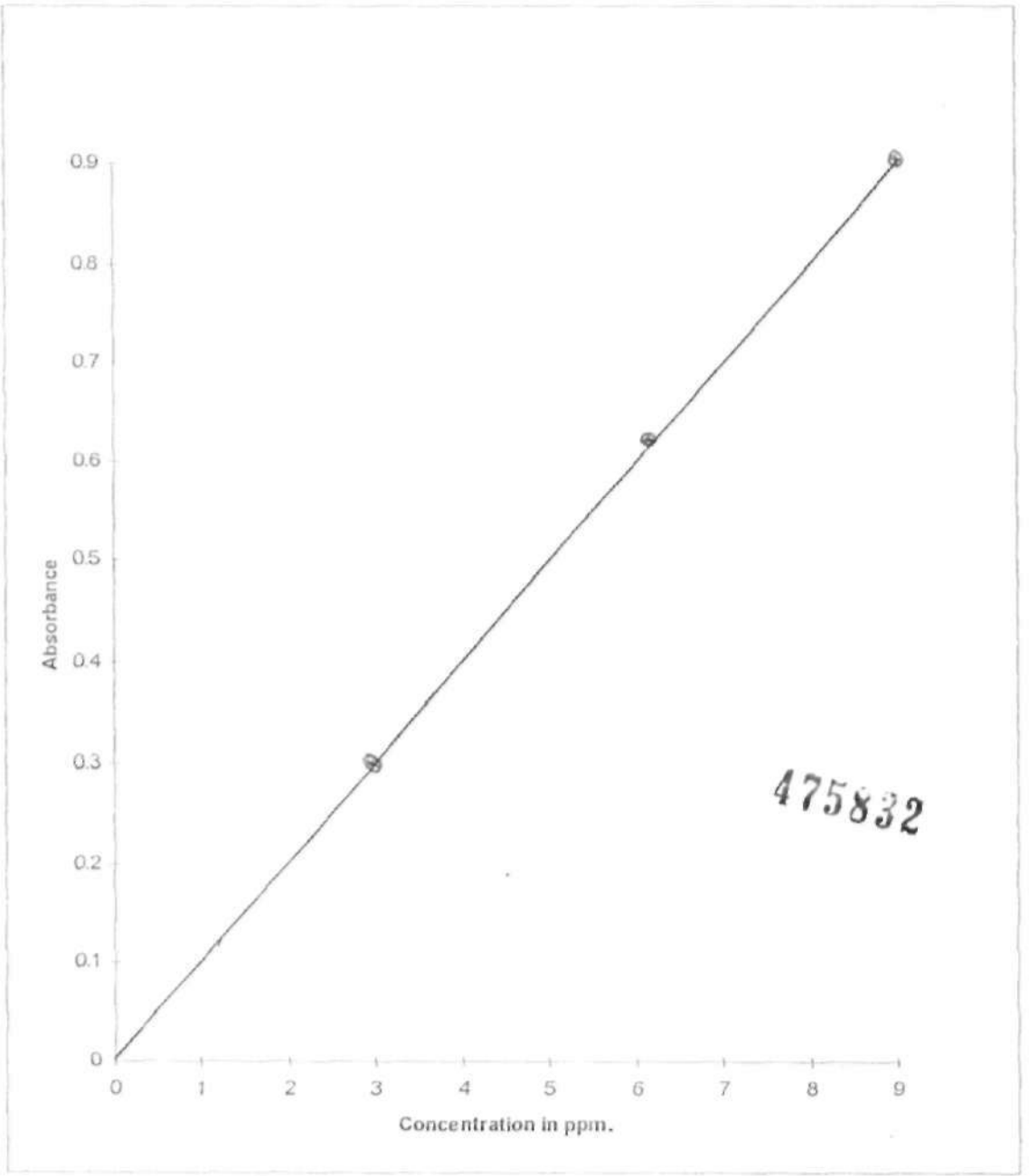
APPENDIX V

Calibration curve for manganese



APPENDIX VI

Calibration curve for calcium



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