CONSUMPTION PATTERNS OF TRADITIONAL LEAFY VEGETABLES AND THEIR CONTRIBUTION TO RECOMMENDED DIETARY INTAKES OF VITAMINS A AND C, AND IRON IN KALAMA DIVISION, MACHAKOS DISTRICT, KENYA

By

FLORENCE MUMBI MUTHIANI

Dissertation submitted to Department of Food Technology and Nutrition, in partial fulfilment of the Requirements for the Degree of Master of Science in Applied Human Nutrition. University of Nairobi, Kenya.

UNIVERSITY OF NAIROBI,

April 2004

DECLARATION

I, Florence Mumbi Muthiani, hereby declare that this dissertation is my own original work and has not been presented for a degree in any other university.

Florence Mumbi Muthiani

Date: 15/08/2004

The dissertation has been submitted with our approval as University supervisors.

Prof. Jasper. K. Imungi

Department of Food Technology and Nutrition

Date: 5/11/2004

Dr. (Mrs) Jaswant K. Sehmi

Department of Food Technology and Nutrition

Date: 15/09/04

DEDICATION

To my beloved late son, **Kyalli** (1999-2001), with all my love and sweet memories.

To my lovely son, **Kyalle**, for your patience and unique support in my studies.

To my dear husband, **Dr. Kyallo W. Wamitila,** for your love, support and constant encouragement.

To my parents, **Joseph and Alice Kwinga**, for investing in my education.

To **Alfred and Annie Brügemann**: *Vielen dank.*

ACKNOWLEDGEMENTS

I would like to thank **Gandhi Smarak Nidhi Fund** for awarding me a scholarship to pursue my Msc. in Applied Human Nutrition. I also express my sincere gratitude to my supervisors, **Prof. J.K. Imungi**, the late **Prof. N.M. Muroki,** and **Dr. J.K. Sehmi**, all of the Department of Food Technology and Nutrition, who guided me throughout this study.

Special thanks to **Sight and Life** and **International Plant Genetic Resources Institute** (IPGRI), for financial support during the project work. I specifically thank **Patrick Maundu** of KENRIK for his help in the taxonomic identification of some of the vegetables, **Jeremiah M'Thika** who patiently helped me with the laboratory analyses, my field assistants **Geoffrey**, **Eunice** and **Eric** for their dedication, and my colleagues **Immaculate Anyango** and **Louise Ngugi** for sharing every step of the studies.

Finally, I am grateful to my husband **Dr. Kyallo W. Wamitila** for his support throughout this study, for confidence in me, for ensuring that I got to class safely and on time every day, for accompanying me to the field to collect samples, for assisting in editing my dissertation and for offering me moral and financial support. I also thank my son **Kyalle** for his unique contribution to my work. ***May God bless and reward you all abundantly***.

ABSTRACT

This study was undertaken between March 2003 and June 2003 in Kalama division of Machakos district to establish the consumption patterns and nutrient contents of traditional vegetables. A household survey was carried out using a self-administered structured questionnaire to collect data on demographic characteristics of the population and production, utilization, preferences, preparation and preservation of the vegetables. Samples of raw commonly consumed vegetables were collected and cooked in simulated traditional methods. The raw and cooked vegetables were analysed for reduced ascorbic acid and beta-carotene. The data was used to calculate the contribution of the vegetables to the household dietary intakes of the two vitamins in the division.

Results showed that the average household size in Kalama division was 4.9, the female to male ratio was 100:88, and the dependency ratio was 88. Majority of household heads were farmers. Literacy levels among the household heads were high, with more than 75% having some formal education.

The study found that about 16 species of traditional vegetables were consumed in Kalama division. The highest ranked in terms of preference were *Amaranthus* spp, *Vigna* spp, and *Cucurbita maxima* in that order. The most common method of preparation was boiling then mashing the vegetables in a mixture with the staple food, *isyo*. However, the vegetables were also prepared for consumption as a side dish, in which case they were boiled then stewed. The average time for both methods of cooking ranged between 5-80

minutes with a mean of about 31 minutes, while the proportion of cooking water ranged between the amounts retained after washing to 1000ml added per kilogram of vegetables. During preparation as a side dish, nearly one-third of the respondents drained the vegetables and discarded the water before stewing.

Preservation of the traditional vegetables was practised by only 8.0% of the respondents though 17.0% reported consuming them whenever they accessed them, implying that consumption would be higher if more were availed.

Reduced ascorbic acid contents in the raw vegetables ranged from 78.3 mg/100g in *V. unguiculata* to 102.3mg/100g in *Erucastrum arabicum*. Raw samples of *Solanum nigrum* had the highest levels of beta-carotene (6770μg/100g), while *V. unguiculata* had the lowest (5028 μg/100g). The percent beta-carotene retention after cooking was highest in *Solanum nigrum* (over 80%) and lowest in *Cucurbita maxima* (35%). For ascorbic acid, retention was below fifty percent in all vegetables, with *Solanum nigrum* having the highest retention at 48.8% and the lowest being in *Cucurbita maxima* at 12.5%.

The mean intake of the study population was 944RE/cu/day for vitamin A, 68.8mg/cu/day for vitamin C and 16.2mg/cu/day for iron. For almost half of the study population, traditional vegetables contributed about 50% of the recommended dietary intake for all the three micronutrients. Only a third received more than 100% of the RDI for vitamin A and iron from traditional vegetables.

The study revealed that a diversity of traditional vegetables are grown and consumed in Kalama division. Consumption of the vegetables would be increased by improving availability. Hardly any processing or preservation of the vegetables was practised. despite the prolonged cooking, the contribution of traditional vegetables to dietary intakes of the three micronutrients was high. This implies that this contribution would even be higher if discarding of cooking water was not practiced at all and cooking time was shorter.

The contribution of the vegetables to the dietary intake of Vitamins A and C, and iron was high. Consumption of the cooking water would definitely increase the dietary intake of the three micronutrients.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS

ACC/SCN: Administrative Committee on Co-ordination/Subcommittee on Nutrition

ANV: Average Nutritive Value.

ANV= Protein (g)/5 +fibre (g) + Calcium (mg)/100 + Iron (mg)/2+ Carotene (mg) + Vitamin C (mg)/40

BPS: Board of Postgraduate Studies

CIKSAP: Centre for Indigenous Knowledge Systems and by Products.

FAO: Food and Agriculture Organisation

FGD: Focus Group Discussion

FNP: Food and Nutrition Programme

ICRAF: International Centre for Research in Agroforestry

IPGRI: International Plant Genetic Resources Institute

KENRIK: Kenya Resource Centre for Indigenous Knowledge

NEVEPA: Network Vegetable Production in Africa

KIRDI: Kenya Industrial Research and Development Institute

MERS&T: Ministry of Education, Research, Science, and Technology

RDI: Recommended Dietary Intakes

TLVs: Traditional Leafy Vegetables

WHO: World Health Organisation

DEFINITION OF TERMS

Anaemia: Blood condition characterised by low Hb concentration or low haematocrit (percentage of blood volume that consists of red blood cells) or both (ACC/SCN, 2001).

Bioavailability: The fraction of the ingested nutrient that is available for utilization in normal physiologic functions and storage (Lieshout, 2001).

Bioefficacy: The fraction of an ingested nutrient that is absorbed and converted to the active form of the nutrient in the body (Lieshout, 2001).

Chapati: Flat pan-fried unleavened wheat flour bread.

Dependency ratio: The sum total of all persons under 15 and over 64 years divided by the number of persons aged 15-64 years, multiplied by 100.

Iron Deficiency Anaemia: Haemoglobin levels below acceptable standard for age and sex.

***Isyo*:** Mixture of maize and beans (also other legumes) boiled together till soft.

Keratomalacia: Irreversible cornea damage due to prolonged deficiency of vitamin A.

Matumbo: Offals, mainly intestines and stomachs.

Micronutrient: A nutrient required by the body at less than 5ppm. (Guthrie and Picciano, 1995)

Micronutrient malnutrition: Vitamin and mineral nutritional deficiency (ILSI/FAO, 1997)

***Muthokoi*:** Mixture of shelled maize boiled together with beans or peas.

Nutritional anaemia: Anaemia that is caused by the absence of any dietary essential that is involved in haemoglobin formation or poor absorption of these dietary essentials.

Ugali: Stiff porridge, usually prepared from water and maize meal.

CHAPTER ONE: INTRODUCTION

1.1.1 Background Information on Traditional Vegetables

In the context of this document, traditional vegetables are defined as all categories of edible parts of plants, which have been identified and consumed as vegetables by communities as a tradition. Most of these vegetables are leaves. They are collected from the wild, as they grow as weeds in cultivated fields or abandoned homesteads, or from cultivation of a few domesticated species (Anzaya, 1987; Opole *et al.*, 1995; Omuga and Opole, 1997). Some are also harvested from plants growing for other purposes such as yield of seed, roots, or tubers (Scherer, 1969). Availability of traditional vegetables is therefore largely seasonal. They are abundant soon after the rains. During the dry season, they are scarce unless they are grown by irrigation, which in recent years has become common especially in urban areas.

Traditional leafy vegetables are widely consumed in Africa but the species consumed vary from region to region (IPGRI, 1997). In Kenya, at least 200 species have been identified and 20 recognised as commonly consumed (Maundu *et al.*, 1999; Onyango, 1996). Among the commonly consumed species are the *Amaranthus* spp, *Vigna* spp, *Solanum* spp, *Cucurbita* spp, *Corchorus* spp, *Crotolaria* spp and *Gynandropsis* (*Cleome*) *gynandra*. Research has, however, shown that preference in consumption varies from one ethnic community to another (Opole *et al.*, 1995; Mwanjumwa *et al.*, 1991) and that most communities tend to hold onto their preferred vegetables and are reluctant to accept new ones (Maundu, 1997).

In the past, consumption of traditional food plants, including traditional green leafy vegetables, had declined due to competition from introduced or exotic vegetables. The latter, because they are also cultivated for cash, enjoy higher preference in cultivation. Because they are perceived to promote a sense of sophistication, they also enjoy consumption preference in urban diets (FAO, 1985). Population growth and increased deforestation also contributed to decreased availability of traditional food plants and consequently decline in their consumption. However, this trend is slowly being reversed, thanks to the activities of the relevant government ministries, institutions such as Universities, and non-governmental organizations such as Centre for Indigenous Knowledge Systems and by Products (CIKSAP) and International Plant Genetic Resources Institute (IPGRI). Currently, traditional vegetables are being cultivated and commercialised alongside their exotic counterparts in some parts of the country such as Western Kenya (Opole and Maina, 2001). They are recently sold not only in open-air markets, but also in modern supermarkets in the urban areas.

Most low-income rural households consume foods of plant origin because they cannot afford those of animal origin. It has for example been reported that in the Eastern African region, 80% of vitamin A is obtained from vegetables (Kogi-Makau, 1995; Kigutha, 1995). For such households, therefore traditional green leafy vegetables and to a less extent fruits, constitute the main source of micronutrient in the diets. Kenyans are, however, not habitual consumers of fruit (Kusin, *et al.*, 1985; Mwaniki *et al.*, 1999). It is therefore possible to have manifestations of micronutrient deficiency symptoms even within the context of available fruits. Vegetables, on the other hand, are common items of diets in many rural and urban households. Whereas exotic vegetables may be expensive for the urban poor, traditional vegetables are cheaper and more readily available especially to the rural populations (Chweya, 1997a; 1997b).

1.1.2 Background information on micronutrient deficiencies

In Kenya, micronutrient deficiencies, especially of vitamin A and iron, are widespread. Prevalence of acute and moderate vitamin A deficiency among children are estimated at 14.7% and 61.2% respectively while the prevalence among mothers is 9.1% (acute VAD) and 29.6% (moderate) (Mwaniki *et al.*, 1999). A study done in Muumandu in Kalama location, Machakos District reported that 1.4% of children aged below 15 years had Bitot's spots (Dijkhuizen *et al.*, 1981). The 1999 Micronutrient Survey (Mwaniki *et al.*, 1999) reports prevalence rates of iron deficiency among pre-school children, mothers and adult males in Kenya of 43.2%, 42.9% and 15.9% respectively. Iron deficiency accounted for 50% of the anaemia cases among children and 67% of anaemia cases among mothers.

Several approaches have been adopted in the past to combat micronutrient deficiencies. Supplementation and food fortification have been preferred but these only serve as short to medium term measures. Long-term strategies are required. It has been realised that the best long-term measures are those involving food-based approaches coupled with nutrition education, because these are preventive, feasible, cost-effective, are sustainable, can address multiple nutrient deficiencies simultaneously, have little risk of toxicity (because amounts consumed are within normal physiological limits), and are adaptable to different cultural and dietary traditions and locally feasible strategies (ILSI/FAO, 1997). Local production and consumption of a variety of micronutrient rich foods have received support as a sustainable solution to micronutrient deficiencies in communities (Rahmathullah *et al.*, 1990; Buyckx, 1993; Shrestha and Hussain, 1993; King and Burgess, 1993; GoK, /UNICEF, 1994; WHO/FAO, 1996; FAO/WHO, 2002). Eating a variety of foods enhances dietary diversity, which is important in determining dietary quality, a factor that strongly influences nutritional status (Sehmi, 1993; Kennedy *et al.*, 2003). Dietary diversity increases bioavailability when nutrients are consumed simultaneously. For example, iron absorption is increased when it is consumed with vitamin C or animal proteins (Passmore and Eastwood, 1986; ILSI/FAO, 1997). Also, deficiency of one micronutrient can lead to deficiency of another micronutrient. When adult male volunteers in the USA were depleted of vitamin A, their Hb concentrations fell from about 150 to <110 g/litre within twelve months. Treatment with iron alone did not change the Hb levels, whereas Vitamin A plus iron readily restored Hb concentrations (ACC/SCN, 2001). This implies that these nutrients complement one another in the body.

1.2 Problem Statement

Most of the mineral and vitamin requirements of poor rural Kenyans are met from vegetable sources (Sehmi, 1993; Kogi-Makau, 1995). Despite reports of availability of traditional vegetables in most parts of the country, (Kigutha, 1995; Mwaniki *et al.*, 1999), prevalence rates of micronutrient deficiencies remain high (Mwaniki *et al.*, 1999). This has been attributed to inadequate consumption of micronutrient rich foods and in forms that enhance absorption, and to a less extent to parasitic infections. However, although they have the potential to contribute significantly to recommended daily dietary intakes of vitamin A, C, and iron, information on the consumption patterns of traditional vegetables is scarce.

Mwanjumwa *et al.* (1991) reported the nutrient contents of some traditional vegetables consumed in Machakos district, the study area. However, reports on studies on the consumption patterns of these vegetables are not available. Such a study, combined with the existing knowledge about the nutrient contents, would be useful especially in formulating interventions aimed at dietary diversification to minimize deficiencies of vitamins A and C, and the mineral iron.

1.3 Research Objectives

1. 3. 1 Broad Objective

The aim of the project was to determine the consumption patterns of traditional green leafy vegetables and assess their potential contribution to household intakes of the vitamins A and C, and the mineral iron.

1. 3. 2 Specific Objectives

1. To determine and prioritise the common traditional leafy vegetables consumed in Kalama division.

2. To document the methods of incorporation of traditional leafy vegetables in the diets.

3. To document the extent of preservation of traditional leafy vegetables in Kalama division.

4. To determine the levels of beta-carotene and reduced ascorbic acid of the traditional vegetables most commonly consumed in the division.

5. To determine the intakes of vitamins A and C, and iron from traditional leafy vegetables dishes.

1.4 Expected Benefits

1. The study will be useful to policy makers, nutritionists, the community, and non-governmental organizations involved in one way or another in interventions, especially with regard to micronutrient deficiencies.

2. The study will be useful in promotion of production, consumption and preservation of traditional vegetables, which are rich in vitamin A, C and iron, among other nutrients.

CHAPTER TWO: LITERATURE REVIEW

2.1 Trends in Consumption of Traditional Leafy Vegetables in Kenya

In sub-Saharan Africa, the per capita consumption of vegetables is far below the recommended daily intake of 200 grams of which about two thirds should be green leafy vegetables (Mnzava, 1997). A National Micronutrients Survey in Kenya reported that fruits and vegetables were consumed by less than 10% and 50% of households respectively (Mwaniki *et al.*, 1999).

Rural urban migration has contributed to reduction in the consumption of traditional vegetables. This is because these vegetables are not as readily available in the urban areas as their exotic counterparts. In a workshop organised by CIKSAP in 1999 in Nairobi, participants lamented that their traditional vegetables were scarce in urban outlets and therefore consumption had gone down.

Lack of coverage of traditional vegetables in the media has also contributed to the lack of knowledge about their availability, production and nutritional value. Exotic foods are better covered by the media and are therefore more popular than traditional foods among consumers.

The absence of traditional vegetables in the school curriculum also has contributed to the diminishing knowledge on and low consumption of traditional vegetables (Chadha and Oluoch, 2003). Much of the knowledge about utilization of traditional vegetables is with the older generations and unless this information is incorporated in the education system, it will remain unavailable to younger generations and could be lost altogether.

The low domestication of traditional vegetables has also contributed to their reduced consumption (Maundu, 1997; Chweya 1997b). In a survey done among small-scale farmers in Kitui District, 47 species of traditional vegetables were named, but only seven were available for identification. The rest were not available (Opole *et al.*, 1995).

Culture has also considerably contributed to the downward trend in consumption of traditional vegetables. Most communities tend to hold on to their traditional vegetables. The acceptance of vegetables from other communities is a slow process (Maundu, 1997).

In the recent past, traditional food plants have received attention as valuable foods, not only because their production is more efficient under particularly harsh conditions, but also because their nutritional value is being more and more recognised. Several organizations have in the recent past been actively involved in research on traditional vegetables. CIKSAP has recently released manuals on the production of *Gynandropsis gynandra* and *Corchorus* spp. Other organizations involved in the promotion of production of traditional vegetables include International Plant Genetic Resources Institute (IPGRI), Network Vegetable Production in Africa (NEVEPA) and Kenya Resource Centre for Indigenous Knowledge (KENRIK).

2.2 Importance of Traditional Green Leafy Vegetables in Nutrition

The nutritional value of traditional leafy vegetables is being recognized or rediscovered by nutrition scientists (Goode, 1989). Because of their proven high nutrient contents (FAO, 1981; Gomez, 1981; Imungi, 1985; Mwanjumwa, 1991; Opole *et al.*, 1995; Mosha, 1995; Mnzava, 1997; Mziray *et al.*, 2000), traditional vegetables have the potential to improve health and nutrition. In a study done in South Java, children from a community which resorts to a rather high consumption of leaves during periods of scarcity were compared with children from a prosperous school in Jakarta. It was found that the blood levels of vitamin A and carotene of the former children were higher than those of the latter (Oomen and Grubben, 1977). Similarly, reports from Bangladesh, Tanzania, Thailand, Ethiopia and Indonesia showed reduced prevalence of severe vitamin A deficiency in project areas where production of green leafy vegetables was promoted as compared to the non-project areas. The results were, however, more pronounced where projects included a component of nutrition education (Ruel, 2001).

In addition to the minerals and vitamins, traditional leafy vegetables also contain significant levels of fibre whose consumption has been associated with decreased risk of degenerative diseases, including cancer (Geddes and Grosset, 1996). The leaves are also high in protein. A portion of 200g of leaf vegetables may supplement the diet with 6-14 g of protein (Oomen and Grubben, 1977). In addition, traditional leafy vegetables add variety to the diet of most rural households, usually consisting of predominantly the starchy staple.

Because of the low bioavailability of nutrients in traditional vegetables, consumption should be frequent to avoid micronutrient deficiencies. Consumption of these vegetables accompanied by fruits rich in vitamin C as well as presence of fat (as a cooking ingredient, fat-containing foods or in fruits such as avocadoes) enhances the bioavailability.

2.3 Production and Consumption of Traditional Green Leafy Vegetables

Traditional vegetables are adapted to local ecological conditions including climate. *Amaranthus* spp for instance grow under practically any condition and show high tolerance to water requirements, equal to 42-47% of that of maize (FAO, 1999). They also require minimum purchased inputs and therefore fit into the economic conditions of poor rural households (Grubben, and Almekinders 1997). In a survey done in Kitui, 95% of the farmers growing traditional vegetables were not using any fertilizers or pesticides (Opole, *et al.*, 1995). Some of the farmers even reported that intercropping with traditional leafy vegetables such as *Amaranthus* spp and *Vigna* spp helped to control pests. In addition, labour input is low compared to the intensive labour of cash crop production, and therefore does not put heavy demand on household energy requirements (Immink and Alarcon, 1992). The location of cultivated lands (where traditional vegetables are likely to grow as weeds) near homes ensures freshness of produce, reduces transportation and storage losses, and facilitates harvesting (Goode, 1989). This is particularly important because the nutrient content of leafy products is affected by post harvest handling among other factors.

Most traditional leafy vegetables are tolerant to biotic and abiotic stresses (FAO, 1999). They can also be intercropped with cereals, root crops, pulses and other vegetables. Some of them, such as *Vigna* spp and *Crotalaria* spp are nitrogen fixing. This is important for most rural farmers who cannot afford adequate fertilizers for crop production (Opole *et al.*, 1995).

Traditional vegetables provide direct access to diverse foods that can be harvested, prepared and fed to family members often on a daily basis, even by the poor and the landless (Marsh, 1998). When produced purely for household consumption, traditional vegetables will require very little land. In many parts of Kenya where most land is preferentially allocated to production of cash crops, a kitchen garden in the backyard is sufficient to provide the family with sufficient vegetables in the diet.

When grown for sale, traditional vegetables have the potential to generate income and provide employment. A survey conducted in Nairobi markets (Opole, and Maina, 2001) revealed that 54.7% of vendors were selling traditional vegetables as compared to 29.9 % who were selling exotic vegetables. The same survey showed that traditional vegetables accounted for the highest share of income compared to other foods sold, such as fruits, cereals/proteins and root crops. This clearly indicates a growing market demand for traditional vegetables in the urban areas.

Some traditional vegetables have medicinal value in addition to nutritive value and a few of these have been domesticated purely for their medicinal properties. For example, in

Western Kenya, aqueous extracts from *Amaranthus* spp were traditionally used to relieve pulmonary problems. Among the Luos, leaves of *Commelina africana*, when chewed, were believed to promote fertility, while the juice from the same leaves was used to relieve earache.

2.4 Nutritive Value of Some Traditional Vegetables

Dark green vegetables are some of the richest sources of beta-carotene, an important precursor of vitamin A (Latham, 1976; Oomen and Grubben, 1977; Geddes and Grosset, 1996). It has been observed that the greener the vegetables are, the richer they are in beta-carotene (Oomen and Grubben, 1977; Sehmi, 1993; Guthrie and Picciano, 1995). Other nutrients present in vegetables are fibre, protein, calcium, iron, some B vitamins, pyridoxine, folic acid, vitamin K, magnesium, phosphorus, potassium, calcium and sodium.

There is evidence that traditional vegetables are superior to their exotic counterparts in nutrient contents (Latham, 1976; Chweya, 1985; Sehmi, 1993; Opole et al., 1995; Onyango, 1996; Mnzava, 1997). Amaranthus spp for example, has been reported to contain higher levels of lysine (300-325 mgs per gram of nitrogen) than cabbage (170-226 mgs per gram of nitrogen) (FAO, 1981). Table 1 shows comparative nutritive content of some vegetables.

Fruits and vegetables are the principal sources of micronutrients such as Vitamins A and C, and iron in the diets, subject to bioavailability (Sehmi, 1993; Passmore and Eastwood, 1986). Other nutrients that abound in traditional vegetables include calcium, phosphorus, magnesium, sodium and potassium (Tables 1 and 2). They also contain ample amounts of folic acid, thiamine, nicotinic acid vitamin E, vitamin K, riboflavin, the B vitamins, protein and the all-important fibre.

The most critical nutrients from traditional vegetables in the developing countries include vitamin A, iron and zinc. The role played by these foods in the provision of vitamin C can, however, not be ignored. They have also been shown to contribute significantly to dietary intakes of several nutrients (Table 2).

2.4.1 Vitamin A

Vitamin A is a fat-soluble vitamin. It is available in animal foods in its preformed form, retinol. In plants, it is available as closely related hydrocarbons, the carotenoids. There are many known carotenoids but only a few of them break down in the body to yield vitamin A (Oslon, 1989; Combs, 1998). These are then referred to as precursors to the vitamin. In the body, vitamin A is needed for vision, growth, cell differentiation, reproduction (foetal development) and maintaining the integrity of the mucosal cells and epithelial tissue. The vitamin is also an antioxidant and maintains the immune system.

Table 1: Nutrient Content of Some Selected Traditional and Exotic Vegetables

Vegetable	Carotene (mg)	Vitamin C (mg)	Protein (mg)	Calcium (mg)	Iron (mg)
Traditional vegetables					
Cleome gynandra	6.7-18.9	127-177	5.4-7.7	434	11.0
Corchorus spp	3.9-5.4	170-204	4.5-5.5	270	7.7
Exotic vegetables					
Spinach	2.8-7.4	1-59	2.3-3.1	60-595	0.8-4.5
Brassica spp	Tr.-4.8	20-220	1.4-3.3	30-204	0.5-1.0
Lettuce	0.15-7.8	3-33	0.8-1.6	17-107	0.5-4.0
French beans	0.02-0.6	5-28	2.4-10.1	30-65	0.5-3.4

Source: Opole *et al.*, 1995.

Table 2: Contribution to RDI of an adult male by Some Indigenous Leafy Vegetables

Vegetable	Percent RDI (raw leaves)			
	Vitamin A	Vitamin C	Calcium	Iron
Cleome gynandra	196	437	56	80
Solanum spp	122	210	27	34
Amaranthus spp	170	320	100	34
Crotalaria spp	131	420	32	28
Corchorus spp	113	521	32	56
Cucurbita spp	110	427	5	17
Vigna spp	150	260	110	35

Source: *Mnzava, 1997.*

Important animal sources of Vitamin A include butter, egg yolk, animal fats and liver. Green leafy and yellow/orange vegetables are rich sources of carotenoids. In the body, excess vitamin A is stored in the liver, under the skin and in the flesh in the adipose. The vitamin has a half-life of between 200 and 300 days (Geddes and Grosset, 1996). This implies that the vitamin balance is only disturbed if intake is low enough to deplete the store over a period of months.

There are more than 500 types of carotenoids known to occur naturally in plants, but only about 50 of them have vitamin A activity (Oslon, 1989; Guthrie and Picciano, 1995). The most common carotenoids found in plant foods are beta-carotene, alpha-carotene, cryptoxanthin, lycopene, lutein and zeaxanthin. The most important precursors of vitamin A are beta-carotene, alpha-carotene and cryptoxanthin. Vegetables known to be good sources of provitamin A are broccoli, carrots, kale, pumpkin, spinach, squash, tomato, red and green peppers, and collards (Guthrie and Picciano, 1995). Traditional vegetables reported to be good sources of provitamin A are sweet potato leaves, *Amaranthus* spp, bush okra (*Corchorus* spp), spider weed (*Gynandropsis or Cleome gynandra*), black nightshade (*Solanum* spp) and cowpea leaves (*Vigna* spp) (Opole and Maina, 2001; Mosha, 1995). *Cleome gynandra*, *Corchurus* spp and *Amaranthus* spp are particularly rich in beta-carotene.

The factors that affect bio-availability and bioefficacy of carotenoids (including beta-carotene) in plant foods include species of carotenoids, molecular linkage, amount of carotene consumed in a meal, the matrix in which the carotenoid is incorporated, effectors of absorption and bioconversion, nutrient status of the host, genetic factors, host-related factors, and the mathematic interactions (Oslon, 1996; West, 2000b; Lieshout, 2001).

In typical diets in the developing world, beta-carotene is the predominant dietary source of vitamin A (Sehmi, 1993; Guthrie and Picciano, 1995; Kogi-Makau, 1995; Basu and Dickerson, 1996; West, 2000b). It has been reported that 75% of preformed dietary vitamin A mainly from animal sources is absorbed compared to 5-50% of beta-carotene and other carotenoids (Guthrie and Picciano, 1995; Basu and Dickerson, 1996).

Income levels of households affect availability of vitamin A to households. This affects the ability to purchase vegetables if household production is absent or inadequate as well as the access to other foods that enhance the absorption of the vitamin A from the vegetables. When people cannot afford to diversify their diets with adequate amounts of fruits, vegetables or animal-source foods that contain large amounts of micronutrients (including vitamin A), or other foods that enhance the absorption of the micronutrients, deficiencies are inevitable (Kennedy *et al.*, 2003).

In the body, absorption of vitamin A is enhanced by factors that promote fat absorption and impaired by factors that inhibit fat absorption, such as reduced production of bile or obstruction of the bile duct (Williams, 1994; Guthrie and Picciano, 1995). Factors that enhance absorption of carotenoids from plant sources are protein, amount of other carotenoids, digestibility of the food, presence of antioxidants, zinc and the overall vitamin A status of the individual (Passmore *et al.*, 1986; West, 2000b; Lieshout, 2001).

Vitamin A and the carotenoids are stable on exposure to moderate heat and alkali, but unstable in the presence of light, acids and a variety of oxidising agents (Mosha, 1995). In most households in Africa, and probably in other parts of the world, leafy vegetables are boiled and often stewed prior to consumption, or they are boiled separately in varying quantities of water and the boiling water discarded (Imungi and Mathooko, 1994). Such methods of cooking and preparation of vegetables may lead to loss of beta-carotene (Gomez, 1981; Mosha, 1995). The losses increase with increased cooking time especially if the cooking container remains uncovered during cooking. Traditional drying methods of preservation of leafy vegetables also result in nutrient losses, the extent of which depends on the type of vegetable (Gomez, 1981; Mziray *et al.*, 2000; Mosha, 1995).

Vitamin A deficiency plagues many developing countries and its most tragic consequence is mainly seen in children (FAO, 1992; ILSI/FAO, 1997; ACC/SCN, 2001). Deficiency may occur due to inadequate dietary intake, poor absorption due to lack of bile or defective absorbing surface, inadequate conversion of carotene because of liver or intestinal disease, parasitic infestation and protein deficiency. Vitamin A Deficiency (VAD) is associated with night blindness and in extreme cases with xerophthalmia and keratomalacia. It also causes increased susceptibility to infections since vitamin A maintains the integrity of the epithelial tissue, including the skin and inner mucous membranes. Severe VAD has a fatality rate of 60% while the rate in subclinical deficiency is 23%. In the case of HIV patients, VAD increases morbidity and mortality in all age groups and sexes. It has also been associated with high maternal-child transmission rates, faster progression from HIV to AIDS, higher infant mortality and child growth failure (FANTA, 2001).

Vitamin A and carotene deficiency have also been associated with cancer (Geddes and Grosset, 1996). Vitamin A deficiency can also affect the metabolism of proteins by lowering the plasma levels of the vitamin A transport protein, namely Retinol-Binding-Protein, thus impairing nitrogen balance and decreasing the synthesis of some specific proteins.

2.4.2 Iron

Iron is a micronutrient that is needed in the body for the production of red blood cells, which are responsible for the transport of oxygen from the lungs to body and carbon dioxide from the cells to the lungs for excretion. It is also required for energy production in the cells and is essential for the metabolism of all B vitamins (King and Burgess, 1993; Williams, 1994; Guthrie and Picciano, 1995).

Iron is available in haem form in meat (especially liver) and eggs and as non-haem iron in plant foods such as whole grain, pulses and leafy vegetables (Geddes and Grosset, 1996; Williams, 1994). The iron in plant foods is present as non-haem complexes in which $Fe^{3}+$ is bound in an insoluble form to proteins, phytates, oxalates, phosphates and carbonates (Passmore and Eastwood, 1986). Absorption of haem iron is better than that of non-heme iron (Whitney and Rolfes, 1999; Passmore and Eastwood, 1986).

Iron is absorbed primarily from the upper part of the small intestines. Factors that enhance iron absorption include body need (in periods of deficiency or extra need as in pregnancy, more iron is absorbed), acidity in the gut (from gastric hydrochloric acid or ingested ascorbic acid) and calcium (binds and removes iron binders such as phosphates and phytates), presence of animal foods, sugars, amino acids and in some cases germination or fermentation of the food. The most important dietary promoter of iron intake is ascorbic acid (Passmore and Eastwood, 1986). Some iron is normally held in the intestinal mucosal cells and is only absorbed when the body needs it.

Iron absorption is hindered by binding agents such as phytates, phosphates, fibres and oxalates, reduced gastric acid secretion, severe infection and gastrointestinal disease, food additives and tannins. In addition, when there is a lot of iron in the body, less iron is absorbed. The body excretes iron through faeces, skin and gastrointestinal cells (Whitney and Rolfes, 1999; Williams, 1994).

Plant foods act as important sources of the mineral in communities where meat is unavailable or too expensive. According to Sehmi (1993), inclusion of about 50 grams of green leafy vegetables in the diet meets a considerable amount of iron requirement. Traditional vegetables serve as principal sources of iron in the diets of communities in the developing world. The traditional leafy green vegetables rich in iron include spider weed, *Amaranthus* spp, cowpea leaves, and pumpkin leaves (Sehmi, 1993; Maundu *et al.*, 1999; Imungi and Potter, 1983; Mosha, 1995).

Lack of iron in the diet is one of the main causes of nutritional anaemia, which is accompanied by weakening of the immune system. Deficiency symptoms include reduced resistance to infections (lowered immunity), reduced productivity, reduced physical fitness, fatigue, impaired cognitive function in children, reduced learning ability, impaired visual discrimination, impaired reactivity and coordination. The most vulnerable groups to iron deficiency are infants and young children, pregnant women and female adolescents (ILSI/FAO, 1997).

Nutritional anaemia is also caused by lack of any dietary essential involved in the formation of haemoglobin or poor absorption of vitamins B, C, and E, protein, copper and iron (Williams, 1994; Guthrie and Picciano, 1995).

Communities which are vulnerable to iron deficiency are often those for whom animal sources of iron are too expensive. According to Sehmi (1993), consumption of iron is highly income elastic owing to the fact that as income increases, consumers will purchase more meat, fruits and diverse vegetables, which are the main sources of the nutrient. This would imply that consumption of iron is more likely to be inadequate in poor households. Plant sources, especially green leafy vegetables provide a cheaper source of the mineral. Therefore, an increase in the consumption of green leaves and other vegetables could play a major role in eliminating anaemia.

Cooking affects the amount of iron available to households, especially if the cooking involves boiling and draining of the cooking water. Iron leaches into cooking water, and is lost if this water is discarded (Mosha 1995). Some iron is also lost if vegetables are peeled (Guthrie and Picciano, 1995). However, if the cooking water is consumed, almost 100% of the iron is retained (Imungi and Potter, 1983; Imungi, 1996).

2.4.3 Vitamin C

Vitamin C, also referred to as ascorbic acid or antiscorbutic acid, is a water-soluble vitamin. It is required for the utilization of calcium and absorption of non-haem iron (Passmore and Eastwood, 1986). It is also an anti-oxidant, required for the destruction of free radicals in the body and protection of thiamine, riboflavin, pantothenic acid and vitamins A and E from oxidation. It improves immunity status (King and Burgess, 1993; Geddes and Grosset, 1996), thus reducing bacterial infections. Vitamin C is also required in the formation of connective tissue (collagen) in the skin, ligament and bones. It facilitates the healing of wounds and burns, and aids in formation of red blood cells. The vitamin also prevents haemorrhaging (Passmore and Eastwood, 1986) and aids in metabolism of amino acids phenylalanine and tyrosine and the hormone norepinephrine. Vitamin C also converts folic acid from the inactive form of folinic acid to the active form.

The principal sources of Vitamin C are fresh fruits and green leafy vegetables. Fresh fruits, however, traditionally have a negligible share of the total food consumption and diet of the Kenyan population (Gomez, 1982; Kusin *et al*., 1985; Mwanjumwa *et al.*, 1991). Fruits are also more expensive than vegetables. Traditional vegetables, on the other hand, are widely consumed and are available the year round. Lack of vitamin C in diets causes a nutritional deficiency disease called scurvy, lowers iron absorption, leading to anaemia and injuries take longer to heal.

2.5 Overcoming VAD, Vitamin C and Iron Deficiencies

Methods that are currently available for intervention in vitamins A and iron deficiencies can be grouped into direct and indirect methods. Direct methods include fortification or enrichment of foods and direct administration of nutrient concentrates. Indirect methods are food-based and include increasing production and availability of foods high in iron and vitamin A, increasing consumption of these foods through nutrition education programmes to change eating behaviour, making vitamin A and iron more bioavailable and by breeding new varieties of plants that contain larger amounts and more bioavailable micronutrients (ILSI/FAO, 1997; Ruel, 2001).

Supplementation and fortification maybe needed as short to medium term measures, but long-term improvements lie in dietary diversification with increased consumption of vitamin A, C and iron rich foods and ensuring their availability in the household (Kogi-Makau, 1995; Whitney and Rolfes, 1999; de Pee, 1996; ILSI/FAO, 1997; Ruel, 2001). Their bioavailability can be improved through consumption of foods such as proteins and fats. Negative effects of foods high in antinutrients such as tea can be minimised if they are not consumed along with meals. Other approaches that complement improved Vitamin A status are control of infections such as measles, sanitary environments and nutrition education.

2.6 Potential Drawbacks to Traditional Leafy Vegetables' Production and Utilization

Vegetables have generally been found to be limiting in the essential amino acids lysine, methionine and tryptophan (Stabursvik, 1969). Bioavailability of micronutrients present in green leafy vegetables is also of concern. However, their absorption can be enhanced by consumption alongside other foods. Iron absorption, for instance, is enhanced by presence of vitamin C in the diet. Similarly, vitamin A absorption is increased by presence of fats in the diet.

Toxic compounds have also been isolated in some traditional leafy vegetables (Oomen and Grubben, 1977). An example is hydrocyanic acid, a highly toxic compound present glycisides and must be broken down to remove it from food. Inadequate knowledge about the recommended methods of preparation of cassava leaves or which varieties are low in hydrocyanic acid (sweet varieties) may inhibit their consumption. However, because it is volatile, hydrocyanic acid is easily removed by heating in an open cooking pot, which allows the fumes to evaporate and discarding any water used either for soaking or cooking the cassava.

Other antinutrients bind minerals. Example is oxalic acid, which binds calcium making it unavailable (Oomen and Grubben, 1977). Some traditional vegetables which are high in oxalic acid include *Amaranthus* spp and basella.

The taste of some traditional vegetables can also be a limitation to their consumption. This is especially true for vegetables that are bitter in taste and that require preparation methods, which rid them of the bitterness. In an effort to get rid of the bitter taste, preparation may involve prolonged boiling and then discarding the water. This is accompanied by loss of significant amounts of water-soluble vitamins and iron.

Indigestibility of some leafy vegetables may also limit utilization of vegetables by the body, especially when they appear in the stool hardly unchanged.

Traditional vegetables consumption is usually embedded in the culture of the people (Goode, 1989; Opole, *et al.*, 1995). Certain vegetables may only be eaten by certain members of the households. Kogi-Makau (1995) reports a believe in a community in Tanzania that too much consumption of vegetables causes diarrhoea, and that some days of the week should be vegetable free to give the stomach a break. Such believes or rumours may lead to unnecessary limited and selected consumption of some otherwise very nutritious vegetables.

Knowledge about traditional vegetables is declining with some vegetables previously frequently consumed being regarded as wild and inedible weeds (Opole *et al.*, 2001). This is particularly true among the youth and urban dwellers.

2.7 Twenty Four Hour Recall for Dietary Assessment

World health Organization stresses the need to develop dietary assessment methods, which take into account different food consumption practices (Kigutha, 1994).

Several methods are available for this assessment. They include a twenty-four hour dietary recall method. It is cheaper than other methods and is an easy way of obtaining reliable information if carefully planned and executed (Kigutha, 1994). It is useful assessing average normal nutrient intakes of a large population, provided that the sample is truly representative and that days of the week are adequately represented (Gibson, 1990). Gibson observed that there is no significant difference between intakes of vitamin A, and iron by children assessed by weighed food method and by the twenty-four hour recall method. The weighed food method has a heavy respondent burden, which may change the usual eating patterns of the respondent to simplify the weighing process or to impress the researcher (Kipkurui, 1998).

Twenty four hour recalls are generally less accurate than weighed food records, but are useful where diets do not differ greatly from day to day and where each member of the family has own eating dish and utensils (Shack *et al*., 1990).

2.8 Consumer units

For analysis of survey findings at household level, it is important to standardize household size. In order to take care of various biological characteristics such as age, sex, physiological status and physical activity level, a weighted summation is often used. An approximation of the relative needs is offered by a physiological weighting which takes into account the nutritional requirement of individual household members.

In this study, the weights are expressed as consumer units. One consumer unit (cu) stands for the consumption equivalent (here in terms of vitamin A, vitamin C and iron) of a nominal adult male. All individuals are expressed as a ratio of this unit (adult male equivalents) on the basis of their nutritional requirements as recommended by WHO/FAO/UNU (1985). The requirements of the various age and sex groups, expressed in terms of consumer units, are as follows:

Age	male	female	Age	male	female
0yr	0.3cu	0.3cu	17-19yrs	0.9cu	0.7cu
1yr	0.4cu	0.4cu	20-29yrs	1.0cu	0.8cu
2-4yrs	0.5cu	0.5cu	30-39yrs	1.0cu	0.8cu
5-7yrs	0.6cu	0.6cu	40-59yrs	0.9cu	0.7cu
8-10yrs	0.7cu	0.7cu	60+yrs	0.7cu	0.6cu
11-16yrs	0.8cu	0.7cu			

CHAPTER THREE: METHODOLOGY

3.1 FIELD SURVEY

3.1.1 Study Site

The study was carried out in Kalama division of Machakos district of Eastern Province in Kenya. The division consists of four locations, namely Kola, Kalama, Nziuni and Lumbwa. It covers an area of 330.2 km^2, with Lumbwa location occupying the largest area (185.9 km^2), because it comprises the vast Konza Ranching Cooperative Society. Kalama division experiences two distinct rain seasons: long rains between March and May, and short rains between October and December. Annual rainfall received ranges between 500-1300mm. The rain is, however, unreliable and erratic and varies from year to year. Mean monthly temperatures range from 12^{o} C in the coldest months (July-August) to 25^{o} C in the hottest months (March-October) (GoK, 2002).

Land use and settlement is influenced by soil fertility and rainfall. Agricultural activities consist mainly of growing of food crops and a few cash crops, and some livestock rearing, especially in Lumbwa location. The main food crops produced are maize, beans, pigeon peas, cowpeas, sorghum and cassava, while the main cash crops are coffee, citrus fruits and mangoes. Other fruits that grow in the region are pawpaws, loquats and avocadoes. Agricultural activities are mainly rainfed, with some irrigation of small vegetable gardens near the homes. Irrigated gardening is, however, only common in Lumbwa village near Muumandu shopping centre.

3.1.2 Study Population

Kalama division has a population of 41,000 persons, with an average population density of 124 persons/km^2 (GoK, 2002). The population comprises predominantly the Kamba tribe. Absolute poverty is above 80%. Agricultural and livestock activities contribute 70% of household income. The staple food of the Kamba is *isyo*, a mixture of boiled maize kernels and beans. Sometimes the kernels are shelled, then the cooked mixture is a local delicacy referred to as *muthokoi*. Often, both *isyo* or *muthokoi*, but mainly *isyo*, may be cooked in a mixture with traditional leafy vegetables, potatoes and/or green bananas, then mashed. *Ugali* is also commonly consumed.

3.1.3 Study Type

The study was cross-sectional and descriptive in nature, combining both quantitative methods (household interviews and laboratory analysis) and qualitative methods (focus group discussions).

3.1.3.1 Study Instruments

1. A structured questionnaire (Appendix 4) was developed and pre-tested in neighbouring Kola sublocation. Four field assistants, who had been trained for four days, then administered the questionnaire to female household heads, or wives of household heads, and where they were unavailable, an adult female member of the household was interviewed. Information recorded included socio-demographic information, crop and livestock production, foods consumed and frequency of their consumption, sources of the foods, methods of preparation and possible preservation of traditional leafy vegetables.

2. A twenty-four hour dietary recall (Appendix 4) was carried out on a sub-sample. Respondents were asked to recall all foods and drinks prepared and consumed in the household in the preceding twenty hours. They were also asked to show the amount of each ingredient used to prepare the meals using household measures and food models. Detailed description of all meals and ingredients were recorded using a form specially designed for this purpose. Values of household measures of each ingredient were converted into grams and/or millilitres. For the vegetables, a quantity of $1000cm^3$ of each vegetable was weighed using a kitchen scale and the equivalent weight used for converting household measures.

3. Focus group discussions (Appendix 5). One was conducted in each of the three locations. Each discussion comprised 8-10 women drawn form the research cohort and lasted 50 - 60 minutes. As per the guidelines, information collected included perceptions on production and consumption, procurement, preferences, preparation, preservation and the beliefs and taboos associated with consumption of traditional vegetables.

4. Laboratory analysis. This involved analysis of beta-carotene and ascorbic acid contents of fresh and cooked samples of the five most common traditional vegetables collected from the three locations. The vegetables were boiled in the laboratory by methods identified during the field survey. Both raw and cooked samples were weighed for analyses.

3.1.4 Sample Size and Sampling Method

The sample size was determined using the following formula, applicable to the population of the division, which was more than 10,000. (Fisher *et al.*, 1983)

$$n = z^2 pq / d^2$$

Where:

n = desired sample size

z = standard normal deviate: it is usually set at 1.96, which corresponds to the 95% confidence interval

p = proportion of the target population expected to be suffering from severe vitamin A deficiency (prevalence rate in neighbouring Kitui district was used).

q = 1-p

d= 0.05 (degree of accuracy desired which was set at 5%)

Therefore

$$n = \frac{(1.96)^2 \times (0.034) \times (0.966)}{(0.05)^2}$$

n = 50 households

The sample size was stepped up to 200 in order to account for attrition and the unknown rate of consumption of traditional vegetables, as well as the vastness of the study area.

Multistage sampling was used. Machakos district and its Kalama division were purposively selected. The three locations of the division were selected. Muumandu, the only sublocation in Lumbwa, was purposively selected, while one sublocation in Kola and two in Kalama locations were randomly selected because sublocations in each of these two locations were homogenous with regard to population and lifestyles. Finally, proportionate sampling based on the number of households in each sublocation was used to determine the number of households to interview. The households in these locations formed the sampling units and were selected using cluster sampling.

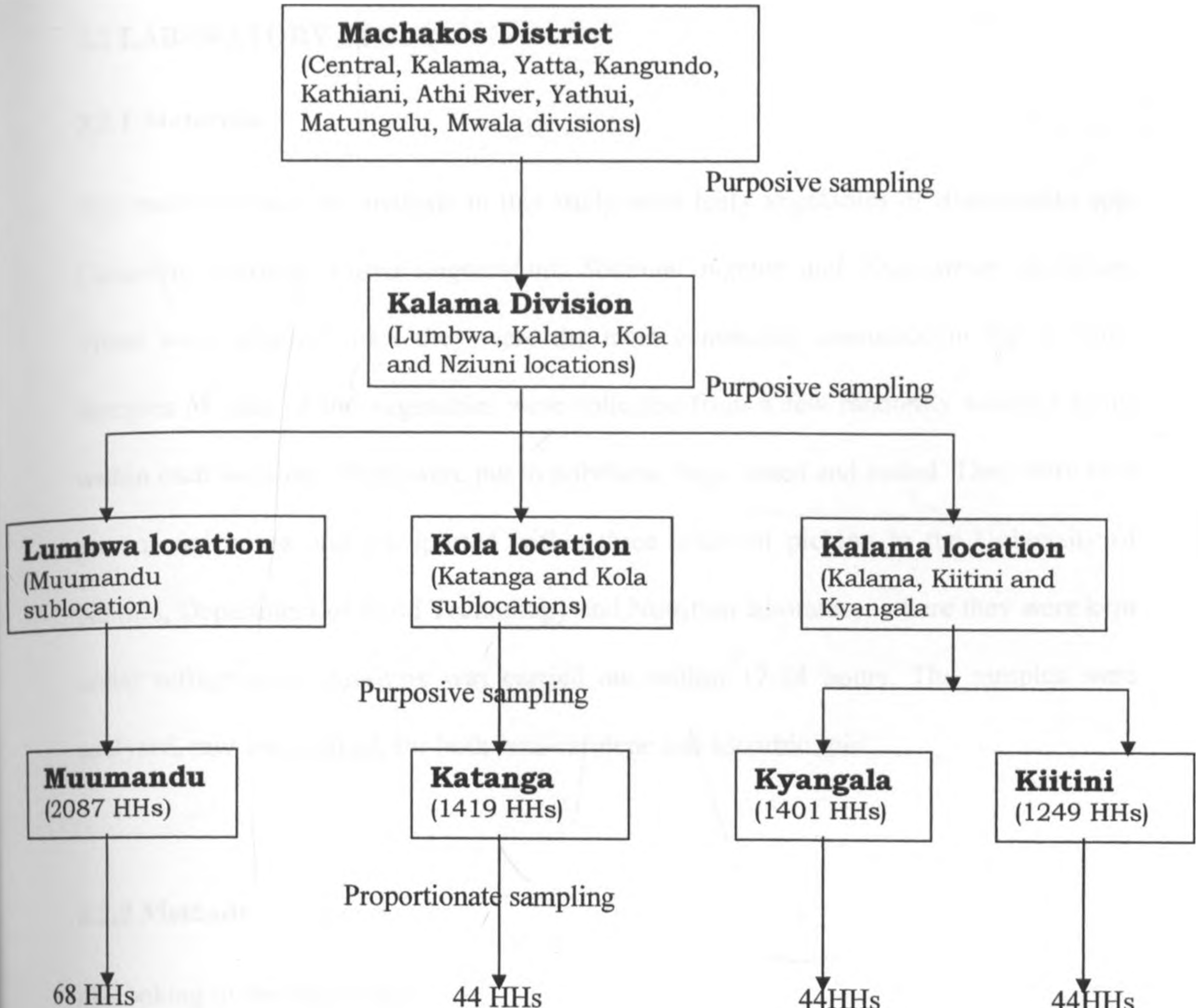

Figure 3.1 Schematic Presentation of the Sampling Procedure

3.2 LABORATORY STUDY

3.2.1 Materials

The materials used for analysis in this study were leafy vegetables of *Amaranthus* spp, *Cucurbita maxima*, *Vigna unguiculata*, *Solanum nigrum* and *Erucastrum arabicum*. These were selected since they were the most commonly consumed in the division. Samples of each of the vegetables were collected from a few randomly selected farms within each location. These were put in polythene bags, dated and coded. They were then put in cool boxes and transported within three hours of picking to the University of Nairobi, Department of Food Technology and Nutrition laboratory, where they were kept under refrigeration. Analysis was carried out within 12-24 hours. The samples were analysed, raw and cooked, for both beta-carotene and ascorbic acid.

3.2.2 Methods

a) Cooking of the vegetables

The samples were first washed then chopped, except for *V. unguiculata*, which was first chopped then washed. Then they were each cooked using the common methods of preparation reported from each of the respective locations. Samples from Lumbwa were boiled for 34 minutes with those from Kola location for 24 minutes and those from Kalama location for 31 minutes. The volumes of water used were 1: 2.5: 1 times for samples from Lumbwa, Kola and Kalama locations respectively, as reported in the household survey. Cooking container was covered for all the samples and the cooking water drained.

b) Determination of beta-carotene

The raw and cooked vegetables were analysed for beta-carotene using AOAC methods (AOAC, 1984). One gram of each sample (raw and cooked) was accurately weighed into a mortar in duplicate and mixed with 5g of acid washed sand. Ten millilitres of acetone were added and the mixture crushed with a pestle to extract the greenish yellow pigments containing the beta-carotene. The extract was filtered into a 100ml volumetric flask and the residue mixed with another 10ml acetone, then crushed as before. The crushing and filtration was continued until all the pigment had been extracted. The combined extract was made to 100 ml with acetone. Then 25 ml of the extract was evaporated under vacuum at about 60^0 C to a final volume of approximately one millilitre. While the extract was evaporating, the column for chromatography was prepared by adding silica gel to a solvent (prepared with petroleum ether, benzene and ethanol at the ratio of 100:20:7) in a flask little by little and swirling the flask first slowly, and then vigorously to form a slurry. A small plug of glass wool was placed at the bottom of the column. The column was filled with petroleum ether, which was then drained to 1 cm. The slurry was then poured into the column to make bed. The concentrated extract was introduced onto the column. The beta-carotene was eluted with petroleum ether into a 25 ml volumetric flask. The volume was made to the mark with petroleum ether. The absorbance of the beta-carotene was read at 450 nm in a 1 cm cuvette. The beta-carotene content of the sample was calculated per 100g of sample, from a standard curve prepared from absorbance values of pure beta-carotene solutions in petroleum ether.

c) Determination of Vitamin C

Vitamin C was determined as reduced ascorbic acid using the method of Barakat *et al.* (1955), in duplicate. Two grams of the sample was crushed with small portions of 10% Trichloroacetic Acid (TCA) and filtered. The filtrate was collected in 50 ml volumetric flask and made upto the 50ml mark with TCA. Five millilitres of the filtrate was mixed with 5ml 4% Potassium Iodide and titrated with 10% N-bromosiccinimide solution using 1% starch solution as indicator to a blue end point. The Vitamin C content of the filtrate was calculated using the following formula:

$$\text{Vitamin C} = V.C\,\frac{176}{178}\ (\text{mg})$$

where V= volume of N- bromosiccinimide (ml)

C= Concentration of N- bromosiccinimide (mg/ml)

The value was used to calculate the vitamin C contents of the sample as mg/100g.

3.3 Data Analysis

Data collected through questionnaires was analysed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics was performed on all data and reported as percentages, proportions, and frequencies at 95% confidence intervals wherever applicable (Munro and Page, 1993).

For the food consumption, a scoring method was used to determine the consumption of different foods. Scoring was done by multiplying the number reporting consuming a particular food at a particular frequency by the score for that frequency, then obtaining the sum total for each food. The highest possible mean score was seven.

Adequacy of nutrient intake was expressed in consumer units, a method of weighting that takes into account sex and age of individual members of each household. All individuals were expressed as a ratio of nominal adult male unit.

Preference rating of traditional vegetables was weighted by giving scores of 5 (most preferred) to 1 (least preferred) for the ranks 1-5. The percentage of respondents naming a vegetable in each of the ranks was multiplied by the score of that rank and summed up as the total score for that vegetable (maximum score was 100x5=500). To get the mean score, the total score for each vegetable was divided by the number of respondents who preferred traditional to exotic vegetables (136). Maximum mean score was therefore 500÷136= 3.68.

The laboratory data was compared as means for each vegetable and Analysis of Variance (ANOVA) done to determine differences in nutrient content. Nutrient contents of cooked samples were used to calculate the nutrient intake and adequacies.

CHAPTER FOUR: RESULTS

4.1 Summary of Focus Group Discussions

Participants reported that fewer traditional vegetables are available presently than in the past. This was especially true for vegetables that were originally collected from the forests.

Gathering of traditional vegetables from open field was becoming rare. In recent past, it was limited to *Commelina africana* and *Launaea cornuta*. This was mainly because these grow on river banks and abandoned homesteads, and are available during the dry season. Most households preferred the vegetables that grow as weeds on cultivated farms, near cowsheds or abandoned homesteads.

Participants noted that traditional vegetables grew in plenty where farms were adequately manured. For the families that did not have access to manure, hardly any traditional vegetables grew as weeds on their farms.

Participants lamented that at the time, most people, especially the young, considered traditional vegetables to be food for the poor or for grandparents. *Commelina africana* and *Launea cornuta* emerged as vegetables which were considered to be for the extremely poor.

Most young people did not know which weeds were vegetables or edible and even when their parents prepared them, they refused to eat them. The main reason given was that in the past, young children accompanied their parents frequently during gathering of the vegetables, but at the time of the study, this was not possible because the young spent most of their time in school. Also, most young parents did not know the traditional vegetables and consequently neither did their children.

Casual labourers employed to weed farms were reported to uproot all the weeds including the non-domesticated traditional vegetables, thus reducing family access to semi-cultivated vegetables. However, when families weeded their own farms, they carried out selective weeding and were therefore not likely to experience shortage of traditional vegetables for household consumption.

According to most participants, preservation of traditional vegetables was done only by grandmothers. However, most participants expressed the desire to preserve some traditional vegetables so as to consume them during the dry period.

Most participants lamented that traditional vegetables were seasonal and therefore could not be depended upon.

4.2 Socio-Economic Characteristics

The socio-demographic characteristics covered in this section included household characteristics, age and sex distribution, household income and expenditure on food purchase.

4.2.1 Household Size

The mean household size ranged between 4.8 in Kalama to 5.0 in Lumbwa locations as shown in Table 3. The divisional average of household size was 4.9. The mean household size did not vary significantly between the three locations.

4.2.2 Sex and Age Distribution of Study Population

Table 4 shows the age distribution of the study population. Upto 54.7% of the population were females while 45.3% were males. The female to male ratio was therefore 100:83. The proportion of the population below 15 years was 42.6%, while that above 65 years was only 4.3%. Over half of the population (53.2%) was between 15 years and 64 years of age.

4.2.3 Sex, Education, Occupation and Marital Status of Household Heads

Table 5 shows the sex distribution, level of education, occupation and marital status of household heads in each location and overall in the division. Majority of the households

Table 3: Size of Rural Households in Kalama Division

	N	Mean household size [a]
Lumbwa	68	5.0±1.9
Kola	44	4.9±2.1
Kalama	88	4.8±1.8
Kalama division	200	4.9±1.9

Table 4: Age Distribution Within Study Households

Age group (years)	% Males N=444	% Females N=536	%Total N=980
0-4	4.9	6.3	11.2
5-14	14.1	17.4	31.4
15-44	20.1	23.5	43.6
45-64	4.7	4.9	9.6
>65	1.5	2.7	4.3
Total	45.3	54.7	100.0

in Kalama division were male headed. Lumbwa location had the highest proportion of female-headed households (23.5%) compared to Kola and Kalama locations.

The proportion of household heads in the division with at least primary education was 80%, with the majority having secondary level education (51%). Less than half of household heads in all locations had secondary level education except in Lumbwa location where 63.3% had secondary education. The proportion of household heads with tertiary education was low. Kola had the highest proportion of household heads with tertiary (college) level education (11.4%) compared to Kalama and Lumbwa locations. In all locations, over half of the household heads had beyond primary education except in Kalama location (46.6%).

Nearly 50% of household heads in Lumbwa earned a salary (48.3%), while in Kola and Kalama locations, majority were farmers, the latter being the case in the whole division. The study population generally practices subsistence farming, even those who earned salaries. Those who indicated being farmers earned their entire livelihood from farming. Those who earned a salary worked away from home, while those who were employed as casual labourers worked in neighbouring homes.

Table 5: Characteristics of Household Heads by Location

Characteristic	Percentage of household Heads			
	Lumbwa N=68	Kola N=44	Kalama N=88	Kalama Division N=200
Level of Education				
None	19.1	20.5	20.5	20.0
Primary	16.2	22.7	33.0	25.0
Secondary	63.2	45.5	44.3	51.0
College	1.5	11.4	2.3	4.0
Sex				
Males	76.5	79.6	78.4	78.0
Females	25.5	20.5	21.6	22.0
Occupation				
Farmer	41.2	54.6	52.3	49.0
Employed	48.5	36.4	27.3	36.5
Casual labourer	8.8	4.5	17.0	11.5
Self-employed	1.5	4.5	3.4	3.0
Marital Status				
Married	76.5	77.3	76.1	76.5
Single	0.0	0.0	1.1	0.5
Widowed	23.5	20.4	22.6	22.5
Divorced	0.0	2.3	0.0	0.5

A small proportion of the respondents (3.0%) were self employed and engaged in such income generating activities as running retail kiosks, vending vegetables and general foodstuffs.

Majority of household heads in the study population were married. However, 22.5% were widowed, while the rest were either single or divorced. This trend is seen in the individual locations as well.

4.3 Cash Income and Food Purchase by Households

Over 80% of the households in the division had cash income, the highest proportion being in Lumbwa location (95.5%) and lowest in Kalama location (80.0%). Table 6 shows the household expenditure on food purchase. Majority of the households in Kalama division (81.0%) spent between Ksh. 100 and Ksh. 2,000 on food purchase per month. Nearly half of the households in Kola location (48.0%) spent more than Ksh. 2000 per month on food purchase compared to Kalama and Lumbwa locations. Similarly, households in Kola location had the highest mean monthly expenditure on food purchase (Ksh. 2,302.3), while Lumbwa location had the lowest at Ksh. 676.5. Households in Kalama location spent on average Ksh 1,483 per month on food purchase.

4.4 Land Ownership

Land ownership in Kalama division is shown in Table 7. Almost all households owned some land. Land sizes ranged from none to 20 acres. All households in Lumbwa location

Table 6: Expenditure on Monthly Food Purchase by Households

Characteristic	Lumbwa N=68	Kola N=44	Kalama N=88	Kalama Division N=200
Amount spent (Ksh)				
100-2000	97.0	52.0	83.0	81.0
2001-4000	3.0	43.0	15.0	17.0
2001-4000	0.0	5.0	2.0	2.0
Mean monthly expenditure				
Mean	676.5	2302.3	1483.3	1389.2
SD	572.2	1374.4	1219.3	1237.0

Table 7: Land Ownership by Location

Characteristic	Lumbwa (%) N=68	Kola (%) N=44	Kalama (%) N=88	Kalama division (%) N=200
Mean land size	2.8	3.5	3.6	3.3
SD	1.8	3.4	3.1	2.8
Land size (acres)				
0.0-0.5	92.7	90.9	79.6	86.5
5.1-10.0	7.4	2.3	17.1	10.5
10.1-15.0	0.0	4.6	2.3	2.0
15.1-20.0	0.0	2.3	1.1	1.0

owned less than 10 acres of land, while a small fraction (6.9% and 3.4%) of families in Kola and Kalama locations respectively owned more than 10 acres. In the whole division, only 3.0% of the households owned more than 10 acres of land.

Similarly, the mean land size was lowest in Lumbwa (2.8 acres). Average land size was nearly the same in Kalama and Kola locations (3.6 and 3.5 acres respectively). Overall, in the division, households owned an average of 3.3 acres of land.

4.5 Food Consumption

A high proportion of the population in Kalama division (89.5%) had at least three meals per day. The proportion of households with three meals per day ranged from 83.8% in Lumbwa location to 93.2% in Kola location. Lunch was the meal commonly missed by all the households who reported having two meals per day.

Table 8 shows the mean scores of different foods and the scores at different meal times. Appendices 1 and 2 show the frequency of consumption at different meal times.

The food most commonly consumed at breakfast was tea, with or without milk. In all three locations, it was consumed by over 80% of the households on a daily basis. It had the highest score of 6.40 among all foods consumed at breakfast, but was consumed at all during the other meals.

Table 8: Ranking of Different Foods Consumed at Different Meal Times in Kalama Division

1. Breakfast		2. Lunch	
Food	Mean scores	Food	Means scores
Tea	6.40	Maize *Ugali*	4.40
Millet porridge	2.04	*Isyo*	3.58
Maize porridge	1.50	Rice	0.68
Maize Ugali	1.17	*Muthokoi*	0.42
Isyo	0.58	Millet ugali	0.19
Muthokoi	0.18	*Chapati*	0.04
Chapati	0.07	Oils and fats	1.06
Bread	0.12	Sweetpotato	0.16
Rice	0.05	Cassava	0.10
Cassava	0.26	Meat	0.03
Sweet potato	0.04	Traditional vegs	1.65
Pumpkin	0.01	Exotic vegetables	1.55
Eggs	0.37	Pumpkin fruit	0.09
3. Supper			
Maize *Ugali*	3.31		
Isyo	3.22		
Rice	1.12		
Muthokoi	0.51		
Millet *ugali*	0.07		
Oils and fats	1.80		
Traditional vegetables	1.51		
Exotic vegetables	1.58		
Sweetpotato	1.35		
Meat	0.31		
Eggs	0.00		
Matumbo	0.06		
Liver	0.03		
Chicken	0.03		

Scores: 7 = 7 times/week; 4 = 3-6 times/week; 2 = 1-2 times/week; 1=1 time/month

Cereal consumption at breakfast was low, with preference being of the locally produced cereals (maize and millet) as compared to rice and wheat products, which are both not produced locally. *Ugali* had the highest mean scores at both lunch and supper (4.40 and 3.31 respectively), while *isyo* had the second highest scores. Over a third of the respondents consumed them at least 3-6 times/week. Rice, a cereal that is not grown within this region, was consumed by few households (2.5%) daily and by only 8.5% of respondents 3-6 times/week. Its highest mean score was 1.12 (at supper) compared to 4.40 for *ugali* and 3.57 for *isyo*.

Consumption of roots and tubers was not popular in the study area; cassava and sweet potatoes were consumed by less than 5% of the households at all frequencies considered. While cassava was consumed mainly at breakfast, sweet potatoes were more popular at lunch and supper.

Animal products were also not frequently consumed. Eggs were consumed by only 1% of the respondents on a daily basis and by 7% at 3-6 times/week. They were mainly consumed at breakfast and supper. Meat was consumed once per month by 14% of the respondents, with consumption at supper (mean score of 0.31) being higher than at lunch (mean score of 0.02). Other less frequently consumed animal products were *matumbo*, liver and chicken, which were only occasionally included in the evening meal.

Consumption of vegetables was moderate, mainly at lunch and supper. They were only consumed at breakfast if they were mashed with *isyo* from the previous evening.

Traditional and exotic vegetables were consumed by 56.5% and 57.5% of the households at a frequency of 3-7 times per week, respectively. Consumption of traditional vegetables was higher at lunch than suppertime. The mean score of both types of vegetables were nearly equal at both lunch and supper.

Oils and fats were popularly consumed with 50% of the households consuming them 3-6 times in a week. Most households only consumed them at lunch and/or supper, and none reported consuming them at breakfast. The mean score for oils and fats at supper (1.80) was, however, higher than at lunch (1.06).

4.6 Production of Traditional Vegetables

Table 9 shows the proportion of the study population in each location that grew 12 of the 17 different species of both wild and cultivated traditional vegetable grown in the division. As the Table shows, the most commonly found traditional vegetables were *Amaranthus* spp, *Cucurbita maxima, Vigna unguiculata*, *Solanum nigrum*, *Erucastrum arabicum*, and *Commelina africana*. Other vegetables grown by a smaller proportion of the population were *Launaea cornuta, Cleome gynandra, Ipomea batatas, Commelina benghalensis, Cucumis dipsaceus, Corchorus olitorius, Lagenaria siceraria, Manihot esculenta* and *Coxia grandis*. Other local vegetables produced were *Kathukambiti* and

Table 9: Distribution of Households Growing Traditional Vegetables (%)

Vegetable	Lumbwa (N=68)	Kola (N=44)	Kalama (N=88)	Kalama Division (N=200)
Amaranthus spp	97.0	95.0	95.0	95.6
Cucurbita maxima	91.0	91.0	94.0	92.0
Vigna unguiculata	87.0	80.0	98.0	88.3
Solanum nigrum	81.0	57.0	71.0	69.7
Erucastrum arabicum	44.0	9.0	21.0	24.7
Commelina africana	29.0	41.0	26.0	32.0
Launaea cornuta	13.0	34.0	13.0	20.0
Commelina benghalensis	4.0	5.0	3.0	4.0
Cleome gynandra	1.0	0.0	6.0	2.3
Ipomea batatas	1.0	5.0	3.0	3.0
Cucumis dipsaceus	1.0	0.0	2.0	1.0
Corchorus olitorius	0.0	0.0	1.0	0.3

Kang'ei, for which taxonomical classifications were not possible because samples were not available for identification.

Amaranthus spp and *C. maxima* were the most commonly produced traditional vegetables, with over 90% of the households in all locations producing them. However, in Kalama location, *V. unguiculata* was more popularly grown (98.0%) than *Amaranthus* spp and *C. maxima*. *C. africana* and *L. cornuta* appear to be more common in Kola location where they were produced by 41% and 34% of the households respectively, while in Lumbwa and Kalama locations, less than 15% reported them.

In all households, traditional vegetables were rain fed and none were irrigated. The wider variety of traditional vegetables were available in Kalama location where all 17 varieties were usually grown, while in Lumbwa and Kola locations, the varieties usually grown were 13 and 9 respectively. From the Table, it is evident that more wild than cultivated vegetables were produced in the study area. The latter included *Cucumis dipsaceus*, *Commelina africana*, *Launaea cornuta*, *Commelina banghalensis*, kang'ei, kathukambiti, *Coxia grandis*, *Cleome gynandra* and *Corchorus olitorius*. Some of the leafy vegetables were leaves harvested from food crops grown for other purposes. These included leaves of *Manihot esculenta*, *Ipomea batatas* and *V. unguiculata*. *V. unguiculata* leaves were, however, occasionally planted solely for vegetable.

Table 10: Distribution of Study Households by Production and Use of Some Traditional Vegetables

Vegetable	Common name	Scientific name	Production: (% households)	Use (% households)	
				HC	HCS
Wua	Pig weed	*Amaranthus* spp	95.5	92.0	3.5
Kyunyu		*Erucastrum arabicum*	26.0	26.0	0.0
Nenge	Pumpkin leaves	*Cucurbita maxima*	92.0	90.0	2.0
Nthooko	Cowpea leaves	*Vigna unguiculata*	89.5	71.5	18.0
Ndulu	Black nightshade	*Solanum nigrum*	70.5	68.5	2.0
Kikoowe		*Commelina africana*	30.5	30.0	0.5
Mwianzo	Cat's whiskers	*Cleome gynandra*	3.0	3.0	0.0
Uthunga	Sow thistle	*Launaea cornuta*	17.5	17.5	0.0
Ukwasi	Sweetpotato leaves	*Ipomea batatas*	3.0	3.0	0.0
Itula		*Commelina benghalensis*	3.5	3.5	0.0
Kyambatwa	Teseal gourd	*Cucumis dipsaceus*	2.0	2.0	0.0
Mlenda	Bush okra	*Corchorus olitorius*	1.0	1.0	0.0
Yungu	Bottle gourd	*Lagenaria siceraria*	1.0	1.0	0.0
Manga	Cassava leaves	*Manihot esculenta*	90.2	0.0	0.0

Key: HC=Home consumption; HCS= Home consumption and sale

Most households grew traditional vegetables for home consumption only. From table 10, it is evident that *V. unguiculata* was the only vegetable that was grown for both home consumption and commercial purposes. The other vegetables that were also occasionally grown for commercial purposes are *Amaranthus* spp (3.5%), *C. maxima* (2%), *S. nigrum* (2%) and *C. africana* (0.5%). The wild species were hardly sold. Production of most vegetables was rain fed and although some irrigation of tomatoes and kales or collards was observed, there was no irrigation of traditional vegetables.

4.7 Consumption of Traditional Vegetables

Table 11 shows the weekly consumption of traditional vegetables. Up to 83% of all households interviewed had consumed one or more traditional vegetable during the last seven days in various quantities and frequencies. Of these, 67% and 63% had consumed *V. unguiculata* and *C. maxima* respectively. *Amaranthus* spp was consumed by a smaller proportion of the respondents (28%), and *E. arabicum* and *S. nigrum* by 10% and 8% respectively. Out of the 17 varieties of traditional vegetables grown in Kalama division, 12 had been consumed in households in the last week.

The family farm was the main source of the vegetables. A few households, however, reported purchasing the vegetables in times of scarcity (Table 12). Some households reported receiving the vegetables occasionally as gifts.

Table 11: Traditional Vegetables Consumption per Week

Vegetable	Consumption: percent Households
Vigna unguiculata	67.0
Curcubita maxima	63.0
Amaranthus spp	28.0
Erucastrum arabicum	10.0
Solanum nigrum	8.0
Commelina africana	2.0
Ipomea batatas	1.0
Cleome gynandra	1.0
Launaea cornuta	1.0
Cucumis dipsaceus	1.0
Manihot esculenta	1.0

Table 12: Sources of Traditional Vegetables for Consumption

		Source (% households)		
	N	Own garden	Purchase	Gifts
Lumbwa	68	100	6.0	6.0
Kola	44	98.0	30.0	7.0
Kalama	88	99.0	16.0	6.0
Kalama Division	200	99.0	16.0	16.0

Most of the vegetables were consumed in both the main meal (mashed with *isyo*) and as a side dish (Table 13). *Vigna unguiculata* was more consumed as a side dish than in the main meal in all the locations. Majority of the households in Lumbwa consumed *C. maxima* in the main dish while in the other two locations, there was equal consumption of this vegetable in the main meal and as a side dish. *Amaranthus* spp was more consumed as a side dish in Lumbwa location, while households in Kola location preferred it as aspects of the main meal.

4.8 Preference Rating of the Traditional Vegetables

Table 14 shows the preference rating of vegetables in Kalama location. Preference for traditional over exotic vegetables was highest in Kalama location. In all the locations, however, preference was higher for traditional vegetables compared to exotic vegetables, except in Lumbwa location where the preference was 1:1. In the whole division, slightly more than two thirds of the respondents preferred traditional vegetables compared to about a third who preferred exotic vegetables.

As shown in Table 15, the respondents gave various reasons for their preference of traditional to exotic vegetables. The main reason given for this preference was taste which was reported by close to three quarters of the respondents. Nearly half of the respondents (46%) preferred traditional vegetables because of their favourable cooking characteristics. Slightly less than a quarter (24%) had knowledge on nutritional

Table 13: Consumption of Some Traditional Vegetables Among Study Households (percent)

	Lumbwa N=56		Kola N=36		Kalama N=74		Kalama division N=166	
Vegetable	Main meal	Side dish	Main meal	Side dish	Main meal	Side dish	Main meal	Side dish
Amaranthus spp	11.0	21.0	36.0	17.0	15.0	15.0	18.0	17.0
E. arabicum	0.0	9.0	14.0	14.0	9.0	7.0	7.0	9.0
C. maxima	61.0	39.0	44.0	44.0	42.0	41.0	49.0	41.0
V.unguiculata	20.0	43.0	14.0	39.0	51.0	74.0	31.0	57.0
S. nigrum	20.0	4.0	17.0	8.0	3.0	4.0	13.0	5.0
C. africana	0.0	0.0	8.0	3.0	0.0	0.0	2.0	1.0
I. batatas	0.0	0.0	0.0	3.0	0.0	0.0	0.0	1.0
C. gynandra	2.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
L. cornuta	0.0	0.0	3.0	0.0	0.0	0.0	1.0	0.0
M. esculenta	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0
C. dipsaceus	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0

Table 14: Differences between the Preference of Traditional and Exotic Vegetables

Vegetable	Lumbwa(%) N=68	Kola(%) N=44	Kalama(%) N=88	Kalama division (%) N=200
Traditional vegetable	50.0	64.0	84.0	68.0
Exotic vegetables	50.0	36.0	16.0	32.0

Table 15: Reasons for Preferring Traditional over Exotic Vegetables (Favourable Characteristics): Percent households mentioning

Characteristic	Lumbwa N=34	Kola N=28	Kalama N=74	Kalama division N=136
Taste	68.0	68.0	74.0	71.0
Cooking characteristics	47.0	61.0	39.0	46.0
Texture	24.0	26.0	22.0	25.0
Nutritional value	21.0	29.0	24.0	24.0
Medicinal value	15.0	14.0	8.0	11.0
Post harvest qualities	9.0	18.0	8.0	10.0
Colour	3.0	14.0	5.0	7.0
Cost	0.0	0.0	1.0	1.0
Odour	0.0	0.0	1.0	1.0

superiority of traditional over exotic vegetables. A quarter of the respondents (25%) reported that traditional vegetables were softer than exotic vegetables. Other reasons were colour, superior post harvest characteristics, medicinal value, favourable cost and odour.

When the respondents who preferred traditional to exotic vegetables were asked to rank the five most commonly consumed traditional vegetables in order of preference, *Amaranthus* spp, *Vigna unguiculata,* and *Cucurbita maxima* emerged as the highest ranking vegetables (Table 16).

The three vegetables were named among the five most preferred traditional vegetables by over 80% of the respondents. Over half of them (53.7%) ranked *V. unguiculata* as number one, compared to a third (34.6%) who best preferred *Amaranthus* spp. The other three vegetables were ranked number one by less than 10% of the respondents. Slightly less than a third of the respondents (about 30%) ranked both *Amaranthus* spp and *Cucurbita maxima* as number 2. *Amaranthus* spp, *V. unguiculata*, and *Cucurbita maxima* were given ranks 1, 2 and 3 by 91.2%, 83.9% and 69.2% respectively, thus making *Amaranthus* spp the most important traditional vegetable, followed by *V. unguiculata. Cucurbita maxima* is clearly the third most important traditional vegetable.

The same trend was evident when the same vegetables were weighted in order of preference (scores 5-1) as shown in Table 17. *Amaranthus* spp, *V. unguiculata*, and

Table 16: Ranking of Some Traditional Vegetables in order of preference

Rank	Traditional vegetables and proportion of households reporting them							
	Amaranthus spp		*Cucurbita maxima*		*Vigna unguiculata*		*Solanum nigrum*	
	N	%	N	%	N	%	N	%
1	47	34.6	12	8.8	73	53.7	3	2.2
2	42	30.9	41	30.2	16	11.8	22	16.2
3	35	25.7	41	30.2	25	18.4	17	12.5
4	7	5.1	20	14.7	6	4.4	38	27.9
5	0	0.0	6	4.4	3	2.2	2	1.5
Total	131	96.3	120	88.3	123	90.5	82	60.3

Table 17: Total and Mean Preference Scores of Selected Traditional Vegetables

Vegetable	Total Score	Mean Score
Amaranthus spp	383.9	2.82
Vigna unguiculata	381.9	2.81
Cucurbita maxima	289.2	2.13
Solanum nigrum	170.6	1.25
Erucastrum arabicum	61.2	0.45

Scores: 1=5; 2=4; 3=3; 4=2; 5=1

Cucurbita maxima appear in that order of preference with *Amaranthus* spp having the highest total and mean scores (383.9 and 2.82 respectively), followed closely by *V. unguiculata* (381.9 and 2.81 respectively). *C. maxima, S. nigrum* and *E. arabicum* had the third, fourth and fifth total and mean scores respectively.

4.9 Methods of Cooking

The common methods of preparation of traditional vegetables are given in Table 18. The most common method of cooking was mashing in a mixture with the staple food as *isyo* (a mixture of boiled maize and beans), which was reported in all the households interviewed.

When prepared as a side dish, the most common method in the division was boiling then stewing, which was practiced by slightly more than a third (35.5%) of the respondents. Stewing only and boiling, draining then stewing were both reported by nearly a third (30%) of the respondents. Boiling only was least practiced in the division, with only 1.5% of households reporting it.

However, popularity of the methods varied from location to location and from vegetable to vegetable. Stewing only was the most popular method of cooking in Kola location, where it was reported by nearly half of the respondents (47.8%), while in Kalama

Table 18: Methods of Cooking by Location: percent households reporting

Cooking method	Lumbwa (%) N=68	Kola (%) N=44	Kalama (%) N=88	Kalama Division (%)N=200
Mashing with *isyo*	100.0	100.0	100.0	100.0
Boiling then stewing	42.6	27.8	37.5	35.5
Stewing only	36.8	47.8	17.0	30.0
Boiling, draining then stewing	16.2	38.6	38.6	30.0
Boiling only	4.4	2.3	2.3	1.5

Table 19: Cooking Methods of Selected Traditional Vegetables

Vegetable	Percentage households cooking vegetable	Boiling only (%)	Stewing only (%)	Boiling then Stewing (%)	Boiling then Draining and Stewing (%)
Amaranthus spp	87.0	1.0	28.0	35.5	22.5
E. arabicum	12.5	0.0	5.5	2.5	4.5
C. maxima	69.5	1.5	22.5	27.5	18.1
V.unguiculata	79.5	2.0	19.5	32.5	25.5
S. nigrum	42.0	1.0	13.5	14.0	13.5

location, the most popularly used method of cooking traditional vegetables as a side dish was boiling, draining then stewing, which was practiced by over a third (38.6%) of the households in the location. However, in Lumbwa location, the most popular method was boiling and stewing (reported by 42.6% of the households). Draining of cooking water was most popular in Kola and Kalama locations compared to Lumbwa location.

As shown in Table 19, different cooking methods were used for different vegetables. Cooking by boiling only was rare, but was frequently accompanied by stewing or mashing with other ingredients.

V. unguiculata, and *Amaranthus* spp were boiled and then stewed by about one third of the households (32.5% and 35.5% respectively), but about one quarter also drained the cooking water when preparing them. Draining of cooking water was, however, more common when preparing *V. unguiculata.* For *S. nigrum,* almost equal proportions of respondents cooked by stewing only, boiling followed by stewing, with or without draining of cooking water. For all the vegetables listed, boiling followed by stewing was most practiced compared to the other methods, except for E. *arabicum* for which stewing only was more popular than all the other methods.

Addition of water during cooking ranged from 0-1000 millilitres (Table 20) per kilogram of vegetables cooked. The highest amounts were added in Kola location (202 ml on average), compared to Kalama and Lumbwa, where the average quantity added was 74 ml and 79 ml respectively. On average, 104 ml of water was added during preparation of traditional vegetables in Kalama division. Though households in Kalama location added the least amount of water during cooking, it also had the highest proportion reporting draining cooking water (38% of the households). Cooking time ranged between 5 minutes and 80 minutes (Table 20). On average, most households cooked their vegetables for more than half an hour, except in Kola location, where average cooking time was about 24 minutes. Cooking time was longest when vegetables were cooked in the main dish (*isyo*) and relatively shorter when prepared as a side dish.

4.10 Preservation of Traditional Vegetables

The preservation and consumption of preserved traditional vegetables in the study area is given in Table 21. A very small proportion of the study population (8.0% or 16 households) carried out some household preservation of traditional vegetables mainly by drying. The proportions ranged from 1.5 % in Lumbwa to 14.0% in Kola locations. However, within the division a slightly higher proportion of households (17.0%) reported that they would consume preserved traditional vegetables if they had access to them. This proportion was higher in Kalama (22%) and lowest in Lumbwa location (7.4%).

Table 20: Water Addition During and Length of Cooking by Percent Households

Location	Cooking time (minutes)			Water added (millilitres)		
	Minimum	Maximum	Mean	Min.	Max.	Mean
Lumbwa	5	77	33.9±16.2	0	350	88.0±78.9
Kola	5	80	24.3±14.3	0	1000	187.7±30.2
Kalama	5	70	31.2±17.3	0	1000	62.4±110.0
Kalama division	5	80	30.7±16.7	0	1000	100.0±171.1

Table 21: Percent Households Reporting Preserving and Consuming Preserved Traditional Vegetables

Location	N	Preserve traditional vegetables	Would consume preserved traditional vegetables if accessible
Lumbwa	68	1.5	7.4
Kola	44	14.0	20.0
Kalama	88	10.0	22.0
Kalama division	200	8.5	17.0

Table 22: Reasons for not Consuming Preserved Traditional Vegetables

Reason	Lumbwa (%) N=63	Kola (%) N=35	Kalama(%) N=69	Kalama division (%) N=167
Do not preserve any	73.0	85.7	72.5	75.4
Unavailability	3.2	2.9	5.8	4.2
Texture changes	3.2	5.7	4.3	4.2
Lack of knowledge on preservation technology	15.9	2.9	5.8	9.0
Odour changes	1.6	0.0	1.4	1.2
Taste changes	3.2	0.0	1.4	1.8
Inadequate amounts harvested	0.0	2.9	8.7	4.2

Sun-drying was the most popular preservation method and was practised by majority (87.5%) of those who preserved traditional leafy vegetables. The rest used shade-drying preservation method and was practised by majority (87.5%) of those who preserved traditional leafy vegetables. The rest used shade-drying parboiled then sun-dried the vegetables.

The respondents, when asked why they do not consume any preserved traditional vegetables, gave various reasons (Table 22). Over three quarters (76%) reported that they simply did not preserve any even though they had knowledge of preservation methods. About 10% had no knowledge on preservation technology, while 4% reported not producing any surplus for preservation. Lumbwa location, where preservation and consumption of preserved traditional vegetables was lowest (1.5% and 7.4% respectively), also recorded the highest proportion of respondents who reported lack of knowledge on preservation technology (15.9%). Other reasons cited were unavailability of preserved vegetables (4%), undesirable taste, odour and texture of cooked preserved vegetables (7%).

4.11 Nutrient Contents of Traditional Vegetables

Beta-carotene and ascorbic acid contents of raw and boiled vegetables and the vitamin retentions are shown in Table 23. Values for beta-carotene are calculated as micrograms (μg beta-carotene equivalents), while ascorbic acid contents are calculated as milligrams per 100g sample. For conversion of beta-carotene to retinol quivalents (RE) a conversion rate of 1RE=6 μg beta-carotene was used (West, 2000a).

Raw and cooked samples of *S. nigrum* had the highest levels of beta-carotene (6770 μg and 5471 μg per 100g respectively). Among the raw samples, *V. unguiculata* had the lowest beta-carotene content (5028 μg) while *C. maxima* had the lowest among cooked samples (2300 μg).

When beta-carotene content and retention of individual vegetables were compared, there was no significant difference between the beta-carotene content of the raw samples ($p=0.05$ Levene's test for Equality of variances) for all the vegetables. Similarly, there was no significant difference in beta-carotene content between cooked samples of *C. maxima* and *V. unguiculata*, *E. arabicum* and *S. nigrum*, *E. arabicum* and *Amaranthus* spp and *S. nigrum* and *Amaranthus* spp and *S. nigrum*. However, there were significant differences in beta-carotene content between all the other pairs of vegetables. Among the raw samples, *E. arabicum* had the highest levels of ascorbic acid (102 mg) while *V. unguiculata* and *S. nigrum* had the lowest and almost equal contents (78.3 mg and 78.7 mg respectively). Cooked *S. nigrum* had the highest ascorbic acid content (38.4 mg), while cooked *E. arabicum* had the lowest (15.5 mg). There was no significant difference in ascorbic acid contents of raw samples of the five vegetables. *C. maxima* and *V. unguiculata* and *E. arabicum* and *V. unguiculata*, had significantly different in beta-carotene contents ($p=0.05$). However, when cooked samples were compared, ascorbic acid contents were significantly different among all vegetables except between *C. maxima* and *E. arabicum*, *V unguiculata* and *E. arabicum* and between *Amaranthus* spp

Table 23: Nutrient Content of Some Raw and Cooked Traditional Vegetables[1,2]

Sample	Beta carotene (µg)- raw sample	Beta carotene (µg)-cooked sample	Beta carotene retention (%)	Ascorbic acid (mg)-raw sample	Ascorbic acid (mg)-cooked sample	Ascorbic acid retention (%)
C. maxima	6547±1024[a]	2300±609[a]	35.1[a]	95.3±19.5[a]	11.9±4.2[a]	12.5[a]
V. unguiculata	5028±2524[a]	2978±1159[a]	59.2[ab]	78.3 ±11.2[b]	19.4 ±5.1[b]	24.7[b]
E. arabicum	6520±1013[a]	4100±49[b]	63.0[b]	102.3±23.9[a]	15.5±2.3[ab]	15.1[ab]
S. nigrum	6770±1889[a]	5471±1365[c]	81.0[b]	78.7 ±18.0[ab]	38.4 ±10.6[c]	48.8[c]
Amaranthus spp	6432±558[a]	4770.75±13.7[bc]	74.0[b]	85.0 ±25.1[ab]	31.4±13.7[c]	36.9[c]

[1] means± standard deviation based on two observations; data for the three locations was combined and calculated for raw samples and cooked samples, each per 100g

[2] means within a column with different superscripts are significantly different using Levene's test for Equality of variance (p=0.05) (p=0.05) ANOVA

and *S. nigrum*, for which ascorbic acid contents were not significantly different.

For all the vegetables, beta-carotene and ascorbic acid content decreased upon cooking. Beta-carotene retention was highest in *S. nigrum* (81.0%), and lowest in *C. maxima* (35.1%). Retaining nearly three quarters of its beta-carotene (74.2%), *Amaranthus* spp had a better retention than both *E. arabicum* (62.9%) and *V. unguiculata* (59.23%). All vegetables retained more than half of the beta-carotene originally present in the raw leaf except *C. maxima*, which retained about a third (35.1%) of its beta-carotene. There was a significant difference (p=0.05) in the beta-carotene retention between different vegetables except between *C. maxima* and *E.arabicum*, *V. unguiculata* and *E. arabicum*, and *Amaranthus* spp and *S. nigrum*, which showed significant differences in beta-carotene retention.

All the five vegetables studied retained less than 50% of their ascorbic acid after cooking. Though it retained less than half its original amount of ascorbic acid present in the raw leaves, *S. nigrum* had the highest retention rate (48.8%), while *C. maxima* had the lowest retention rate (12.5%) for ascorbic acid. With a rate of 36.9%, *Amaranthus* spp had a better ascorbic acid retention than both *V. unguiculata* and *E. arabicum*. The differences in ascorbic acid retention were significant (0.05) for among all vegetables except between *C. maxima* and *E. arabicum*, *V. unguiculata* and *E. arabicum* and *Amaranthus* spp and *S. nigrum*.

4.12 Contribution of Traditional Vegetables to Recommended Dietary Intakes of Vitamins A And C, and Iron.

Table 24 shows the distribution of households by the percent contribution of traditional leafy vegetables to Recommended Dietary Intakes of vitamins A and C, and iron as well as the mean intake of each of the three nutrients. The RDI for an adult male (20-29 years) were taken as 1000RE for beta carotene, 60mg for vitamin C and 12mg for iron (FAO/WHO, 1988; Cataldo *et al.* 1998) each of which represents one consumer unit.

The vitamin A and C contents used for the calculations were obtained laboratory analysis of the cooked vegetables. In total, five most commonly consumed vegetables were analysed. However, vegetables were not analysed for iron for lack of sufficient laboratory samples, and therefore the contribution to RDI was calculated on the basis of cooked vegetable data from food composition tables (Sehmi, 1993; Maundu *et al.*, 1999; WHO, 1987). The contribution of the traditional vegetables to Vitamin A intake was low with nearly 60% of the study population receiving less than 50% of their RDI from the vegetables. For Vitamin C and iron, the contribution to RDI of the same proportion of the population was 53.1% and 43.8% respectively. Slightly more than a third (37.4%) of the population received more than 100% of the RDI of vitamin A from traditional vegetables while for vitamin C and iron the proportions were 43.8% and 46.8% respectively.

While mean intake for vitamin A was slightly less than the RDI, for vitamin C and iron, the average intake from traditional vegetables was higher than the RDI.

Table 24: Distribution of Households by Percent Contribution of Traditional Vegetables to Recommended Dietary Intakes of the Nutrients*

RDI	Vitamin A 1000RE/cu/day	Vitamin C 60mg/cu/day	Iron 12mg/cu/day
Mean intake	943±1163.1	68.8±81.4	16.2±18.2
0 - 25.0%	46.9	40.6	37.5
25.1 - 50.0%	9.4	12.5	6.3
50.1 - 75.0%	0.0	3.1	3.1
75.1 – 100%	6.3	0.0	6.3
>100%	37.4	43.8	46.8

*Based on analyses of five representative and the most commonly consumed vegetables.

CHAPTER FIVE: DISCUSSION

5.1 Socio-Demography

The average household size of 4.9 established in this study is comparable to the average for Eastern province (4.8), but higher than the national average of 4.3 (GoK, 1999; GoK, 2001). The proportion of respondents in Kalama division under15 years of age was 42.6%, a figure slightly lower than the national one of 45.7%. The dependency ratio of 88 was lower than that of 98 reported in the 1998 Demographic and Health Survey. However, this dependency ratio is consistent with the reports of the trend in Kenya which have shown that the dependency ratio has been declining (GoK, 1999).

The proportion of female-headed households (22%) was lower than the national figure of 34.4% for rural households and 35.1% for Eastern Province (GoK, 1999). This may be due to the fact that in most cases, separated or divorced women lived with their parents, and were then not categorized as heads of households.

Majority of the household heads in the division were farmers, a scenario consistent with rural populations. In Lumbwa location, majority of household heads had beyond primary education and a higher proportion were employed compared to the other two locations. A contributing factor to the higher levels of cash employment in Lumbwa location could be the employment opportunities offered by the nearby Konza Cooperative Ranching Society. Lumbwa location also had a lower proportion of household heads who were farmers, than the other two locations, possibly because due to small land sizes, more household heads are forced to seek employment elsewhere.

5.2 Production and Consumption of Traditional Vegetables

This study established that a wide variety of traditional vegetables grow and are consumed in Kalama division. Up to 17 different species were identified at the time of study. These included the cultivated varieties identified as *Vigna unguiculata*, *Ipomea batatas*, *Manihot esculenta* and *Cucurbita maxima*, semi cultivated species identified as *Amaranthus* spp, *Solanum nigrum, Erucastrum arabicum,* and *Cleome gynandra*. The rest were species collected from the wild and included *Commelina africana*, *Launaea cornuta*, *Commelina benghalensis*, *Cucumis dipsaceus* and *Corchorus* olitorius. The wide availability of traditional vegetables has also been reported in other divisions of Machakos district (Mwanjumwa *et al.*, 1991; Maundu *et al.,* 1999). The same researchers, as did this study, also established that the main source of traditional leafy vegetables is the home garden, and hardly any are purchased for consumption.

The strong presence of exotic vegetables in Lumbwa location all year round (from irrigation taking place along the Lumbwa river) may explain the low preference of traditional vegetables over their exotic counterparts. The reported small land sizes in Lumbwa location may imply that all land was cultivated for the conventional crops and therefore there were hardly any bushland or abandoned fields to collect traditional vegetables from as weeds. The higher levels of education, employment and possibly income could also lead to purchase of the conveniently available exotic vegetables other than spend time collecting traditional vegetables.

The traditional vegetables in this region were grown almost predominantly for home consumption, with a few persons selling the surplus of the cultivated species, mainly *V. unguiculata*. Being purely subsistence farmers, it is possible that the farmers do not produce any vegetables on commercial basis. It is also possible that during the wet season, most households have access to the traditional vegetables from their farms as weeds or as plants grown for other purposes, or from the wild and may not need to purchase them from the markets, which precipitates low market demand. *V. unguiculata* was found to be the vegetable that was most commonly sold in the local markets.

In Kalama division, more of the cultivated species of vegetables were consumed than the wild species, even when both species were equally available. Other researchers have also reported this scenario (Mwanjumwa, 1991; Chweya, 1997b). This suggests preferential selection for domestication. It is also possible that picking vegetables which are grown in an organised form (as is the case for cultivated species) maybe less time consuming and tedious than gathering those growing randomly in the farm (semi-cultivated) or in the wild. In regard to semi cultivated or wild vegetables, the study results suggest that people tend to consume those that are available irrespective of preferences. Even though *S. nigrum* was ranked higher than *E. arabicum*, more households had consumed the latter because it was more widely available in the farms than the former during the time of survey. Similarly, *Amaranthus* spp was ranked highest in preference, but had only been consumed by about 28% of the respondents in the previous one week because of unavailability at the time, compared to *C. maxima*, whose rating was lower but had been consumed by over 60% of the respondents.

That consumption of cultivated traditional vegetables was higher than that of wild or semi-cultivated species is an indication that non-domestication of the latter is a constraint to the consumption of traditional vegetables, a scenario reported by other researchers (Mwanjumwa *et al.*, 1991; Grubben *et al.*, 1997; Maundu *et al.*, 1999). If more traditional vegetables were domesticated, people would consume more varieties and in larger quantities. It is therefore recommended that work on domestication of more of the wild species be intensified to improve consumption of traditional leafy vegetables.

Leaves of *M. esculenta* and *I. batatas,* which were named as crops by most households, were hardly harvested as vegetables as the crops grew. They were therefore not cultivated as vegetables. It is notable that the Average Nutritive Value (ANV) of cassava is 16.67 (Mnzava, 1997). When compared to ANV of white cabbage (3.52), it is evident that a very nutritious vegetable is being excluded from the diets of households in Kalama division. Even *Amaranthus* spp, which is evidently very popular in the study area, is lower in ANV than cassava leaves (11.32). The implication here is that domestication should be accompanied by nutrition education on the nutritional quality and specific preparation methods of different vegetables.

The wide and ready availability of traditional vegetables is a positive situation because they compliment the staple of maize and beans both in micronutrients as well as proteins. They also add variety and improve taste as reported by a majority of the respondents.

Micronutrient deficiencies in Kalama division are likely to be low during the wet season and high during the dry period or drought because traditional vegetables were predominantly rain fed. Kusin *et al.* (1985), while studying the vitamin A status of pregnant and lactating women in Machakos district, observed that serum vitamin A values showed a seasonal pattern, reaching a peak in April-June. This is the period when traditional vegetables are widely available. It is noted that only kales and tomatoes were irrigated on a small scale and most likely only for sale. These are likely to be beyond the reach of many households, especially during the dry period when prices are peak high.

5.3 Household Preservation and Consumption of Preserved Traditional Vegetables

Although majority of the respondents have some knowledge on preservation technology for vegetables, they do not preserve any. The observation that only a few households practiced preservation and those that did dried directly in the sun and the low availability of vegetables during the dry period would automatically lead to a high prevalence of micronutrient deficiencies. Solar drying has been found to cause micronutrient losses of upto 99% for both vitamins A and C (Gomez, 1981; Mosha, 1995; Mziray *et al.,* 2000). The fact that a higher proportion of households reported that they would consume preserved traditional vegetables if they had access than were actually carrying out preservation, implies that both preservation and consumption of preserved traditional vegetables would be higher if household preservation was promoted.

Households in Lumbwa location hardly preserved or consumed preserved traditional vegetables, possibly because they have access to exotic vegetables even during the dry season.

Since both cultivated and wild species of traditional vegetables are widely available during the wet season, most households are likely to have surplus supplies during that season, especially because the market for the vegetables is limited. Preservation of the surplus vegetables would avoid the waste that comes with the wet season, ensure continuity in consumption during the dry season, ensure adequate micronutrient intake throughout the year and possibly open up markets for the dried vegetables during the dry season as is the case elsewhere in Africa (Ngwerume, 1997). Both sun drying and shade drying require cheap technology and are sustainable methods of ensuring both food and nutritional security during the dry period when food in general and vegetables in particular, are scarce.

5.4 Nutrient Contents of Traditional Vegetables

Values of ascorbic acid content of raw samples of the vegetables were comparable to those reported by other researchers. Sebit (1994) reported higher ascorbic acid concentrations of 160.7 mg and 100.7mg per 100g edible portion for *V. unguiculata* and

Amaranthus spp respectively, but a lower value of 44.1mg for *S. nigrum*. For raw *V. unguiculata*, Imungi and Potter (1983) reported a higher ascorbic acid content of 410mg, 78mg was reported by Mwanjumwa *et al.* (1991), Maundu *et al.* (1990) reported a range of 35-87mg. Mosha (1995) reported a lower value of 64.94mg. For *Amaranthus* spp, ascorbic acid concentrations of 89.0mg, 100.7mg and 90-131mg were reported by Mosha (1995), Sebit (1994) and Mwanjumwa *et al.* (1991) respectively. Food composition tables by Maundu *et al.* (1999) and Sehmi (1993) give ranges of 64-127.27mg and 50.0mg respectively for *Amaranthus* spp. For *C. maxima*, Mosha (1995) reported lower ascorbic acid content of 49.17mg, and Sehmi (1993) 80mg while Mwanjumwa *et al.*(1991) reported a higher value of 128mg than that reported in this study. For *S. nigrum*, ascorbic acid content reported by other researchers ranged from 44mg by Sebit (1994) to 144mg by Mwanjumwa *et al.* (1991). Differences in vitamin C content obtained in this study and by other researchers could be due to factors such as stage of maturity of plant, part and type of plant, conditions of growing, harvesting, transporting and storage conditions (Guthrie and Picciano, 1995).

The levels of beta-carotene in raw leaf obtained in this study compare well with those reported by other researchers. Sebit (1994) reported higher values of 80300µg beta-carotene per 100g edible portion for *Amaranthus* spp and 25000µg for *Solanum nigrum*. Mosha (1995) reported beta-carotene levels of 1165.06µg for *C. maxima*, 1677.67µg for *Vigna* spp and 2524.01µg for *Amaranthus* spp, all of which are lower than those obtained in this study. Values reported by Mwanjumwa *et al.* (1991) for *Amaranthus* spp (7000-

7945μg), *S. nigrum* (10000μg), *Vigna* spp (6742μg) and for *C. maxima* (9897μg) were also higher than those reported in this study.

The differences in nutrient content may be attributed to different levels of accumulation of nutrients in plant food products, which depends on agronomic factors such as soil types, type of fertilizers and pesticides used and the stage of maturity at harvest. These factors have been shown to affect concentrations of betacarotene in plant tissues (Rodriguez-Amaya and Marcadante, 1991).

During cooking, there was significant loss ($p=0.05$) in both beta-carotene and ascorbic acid. Similar losses in ascorbic acid have been reported by Imungi *et al.* (1985) for *V. unguiculata*, Mosha (1995) and Imungi and Mathooko (1994) for the same vegetables as well as for some other tropical leafy vegetables. Losses in beta-carotene after cooking of traditional vegetables have also been reported by Mosha (1995).

Ascorbic acid losses during cooking maybe attributed to leaching into the cooking water, heat and oxidative degradation (Guthrie and Picciano, 1995; Passmore and Eastwood, 1986; King and Burgess, 1993). The variations in ascorbic acid content upon cooking of different traditional vegetables clearly indicates that the rate of washing out of the solubles from the vegetables varies from species to species. It is also possible that the access of oxygen to such easily oxidizable nutrients like ascorbic acid differs accordingly.

There was significant loss in beta-carotene after cooking, with the vitamin retention ranging from 35.13% to 80.8%. Similar results have been reported by other researchers. Mosha (1995) reported beta-carotene retention of 83.6% in *Amaranthus* spp. Gomez (1981) also reported a significant loss in beta-carotene content after cooking Kenyan green leafy vegetables. The loss in beta-carotene maybe due to oxidation and conversion from active all-trans isomers to less active cis-forms, which reduces the vitamin A value of the cooked vegetables (Speek, *et al*., 1988; Ruel, 2001).

Because the traditional vegetables were hardly cooked in isolation, it is expected that high losses in micronutrients during cooking of some vegetables would be complemented by low losses in others, thus ensuring a relatively high intake of the micronutrients in the meal.

It is evident that vitamins A and C contents of the Traditional Leafy Vegetables (TLVs) are substantially reduced during cooking. Calculation of dietary intakes should take cognisance of this fact and that considerably larger amounts of cooked vegetables would have to be consumed in order to satisfy the Recommended Daily Intakes (RDI), the low bioavailability especially of vitamin A from vegetables not withstanding. Other measures to increase the contibutiom of vegetables to the intake of micronutrients would be to reduce the time lag between cutting and cooking, reduce the overall cooking time and consumption of the vegetables as soon as they are cooked to minimize further nutrient losses.

5.5 Preparation of Traditional Vegetables for Consumption

The cooking methods identified in this study are consistent with known traditional household methods (Imungi and Potter, 1983; Imungi and Mathooko, 1994). The most popular method of cooking (boiling followed by stewing) involved using just sufficient water for boiling so that no water was discarded. Consequently, some nutrients that would be lost through leaching into the cooking water were spared (Imungi and Potter, 1983). The boiling time of upto 80 minutes could result in large losses of nutrients such as vitamin C, which are susceptible to heat and oxidative degradation, especially if the pot remained uncovered during cooking (Passmore and Eastwood, 1986; Ruel, 2001). All households interviewed, however, reported covering the pot during cooking. Discarding of cooking water after boiling vegetables and before stewing (reported by a quarter of the households), led to further nutrient losses.

5.6 Food Consumption

The main staple food of the study population is maize, which is either ground into flour and used to make *ugali* or porridge, or decorticated and cooked in mixtures with beans or peas and maybe some green leafy vegetables to make *isyo* or *muthokoi*. This finding is in agreement with reports from other studies in Machakos district (van Steenbergen *et al.*, 1984; Mwanjumwa *et al.*, 1991).

The study established that consumption of oils and fats was moderate. Since the absorption of beta-carotene from the diet is very variable and depends on, among other factors, the quantity and quality of the dietary fat (Passmore and Eastwood., 1986), it is expected that presence of fats and oils in the diet of the study population would improve absorption of beta-carotene from the traditional vegetables, especially because oils and fats were frequently used for stewing the vegetables during their preparation. Tea, a known inhibitor of iron absorption, was consumed predominantly at breakfast, a time when no vegetables were consumed, thus effectively excluding its inhibitory effect on iron intake from the diet.

The consumption of animal products reported in this study is similar to findings of other studies in Kenyan rural communities (van Steenbergen, 1984; Mokua, 2001; Sehmi 1993). The low intake of protein, especially animal proteins, is expected to lower the serum levels of retinol-binding-protein, thus interfering with retinol transport in the body (Guthrie and Picciano, 1995). This, combined with the long periods of cooking of the vegetables, is likely to negatively affect the vitamin A status of the study population. In the past, establishment of small animal husbandry projects has been promoted alongside that of kitchen gardens for vegetable production. This joint promotion may be a sustainable option to improve and maintain the vitamin A status of the population in Kalama location by improving intake of animal proteins and vegetable consumption throughout the year.

Nearly 50% of the population received more than 100% of the RDI for iron. It is, however, important to note that bioavailability of iron in the diets is affected by other aspects of the diet. For example, Vitamin C is known to enhance absorption (Geddes and Grosset, 1996; Hahn and Payne, 1999; Sharma, 2003). It is expected that the predominant source of the vitamin in the diet was traditional vegetables, because consumption of fruits is usually low. Its enhancing effect in the absorption of iron would therefore not be optimum. Other factors of the diet such as presence of tannins, phytates, iron binding phenolic compounds, calcium and soy proteins are known to inhibit absorption (Sharma, 2003). Moreover, Imungi and Potter (1983) reported iron availability of 10% for cowpea leaves, one of the vegetables used in the study. In some cases, bioavailability of iron from plant based diets maybe as low as 2.57% (Chunming, 2003). It is therefore possible that even in the context of high iron intakes from the vegetables, iron deficiency could be elicited in the community on account of the low bioavailability. However, the use of iron cooking pots has been reported to increase bioavailability of iron from vegetables (Rule, 2001) as well as the inclusion of cooking water in the diet (Guthrie and Picciano, 1995).

CHAPTER SIX: CONCLUSIONS

A diversity of traditional vegetables are consumed in Kalama division during the wet season and the subsequent period, with the main source being the family garden. The most popularly consumed vegetables include *Amaranthus* spp, *Vigna unguiculata, Cucubirta maxima, Solanum nigrum* and *Erucastrum arabicum.* Consumption is, however, based on the availability rather than preference.

For consumption, the vegetables are either cooked and mashed in a mixture with ingredients for a local dish, *isyo*, or boiled then stewed to make a side dish for *ugali.* Often, during preparation of the side dish, the boiling water is discarded. The cooking time varies between 5-80 minutes.

Very little preservation of traditional vegetables is practiced in Kalama division because preservation technologies are unknown.

Traditional vegetables' contribution to dietary intakes of vitamins A and C, and iron is high for majority of the population.

CHAPTER SEVEN: RECOMMENDATIONS

1. Methods of availing the vegetables during the drought periods should be promoted. Such methods would include expanded production through irrigation and or preservation.

2. Domestication of the popular wild species of traditional vegetables should be promoted.

3. Vitamin A status of the population during the dry period and the wet periods should be determined, to establish the effect of the variability of the vegetable availability.

4. A study should be conducted to establish the patterns of consumption during the dry season.

REFERENCES

ACC/SCN (2001). What Works? A Review of the Efficacy and Effectiveness of Nutrition Interventions. Allen. L.H. and Gillespie. S. R. ACC/SCN Nutrition Policy Paper No. 19. Geneva in Collaboration with the Asian Development Bank. Manila.

Anzaya, M. (1987). Seasonal Variations in Consumption of Selected Indigenous Vegetables in Five Households in Machakos District. Msc Thesis. Kenyatta University.

AOAC, (1984). Official methods of analysis. Association of official Analytical Chemists. Washington D.C.

Barakat, M.Z., El-Wahab M.F.A. and El-Sadir M.M. (1955). Action of n-bromosiccinimide on Ascorbic acid. New Titrimetric Method for Estimation of Vitamin C. Anal. Chem. Vol. 27 pg 536-540.

Basu, T. K. and Dickerson, J. W. (1996). Vitamins in Human Health and Disease. Cab International. Wallingford.

Buyckx, M. (1993). The International Community's Commitment to Combating Micronutrient Deficiencies. Food. Nutrition and Agriculture 7:2. Food and Agriculture Organization. Rome.

Cataldo, C.B., Rolfes, S. R. and Whitney, E. N. (1998). Understanding Clinical Nutrition. Second Edition. West/Wadsworth. New York. Bonn. Boston.

Chadha, M. L. and Oluoch, M. O. (2003). Home-Based Vegetable Gardens and other Strategies to Overcome Micronutrient Malnutrition in Developing Countries. In Food Nutrition and Agriculture 32: 17-21. Food and Agriculture Organisation. Rome.

Chunming, C. (2003). Iron Fortification of Soy Sauce in China. In Food Nutrition and Agriculture 32: 76-82. Food and Agriculture Organisation. Rome.

Chweya, J. A. (1985). Identification and Nutritional Importance of Indigenous Green Leafy Vegetables in Kenya. Acta. Hort 153: 99-108.

--------------------- (1997a). Genetic Enhancement of Indigenous Vegetables in Kenya in Traditional African Vegetables (Workshop Proceedings). Edit. Guarino L. IPGRI. Rome and Gatersleben.

---------------------------- (1997b). Domestication Strategy for Underutilized African Vegetables. In African Indigenous Vegetables. Workshop Proceedings. International Plant Genetic Resources Institute and Natural Resources Institute. Nairobi and Kent.

Combs, G. F. (1998). The Vitamins, Fundamental Aspects in Nutrition and Health. 2nd Edition. Academic Press. San Diego. New York, Boston, London, Sydney, Tokyo, Toronto.

De Pee, S. (1996). Food Based Approaches for Controlling Vitamin A Deficiency: Studies in Breastfeeding Women in Indonesia. Ph.D Thesis. Wageningen Agricultural Universität. Wageningen.

Dijkhuizen, R. S., Jansen, A. A. J., Kiaraho, D. and Poulter, N. (1981). The Nutritional Status of Rural Akamba Children at Muumandu, Machakos District. Report to the National Freedom from Hunger Council. Nairobi.

FANTA (2001). HIV/AIDS: A Guide For Nutrition Care and Support. Food and Nutrition Technical Assistance. Washington DC.

FAO (1981). Amino Acid Content of Food: by Food Policy & Food Science Service, Nutrition Division Food and Agriculture Organization. Rome 1981 pp150-151.

FAO (1984). Food & Nutrition Policies and Programmes: Issues & Experiences. Proceedings of the Fifth Food and Nutrition Planning Workshop. Food and Agriculture Organization. Rome.

FAO (1985). Expert Consultation on Broadening the Food Base with Traditional Food Plants Food and Agriculture Organization. Report of the Expert Consultation held in Harare, Zimbabwe. Food and Agriculture Organization. Rome.

FAO (1992). Nutrition Development: A global Challenge. Food, Nutrition and Agriculture. Report and Declarations of the International Conference on Nutrition 5/6:12-26 Food and Agriculture Organization. Rome.

FAO (1999). Global Newsletter on Under-Utilized Crops. Food and Agriculture Organization. Rome.

FAO/WHO (1988). Requirement of Vitamin A, Iron, Folate and Vitamin B12. Food and Agriculture Organization. Rome

FAO/WHO (2002). Human Vitamin and Mineral Requirements. Report of a Joint FAO/WHO Expert Consultation. Food and Agriculture Organization. Rome

Fisher, A. A., Laing, J. E., Stoeckel, J.E. and Townsend, J. W. (1991). Handbook for Family Planning Operations Research and Design. Operations Research, Population Council. New York.

Geddes and Grosset (1996). Vitamins and Minerals. Children's Leisure Products Limited. New Lanark.

Gibson, R. S. (1990). Principles of Nutritional Assessment. Oxford University Press Inc. New York/ and Oxford.

GoK/UNICEF (1994). Vitamin A deficiency in Kenya: A report of the National Micronutrient Survey. Nairobi.

GoK (1999). Demographic and Health Survey. Government of Kenya. Nairobi.

GoK (2001). The 1999 Population and Housing Census Vol. 2. Government of Kenya. Nairobi.

GoK (2002). Machakos District Development plan (2002-2008). Government of Kenya. Government Printer. Nairobi.

Gomez, M. I. (1981). Carotene Content of Some Green Leafy Vegetables of Kenya and Effects of Dehydration and Storage on Carotene Retention. Journal of Plant Foods, 3:231-234.

Gomez, M.I. (1982). Sources of Vitamin C in the Kenyan Diet and their Stability to Cooking and Processing. Ecology of Food and Nutrition 12:179-184.

Goode, P. M. (1989). Edible plants of Uganda: The Value of Wild and Cultivated Plants as Food. Food and Agriculture Organization. Rome.

Grubben, G. and Almekinders, C. (1997). Developing the Potential of Local Vegetables using the Experiences from Africa and South-East Asia. In African Indigenous Vegetables. Workshop Proceedings. International Plant Genetic Resources Institute and Natural Resources Institute. Nairobi and Kent.

Guthrie, H. A and Picciano, M. F. (1995). Introductory Nutrition. Times mirror/Mosbey College Publishers. St Louis, Toronto, Boston, Los Angeles.

Hahn, D. B. and Payne, W. A. (1999). Focus on health. WCB McGraw-Hill. New York, Boston, Bangkok, Milan.

ILSI/FAO (1997). Preventing Micronutrient Malnutrition: A Guide to Food Based Approaches. A Manual for Policy Makers and Programme Planners. Food and Agriculture Organization. Rome and Washington.

Immink, M. D. C and Alarcon, J. A. (1992). Household Food Security and Crop Diversification among Smallholder Farmers in Guatemala. Food Nutrition & Agriculture Vol. 2. Food and Agriculture Organization. Rome.

Imungi, J. K. (1996). Changes in Vitamin and Mineral Contents during Preparation and Processing of Kenyan Traditional Green Leafy Vegetables- A Review. Journal of Food Technology in Africa 1(1):17-19.

Imungi, J. K. and Mathooko, F. M. (1994). Ascorbic Acid Changes in Three Indigenous Kenyan Vegetables During Traditional Cooking. Ecology of Food and Nutrition 32:239-245.

Imungi, J. K. and Potter, N. N. (1983). Nutrient Contents of Raw and Cooked Cowpea Leaves. J. Food Sci. 48:1252-1254.

Imungi, J. K. and Potter N. N. (1985). Nutritional and Sensory Properties of Canned and Stored Cowpea Leaves. Nutrition Reports International 31:21-34.

IPGRI/NRI (1997). Market Surveys in Nigeria and Kenya. In African Indigenous Vegetables. Workshop Proceedings Pp149-154. International Plant Genetic Resources Institute and Natural Resources Institute. Nairobi and Kent.

IPGRI (2001). Newsletter for Sub-Saharan Africa No. 16, Dec 2001. IPGRI. Nairobi, Kenya.

Kennedy, G., Nantel, G. and Shetty, P. (2003). The Scorge of 'Hidden Hunger': Global Dimensions of Micronutrient Deficiencies. In Food, Nutrition and Agriculture 32:8-14. Rome.

Kigutha, H. N. (1994). Household Food Security and Nutritional Status of Vulnerable Groups in Kenya PhD Thesis, Wageningen Univesität. Netherlands.

Kigutha, H. N. (1995). Effects of Season on Household Food Security and the Nutritional Status of Smallholder Rural Households in Nakuru District, Kenya. Foods and Nutrition Studies Programme. Nairobi/Leiden.

King, S. F. and Burgess, A. (1993). Nutrition for Developing Countries; Second Edition. Oxford University Press. Oxford.

Kipkurui, C. M. (1998). Contribution of Fruits and Vegetables to Dietary Intakes of Vitamins A and C, and Iron in Children 3-5 Years Old, Bomet District, Kenya. Msc. Thesis, University of Nairobi. Kenya.

Kogi-Makau, W. (1995). Production, Consumption and Preservation of Indigenous Vegetables in Mungushi Village, Hai District, Tanzania. Report to Network Vegetable Production Africa (NEVEPA). Hai District, Tanzania.

Kusin, J. A., Van Rens, M. M., Lakhani, S. and Jansen, A. A. J. (1985). Vitamin A Status of Pregnant and Lactating Women as Assessed by Serum Levels in Machakos area. E.A. Med. Journal 62:476-479.

Latham, M. C. (1976). Human Nutrition in Tropical Africa. Food and Agriculture Organization. Rome.

Lieshout, M. (2001). Bioavailability and bioefficacy of beta-carotene measured using ^{13}C-labelled beta-carotene and retinal: studies in Indonesian children. PhD Thesis. Wageningen Universität. Wageningen.

Marsh, R. (1998). Building on Traditional Gardening to Improve Household Food Security. Food. Nutrition & Agriculture 22:4-14. Food and Agriculture Organization. Rome.

Maundu, P. M. (1997). The status of traditional vegetable utilization in Kenya, in Traditional African vegetables: Proceedings of the IPGRI International workshop on genetic resources of traditional vegetables in Africa: conservation and use 29-31 August 1995. ICRAF-HQ Nairobi. Kenya. International Plant Genetic Resources Institute. Nairobi.

Maundu, P. M., Ngugi, W., and Kabuye, H. S. (1999). Traditional Food Plants of Kenya. National Museums of Kenya. Nairobi.

Mnzava, N. A. (1997). Comparing Nutritional Values of Exotic and Indigenous Vegetables. In African Indigenous Vegetables. Workshop Proceedings. Ed. Schippers, R. and Budd, L. pp70-75. International Plant Genetic Resources Institute and Natural Resources Institute. Nairobi/Kent.

Mosha, E. T. C. (1995). Assessment of provitamin A status in selected green Vegetables consumed in Tanzania. MSc. Thesis. Tuskegee University. Alabama.

Munro, B. H. and Page, E. B., (1993). Selected nonparametric techniques. In Statistical Methods for Health Care Research (2nd edition). J.B. Lippincott Company. Philadelphia.

Mwanjumwa, L.B., Kahangi, E.M. and Imungi, J.K. (1991). The prevalence and Nutritional Value of Some Kenyan Indigenous Leafy Vegetables from Three locations of Machakos District. Ec. of Food and Nutrition 26: 275-280.

Mwaniki, D. L., Omwega, A. M., Muniu, E. M., Mutunga J. N., Akelola, R., Shako, B. R., Gotink, M. H. and Pertet, A. M. (1999). Anaemia and Status of Iron, Vitamin A & Zinc in Kenya. 1999 National Survey Report. GoK and UNICEF. Nairobi.

Mziray, R. S., Imungi, J.K. and Karuri, E. G. (2000). Changes in Ascorbic Acid, Beta-carotene and Sensory Properties in Sundried and Stored *Amaranthus hybridus* Vegetables. Ecology of Food and Nutrition 39: 459-469.

Ngwerume, F. C. (1997). Traditional vegetables as a strategic food reserve during periods of food scarcity in southern Africa. In African Indigenous Vegetables. Workshop Proceedings. Ed. Schippers, R. and Budd, L. pp70-75. International Plant Genetic Resources Institute and Natural Resources Institute. Nairobi/Kent.

Omuga, S. and Opole, M. (1997). A Literature Survey Report on Food Habits and Agricultural Practices among the Luo, Luhya and Mijikenda Communities of Kenya. A Report. Centre for Indigenous Knowledge Systems and by-Products. Nairobi.

Onyango, M. O. A. (1996). Nutritive Value of Some Indigenous Vegetables of Kenya: A paper presented at United Millers Award. Maseno University College.

Oomen, H. A. P. C. and Grubben, G. J. H. (1977). Tropical Leaf Vegetables in Human Nutrition. Koninklijk Institüt voor Tropen. Amsterdam.

Opole, M., Chweya, J. A. and Imungi, J. K. (1995). Indigenous Knowledge, Agronomy and Nutritive Value of some Kenyan Indigenous Vegetables, Community and Laboratory

Experiences. A Report. Centre for Indigenous Knowledge Systems and by-Products. Nairobi.

Opole, M. and Maina, M. (2001). Marketing of Indigenous Foods in some markets of Nairobi Kenya. Centre forlindeginous Knowledge Systems And by-Products. Survey Report. Nairobi.

Oslon, J. A. (1989). Biological action of carotenoids J. Nutrition 119: 105-108.

Oslon, J. A. (1996). Article on Vitamin A. In Present Knowledge in Nutrition, 7th edition, Ed. Ziegler E. E and L.J. Filer Jr. pp 113. ILSI Press, Washington DC.

Passmore, R. and Eastwood, M. A. (1986). Human Nutrition and Dietetics. 8th edition. Longman Group UK Ltd. Edinburgh.

Rahmathullah, L., Underwood, B. A., Thulasiraj, R. D., Milton, R. C., Ramaswamy, K., Rahmathullah, R. and Babu. G. (1990). Reduced Mortality among Children in Southern India Receiving a Small Weekly Dose of Vitamin A. N. England Journal of Medicine 323:929-935.

Rodriguez-Amaya, D. B. and Marcadante, A. Z. (1991). Carotenoid Composition of a Leafy Vegetable in Relation to Some Agricultural Variables. J. Agric. Food Chem, 39:1094-1097.

Ruel, M. T. (2001). Can Food-Based Strategies Help Reduce Vitamin A and Iron Deficiencies? A Review Of Recent Evidence. International Food Policy Research Institute (IFPRI). Washington D.C.

Scherer, F. (1969). The development of smallholder Vegetable Production in Kigezi, Uganda. Institüt für Wirtsschaft Forshung. Münich.

Sebit, M. F. (1994). The Potential Role Of Traditional Food Plants In Improving Nutrition And Broadening The Food Base In Uganda. MSc. Thesis. University of Nairobi.

Sehmi, J. K. (1993). National Food Composition Tables and the Planning of Satisfactory Diets in Kenya. Government Printer. Nairobi.

Shack, W. K., Grivetti, L. E. and Dewey, K. G. (1990). Effects of Settlement on the Dietary Intake of Mothers and Children in Lowland Papua New Guinea. Ec. Food Nutrition 24(1): 37-54.

Sharma, K. K. (2003). Improving bioavailability of iron in Indian Diets through Food-based Approaches for Control of Iron Deficiency Anaemia. In Food, Nutrition and Agriculture 32:51-59. Food and Agriculture Organization. Rome.

Shrestha, D. and Hussain, M. A. (1993). Building Nepal's Capacity to Create Nutritional Awareness Through Multisectoral Training. Food Nutrition and Agriculture 7:34-40. Rome.

Speek, A. J., Speek-Saichua, S. and Schreurs, W. H. P. Total Carotenoid and Beta-carotene Contents of Thai Vegetables and the Effect of Processing. Food Chem. 27:245-257.

Stabursvik, A. (1969). Essential Amino Acids And Total Proteins Of Foods Of Uganda In Relation To Human Requirements.

van Steenbergen, W. M., Kusin, J. A., Nordbeck H. J. and Jansen A. A. J. (1984). Food Consumption of Different Household Members in Machakos, Kenya. In Ecology of Food and Nutrition 14:1-9

West, C. E. (2000a). Vitamin A. International Course on Food and Nutrition. International Agricultural Centre. Wageningen.

West, C. E. (2000b). Meeting Requirements for Vitamin A. Nutrition Reviews 58 (11):341-345)

Whitney, E. N. and Rolfes, S. R. (1999). Understanding Nutrition 8th Edition. West Wadsworth.

WHO (1987). Recommended Dietary Intakes. In Food Composition Tables for Foods commonly eaten in East Africa. Ed. West, C.E., Pepping, F., Scholte, I., Jansen, W. and Albers, H. F. F. Wageningen Agricultural Universität. Wageningen.

WHO (1996). Indicators for Assessing Vitamin A Deficiency and their Application in Monitorung and Evaluation of Intervention Programmes. World Health Organization. Geneva.

WHO/FAO (1996). Preparation and use of Food Based Dietary Guidelines. World Health Organization. Geneva.

Williams, S. R. (1994). Essentials of Nutrition and Diet Therapy. Sixth Ed. Mosby-Yr Book Inc. St. Louis.

CHAPTER NINE: APPENDICES

Appendix 1: Distribution of households by frequency of food consumption in Kalama division (percent households)

Food	Frequency			
	7 times/week	3-6 times/week	1-2 times/week	1/month
Tea	87.9	6.0	2.5	0.0
Millet porridge	12.5	16.0	3.5	1.5
Maize porridge	15.0	10.0	3.0	1.0
Maize Ugali	71.5	70.5	51.5	1.0
Millet ugali	1.0	4.0	1.0	1.5
Isyo	59.0	62.0	37.5	1.0
Muthokoi	3.0	17.5	6.5	4.5
Chapati	1.0	19.5	2.0	19.0
Bread	0.5	2.0	0.0	0.0
Rice	2.5	8.5	35.0	11.5
Cassava	1.5	4.0	3.0	3.0
Sweet potato	0.0	3.5	5.0	8.5
Pumpkin	0.5	1.0	1.0	0.5
Eggs	1.0	7.0	1.0	0.0
Meat	0.5	3.5	0.5	14.0
Matumbo	0.0	2.0	0.0	2.0
Liver	0.0	1.5	0.0	1.0
Chicken	0.0	0.0	0.0	0.5
Cabbage	1.0	6.0	1.5	2.0
Trad. vegetables	18.0	38.5	21.0	1.0
Kales	8.5	42.0	22.5	4.5
Oils and fats	13.5	36.5	20.0	5.0

Appendix 2: Distribution of households by food frequency at different meal times

1. Breakfast

Food	Frequency			
	7 times/week	3-6 times/week	1-2 times/week	1/month
Tea	87.8	5.5	2.5	0.0
Millet porridge	12.5	16.0	3.5	1.5
Maize porridge	15.0	10.0	3.0	1.0
Maize ugali	10.5	7.0	2.5	0.0
Isyo	5.0	4.0	3.5	0.0
Muthokoi	1.5	1.5	0.5	0.0
Chapati	0.0	1.5	0.0	0.5
Bread	0.5	2.0	0.0	0.0
Rice	0.0	1.0	0.5	0.0
Cassava	1.5	3.0	1.5	0.0
Sweet potato	0.0	0.5	1.0	0.0
Pumpkin	0.0	0.0	0.5	0.0
Eggs	1.0	7.0	1.0	0.0
3.Lunch				
Maize ugali	38.0	32.5	21.5	0.5
Isyo	26.0	35.0	17.5	0.5
Rice	1.0	13.0	2.5	4.0
Muthokoi	0.0	9.0	1.5	1.0
Millet ugali	0.5	3.5	0.5	0.5
Chapati	0.0	0.5	0.0	1.5
Oils and fats	4.0	17.0	3.5	2.5
Sweet potato	0.0	1.5	1.0	7.5
Cassava	0.0	1.0	1.5	2.5
Meat	0.0	0.0	1.5	0.0

Appendix 2 continued

Traditional vegetables	10.0	19.0	13.0	0.5
Exotic vegetables	5.5	44.0	12.0	0.5
Pumpkin	0.5	1.0	0.5	0.5
3.Supper				
Maize ugali	23.0	31.0	22.5	0.5
Isyo	28.0	23.0	16.5	0.5
Rice	1.5	21.0	5.0	7.5
Muthokoi	1.5	7.0	4.5	3.5
Millet ugali	0.5	0.5	0.5	0.5
Oils and fats	9.5	19.5	16.5	2.5
Traditional vegetables	8.0	19.5	8.0	0.5
Exotic vegetables	4.0	25.0	12.0	4.0
Sweet potato	0.0	1.5	4.0	0.0
Meat	0.5	3.5	0.5	12.5
Eggs	0.0	0.0	0.0	0.0
Matumbo	0.0	1.0	0.0	2.0
Liver	0.0	0.5	0.0	1.0
Chicken	0.0	0.5	0.0	0.5

Appendix 3: Total scores of different foods at different meal times by location

1. Breakfast			
Food	Lumbwa	Kola	Kalama
Tea	641.3	654.5	630.7
Millet porridge	239.7	101.8	127.1
Maize porridge	112.9	254.5	126.3
Maize ugali	86.7	83.9	147.1
Isyo	53.9	22.6	86.5
Muthokoi	0.0	38.7	20.5
Chapati	35.2	9.2	10.3
Bread	16.5	0.0	13.6
Cassava	16.5	74.8	99
Eggs	32.6	68.6	27.9
2. Lunch			
Maize ugali	518.2	395.4	401
Isyo	364.3	324.6	367.9
Rice	69.2	111.8	45.4
Muthokoi	41.2	91.1	13.8
Millet ugali	36.7	4.6	12.1
Chapati	4.5	10.3	0.0
Oils and fats	151.8	43.3	243.3
Sweetpotato	25.0	20.5	4.5
Cassava	8.9	11.5	6.9
Meat	4.4	0.0	0.0
Traditional vegetables	74.6	122.3	260.1
Exotic vegetables	164.3	107.6	167.2
Pumpkin	1.5	18.4	6.6

3. Supper			
Maize ugali	348.6	334.0	314.9
Isyo	319.1	259.4	354.1
Rice	108.8	39.0	78.5
Muthokoi	57.6	75.2	33.9
Millet ugali	1.5	9.2	9.9
Oils and fats	279.3	38.7	140.3
Traditional vegetables	105.5	106.4	206..6
Exotic vegetables	197.6	100.2	141.5
Sweetpotato	19.0	4.5	5.5
Meat	54.7	25.1	6.7
Eggs	0.0	0.0	0.0
Matumbo	16.0	0.0	10.3
Liver	1.5	0.0	0.0
Chicken	1.5	0.0	0.0

Appendix 4: Survey on the consumption patterns of traditional leafy vegetables in Kalama division, Machakos District, Kenya

SECTION I: HOUSEHOLD PROFILE
Questionnaire No.____________
Location_________________Sublocation__________

Name of interviewer____________________________
Date of interview______________2003
Name of respondent______________________________

[List of HH members]

	Sex	Age	Relation to hhh	Marital status	Educ-ation	Occu-pation	Cash income 1=yes 2=no	Amount spend on purchase of food per month

Sex
1 = Male
2 = Female

Education
1 = None
2 = Preschool
3 = Primary
4 = Secondary
5 = College
6= University

Relation to hhh
1= Head of hhh
2= Spouse
3= Son/Daughter
4=Grandchild
5= Grandparent
6= House help
7=Other (Specify)

Occupation
1= Farmer
2= employed
3= Student
4= Casual labourer
5= Self-employed
6= Other (Specify)

Marital status
1=Married
2=Single
3=Widowed
4=Divorced

SECTION II: RESOURCES AND FOOD PRODUCTION

1. Do you own any land? 1= Yes 2=No ______

2. [**If yes**] What is the size in acres? ______

3. Do you keep livestock? 1=Yes 2= No ______

4. Do you grow crops? 1=Yes 2= No ______

5. Do you grow fruits? 1=Yes 2= No ______

6. What crops do you grow in you farm? What livestock do you keep? What fruits do you grow? **[enter the codes as the crops, livestock and fruits are mentioned]**

Crops	Livestock	Fruits

Crops
1=Maize
2= Pigeon peas
3= Cowpeas
4= Millet
5= Vegetables
6= Sweet Potatoes
7= Tomatoes
8= Nzavi
9=Beans
10= Pumpkins
11=Sorghum
12=Irish potatoes
13=Cassava
14=Onions
15=Gourd

Livestock
1=Local cow
2=Hybrid cow
3=sheep
4=Goat
5=Hen
6=Ducks
8=Turkey
9=Donkey

Fruits
1=Mangoes
2=Avocado
3=Guavas
4=Lemons
5=Pawpaws
6=Loquats
7=Bananas
8=Custard apple

SECTION III: TRADITIONAL VEGETABLE PRODUCTION AND ACCESSIBILITY

7. I see that you grow vegetables; do you grow any traditional vegetables?
1= Yes 2= No ________

8. [**If yes in 7**] Please let me know which traditional vegetables you usually grow, how you grow them and how you utilize them.

Name of vegetable	How they are grown? 1=Rainfed 2=Irrigation 3=Other(specify)	Use 1=Home consumption only 2=Sale only 3=Sale and home consumption

1= Wua (*Amaranthus* spp)
2= Kyunyu (*Erucastrum arabicum*)
3= nenge (*Cucurbita maxima*)
4=Itula (*Commelina benghalensis*)
5=Mwianzo (*Cleome gynandra*)
6=Kyambatwa (*Cucumis dipsaceus*)
7=Uthunga (*Launaea cornuta*)
8= Nthooko (*Vigna unguiculata*)
9=Ndulu (*Solanum nigrum*)
10=Ukwasi (*Ipomea batatas*)
11=Kikoowe (*Commelina africana*)
12=Cassava leaves (*Manihot esculenta*)

9. [**If no in 7**] ask why so?
1=lack of seed
2=do not know how to grow traditional vegetables
3=do not consume traditional vegetables
4=other (specify) ________

SECTION IV: TRADITIONAL VEGETABLE CONSUMPTION

10. How many meals do you prepare in your household in a day? ______

11. Which ones? [**tick as they are mentioned**]Breakfast____ Lunch_____Supper____

12. Do you think it is necessary for people to eat vegetables? ______
1= Yes 2= No

13. [**If yes in 12**], ask for what reason? ______
1= Aesthetics 2= Variety 3= Taste
4= Nutrition 5= Medicinal 6=other (specify)

14. Do you consume traditional vegetables? 1=Yes 2=No ______

15. [**If answer is no in 14, skip to 16**] Where do you obtain the traditional vegetables from? ______
1=Own garden 2=Friends (gifts) 3=Market 4=other(specify)

16. [**If answer is no in 14**], ask why is it so? ______
1=they are not available
2=do not like their taste
3=other (specify)

17. Do you consume preserved traditional vegetables? 1=Yes 2=No ______

18. [**If answer is no in 17**] Why not?
1=do not preserve any
2=they are not available
3=other (specify)

19. Do you preserve any traditional vegetables in your household? ______
1=Yes 2=No

20. [**If yes in 19**], which methods do you use? ______
1=sun drying 2=shade drying 3=other (specify)

21. List foods generally eaten at breakfast, lunch and supper, and how often they are eaten: [**mention the meal times and probe on inclusion of traditional vegetables**]

Breakfast		**Lunch**		**Supper**		**In-between**	
Item	frequency	Item	frequency	**Item**	frequency	Item	frequency

Foods
1=Maize *ugali*
2=*Muthokoi*
3=Tea
4=Chicken
5=Cassava
6=*Matumbo*
7=Traditional vegetables
8=Millet *Ugali*
9=Maize porridge
10=Rice
11=Eggs
12=Pumpkins
13=*Sukuma wiki*
14=Oils and fats
15=*isyo*
16=Millet porridge
17=Meat
18=Sweet Potatoes
19=Liver
20=Cabbage
21=*Chapati* (wheat flour)

Usual frequency of consumption
1= 7 times/week
2= 3-6 times/week
3= 1-2 times/week
4= 1 time/month

22. Which traditional vegetables have been consumed in your household in the last one week (7 days)? With which meals were they consumed?

Vegetable	Eaten in mainmeal 1=yes 2=no	frequency in last one week	Eaten in side dish	frequency in last one week	Source	Amount (ml)

Vegetable

1=Wua (*Amaranthus* spp)
2=Kyunyu (*Erucastrum arabicum*)
3=Nenge (*Cucurbita maxima*)
4=Itula (*Commelina benghalensis*)
5=Mwianzo (*Cleome gynandra*)
6=Kyambatwa (*Cucumis dipsaceus*)
7=Uthunga (*Launaea cornuta*)
8=Nthooko (*Vigna unguiculata*)
9=Ndulu (*Solanum nigrum*)
10=Ukwasi (*Ipomea batatas*)
11=Kikoowe (*Commelina africana*)
12=Cassava leaves (*Manihot esculenta*)

Source

1= Own garden
2=Purchased
3=Gift
4=Gathered
5=Other (specify)

23. Are there beliefs/taboos in this community on consumption of some traditional vegetable? 1=Yes 2=No ________

[**If so**] ask which ones?

Vegetable	Belief/Taboo

SECTION V. ACCEPTANCE RATING OF VEGETABLES

24. Between traditional vegetables and exotic vegetables, which ones do you prefer?

1= traditional vegetables

2= exotic vegetables ________

Why? [**Circle as they are mentioned**]

1=Colour 3=Texture

2=Keeping quality after harvesting 4=Cooking characteristics

25. [**If answer is 1 in 24**] Please list traditional leafy vegetables in order of preference.

Vegetables	Remark

Vegetable

1=Wua (*Amaranthus* spp)
2=Kyunyu (*Erucastrum arabicum*)
3=Nenge (*Cucurbita maxima*)
4=Itula (*Commelina benghalensis*)
5=Mwianzo (*Cleome gynandra*)
6=Kyambatwa (*Cucumis dipsaceus*)
7=Uthunga (*Launaea cornuta*)
8= Nthooko (*Vigna unguiculata*)
9=Ndulu (*Solanum nigrum*)
10=Ukwasi (*Ipomea batatas*)
11=Kikoowe (*Commelina africana*)
12=Cassava leaves (*Manihot esculenta*)

SECTION VI: METHODS OF COOKING TRADITIONAL VEGETABLES

26. Please tell me how you prepare your traditional vegetables for cooking.
    How do you cook them?
    How long do you let them cook?
    Do you add any water during cooking? How much water?
    Do you usually cover the cooking pot?

Vegetable	Chopping before washing 1=Yes 2= No	Washing before chopping 1= Yes 2= No	Method of cooking	Water added (ml)	Cooking time (minutes)	Co co' 1= 2=

Vegetables

1= Wua (*Amaranthus* spp)
2= Kyunyu (*Erucastrum arabicum*)
3= Nenge (*Cucurbita maxima*)
4=Itula (*Commelina benghalensis*)
5=Mwianzo (*Cleome gynandra*)
6=Kyambatwa (*Cucumis dipsaceus*)
7=Uthunga (*Launaea cornuta*)
8=Nthooko (*Vigna unguiculata*)
9=Ndulu (*Solanum nigrum*)
10=Ukwasi (*Ipomea batatas*)
11=Kikoowe (*Commelina africana*)
12=Cassava leaves (*Manihot esculenta*)

Methods of cooking

1=Boiling only
2=Stewing only
3=Boiling, draining then stewing
4= Steaming
5=Boiling and draining
6= Boiling and stewing
7=mashing with other foods
8=other (specify)

SECTION VII: 24 HOUR DIETARY RECALL

Questionnaire number ________

Sex of respondent 1= Female 2= Male ________

Please tell me the meals you have prepared in the household in the last 24 hour period (since yesterday morning)

Meal time	Dish	Ingredients	Source	Amount (ml)	Total original amount of dish prepared	Amount consumed (ml)	Amount left over (ml)	Number of people who ate	Age

Meal time 1=Breakfast 2=Mid morning 3 =Lunch 4=Mid afternoon 5=Supper

Source 1= home grown 2= purchased 3= Gift 4= Gathered 5= other (specify)

Appendix 5: Guidelines for Focus Group Discussions

1. What is the general situation about production and consumption of traditional vegetables in this area?

2. What do people think about the consumption of traditional vegetables in this area?

3. Where do people in this area obtain traditional vegetables for consumption from?

4. What influences consumption of traditional vegetables at the household level?

5. What is the general perception of people in this area about preservation of traditional vegetables?

6. How can production and consumption of traditional vegetables be improved at the household level?