TYPES AND QUALITY OF STREET FOODS AND VENDOR CHARACTERISTICS AT SELECTED CONSTRUCTION SITES IN NAIROBI

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DEDICATION.

This work is dedicated to my beloved family Joaz, Sonia and Donna for their patience and constant encouragement through out the study period.

DECLARATION.

I, Salome C. R. Korir, declare that this thesis is my original work and has not been presented for a degree in any other University.

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This thesis has been submitted for examination with our approval as University Supervisors.

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GLOSSARY OF TERMS.

Mboga (Kiswahili)	=	Vegetable stew with the main ingredients as cabbage, kales and a few potatoes.
Githeri (Kikuyu)	=	Dish containing a mixture of beans and maize.
Kienyeji (Kiswahili)	=	Mashed mixture of maize, beans, potatoes, and greens (mainly pumpkin leaves).
Matumbo (Kiswahili)	=	Offals, mainly intestines and stomachs
Chapati (Kiswahili)	=	Flat unleavened bread.
Ndengu (Kiswahili)	=	Green grams.
Ugali (Kiswahili)	=	Stiff porridge.
Uji (Kiswahili)	=	Thin porridge made from maize, millet or sorghum flours among other flours.
Pot/Beef stew	=	Stew containing potatoes, and a few pieces of meat.
Mandazi (Kiswahili)	=	Deep fried buns made from leavened wheat flour.
Hawkers	=	People who had pre-packaged foods and could carry them from one customer to another.
Vendors	=	People who literally sold their food from specified & set areas within construction sites.
Meals	=	Combination of food types e.g. *chapati* + *ndengu* stew as served to the customers.

DEFINITION OF TERMS.

Street foods as used in this thesis is defined as "ready-to-eat foods and beverages prepared and/or sold by vendors or hawkers in construction sites". A modification of a FAO (1989), definition which is stated "street foods are ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers in streets and other similar public places."

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ABSTRACT

Due to rapid urbanization prompted by high population growth rates, street food vending has proliferated in many developing countries, mainly as a means of survival for the urban poor and the unemployed. In this study, the characteristics of vendors and the quality of street foods sold in selected construction sites in Nairobi were determined.

The characteristics of the vendors and the manner of handling of the foods were determined by administering a pretested questionnaire to 58 vendors from 10 sample clusters. The quality of the foods was evaluated by analyzing for proximate chemical composition and total coliforms. Caloric values as well as the contribution of the foods to energy and protein RDAs were calculated.

The survey results indicated that street food vending is carried out by both males and females with females constituting the majority. Both the male and female vendors had low formal education. Though diversified, the foods were similar to those commonly consumed in Kenyan households.

The proximate composition of the foods varied depending on the ingredients. Single servings of most of the foods provided 17-36% of energy RDAs for individuals of ages 18-30, and 18-38% energy RDAs for ages between 31-60 years. Contribution to the protein RDAs were much higher, in some cases reaching as high as 98%.

Coliform counts of the foods were high suggesting contamination of food with faecal material possibly from water used for washing or from the vending environment.

The study indicated that street food vending in Nairobi is a rapidly growing business especially for provision of meals to low wage earners. Much needs to be done, however, to improve the sanitation of the vendors and that of the environment under which the foods are prepared and vended, to improve wholesomeness of the foods.

CHAPTER ONE

INTRODUCTION.

There is increasing rural to urban migration in the developing countries, which is caused mainly by rapid population growth (Salas, 1984). It is projected that by the end of this century, the total urban population in these countries will exceed 2.2 billion (Austin, 1980).

A large proportion of the urban dwellers in the developing countries are "poor", who according to Salas (1984), are underpaid or even unemployed. For this reason, most of these people lack adequate nutrition and other essentials.

Street foods are becoming important in providing nutrition and employment for most urban populations in the world and according to FAO (1989), these foods have become more popular and are now considered a necessity. They have therefore, increased in volume and variety in many countries.

Among the most important features of street foods are their affordability, convenience and availability (FAO, 1992). Many consumers are attracted to a quick snack or meal easily available but, most importantly, within their economic reach. In addition, street food vendors make positive contribution to their local economies. According to FAO (1989), sales from street foods contribute to economic uplifting of persons who in most cases start the business with minimum capital and little expertise.

Studies in some Asian countries, have shown that street foods are quite nutritious (FAO, 1989). The foods are,

however, perceived as a possible health risk due to possibility of microbial contamination, incorporation of unpermitted food additives and presence of other adulterants (FAO, 1992). Whereas this may be true, street foods with high degrees of variability in quality are found selling in different countries of the world. This variability in quality arises due to the variation in ingredients used in preparation and the conditions under which the foods are prepared and handled.

Kenya has shared in the problems of rapid urbanization in the recent past, resulting in increase in the total urban population from 2.3 million in 1979 to 3.8 million in 1989. Of these, 36% reside in Nairobi alone (GOK, 1991). Urban administrations have therefore become increasingly constrained in providing adequate essential services for an increasing population, most of who are unemployed.

Due to lack of sufficient employment opportunities, many people in the urban centres try to survive by trading in all sorts of merchandise in a very informal market. This form of trade includes street vending and hawking of ready-to-eat foods, which seems to have increased tremendously over the last few years, especially around construction sites and the industrial areas, where large concentrations of low wage earners are found.

Although street food vending has been going on for a long time in Kenya, there is no information on their diversity, nutritional and economic contribution and their health safety. The present study was therefore designed to determine the

types and quality of street foods sold for lunch at some of the construction sites in Nairobi. The study was aimed at achieving the following specific objectives:

(1) to determine the characteristics of street food vendors at construction sites in Nairobi;

(2) to determine the types, size and cost per serving of commonly consumed street foods at construction sites of Nairobi.

(3) to determine the proximate chemical composition of different street foods sold to workers at construction sites in Nairobi.

(4) to determine the coliform counts of different street foods sold at construction sites in Nairobi.

CHAPTER TWO

LITERATURE REVIEW

2.1 THE PRESENT STATE OF URBANIZATION IN THE WORLD

High population growth rates that go hand in hand with intense growth in urban populations is one of the most critical problems facing Third World countries today (von Brown et al., 1993).

Rural to urban migration has entailed growth in the sizes of towns and cities. According to Cepede (1984), the proportion of the world's most populous cities in the developing countries as compared to those in developed countries is increasing rapidly. By the end of this century, it is projected that 25 of the biggest urban concentrations will be in the third World.

Urban populations in developing countries grew at a rate of 3.7 percent per annum, between 1965-1980 and 6.8 percent between 1980-1989 (World Bank, 1989). Different regions, however, vary in levels and definitions of urban population growth, although Austin (1980), believes that rapid urbanisation is the rule in developing countries.

Urbanization in itself is an integral part of a normal social and economic process, and was also experienced by the developed countries during their developmental process (Salas, 1984). The problem is that the high rate at which it is occurring in the developing countries leads to imbalances in the distribution of essential services. The effect of such imbalance can be seen in poor human welfare, especially when

the countries are experiencing low or even negative economic growth (von Brown et al., 1993).

Due to industrial expansion, cities tend to provide greater employment opportunities in the industrial and service sectors. People therefore migrate from rural areas to urban centres usually in search of better economic life. The immigrants usually include skilled, semiskilled and unskilled workers. These immigrants in most cases however, fail to find the hoped-for-jobs (Cepede, 1984). As a result, they find themselves faced with unemployment or underemployment (Austin, 1980).

Measures such as structural adjustment programmes (SAPs) in many developing countries have necessitated the restructuring of policies on employment. Some countries have been forced to cut down on employment, especially in government and parastatal organisations. Such measures have resulted in such problems as increased unemployment and food insecurity in urban areas (von Brown et al., 1993).

Living in urban areas is usually more expensive than living in the rural areas because the dwellers depend on the market for everything. The urban poor can hardly afford the basic needs such as medical, housing and food. They have extremely limited assets to draw upon when current incomes fall short. In order to achieve food security in urban areas, the focus may have to be on generation of employment (Per Pinstrup-Anderson, 1989).

In Africa and other developing countries of the world, participation in the informal sectors has been on the increase

due to increasing rates of unemployment in other sectors (Akinyele, 1992). Urban dwellers engage in small scale enterprises or get employed in informal establishments in order to sustain themselves. These sectors, however, have been somewhat ignored in the past by many governments and did not receive any support (FAO, 1989). For many low income families in Africa, street food vending is an informal sector which is one of the many important survival strategies (Akinyele, 1992). Street food vendors and operators make up a reasonably high proportion of the active and self employed inhabitants of most cities in the Third World.

2.2 STREET FOODS.

FAO (1989), defines street foods as "Ready to eat foods and beverages prepared and/or sold by vendors and hawkers especially in the streets and other similar public places".

The range and number of street foods in different countries is varied. In fact, Mbome (1992) reckoned that the variety of street foods is very much reflective of the local diets. Street foods in most countries include meals, side dishes, snacks, beverages, weaning foods as well as herbal medicine among others. Traditional foods are, however, known to form the basis of street foods (Akinyele, 1992).

Street foodstuffs are processed and sold in varied informal establishments, which according to Akinyele (1992), vary in structure from such facilities as a cloth on the ground, a pushcart, open grounds next to market places, to construction sites.

Methods of preparing street foods are also varied to meet the tastes of different consumers. The foods could be prepared by frying, roasting, boiling, stewing or by a combination of these methods depending on the preference of the clientele. The foods are either eaten at the point of purchase or bought for home consumption. In the Philippines and Malaysia street foods have been found to be important even for urban households (FAO, 1989). Upto 25% and 30% of the household expenditure respectively in these countries go into purchasing of street foods. The budget share for street foods is even higher in urban households in Africa and Asia where it could amount to upto 50% (Winarno and Allain, 1991).

2.2.1 The present state of street food vending.

Street food vending is an age old activity in most developing countries. According to Akinyele (1992), street food vending activities in Africa begun at the same time with other age old traditions, whereby people took their wares to the road sides and village gatherings for sale. However, due to increased growth in urban populations, the number of street food vendors has risen greatly in response to the need to feed large numbers of people. Moreover, the daily movement from residential areas to working places has created need among many working people to eat outside the home more often.

From studies carried out in a number of countries in Africa and Asia, substantial numbers of people are involved in street food vending directly and indirectly (FAO, 1989). In China, over a million people are involved in one aspect or

another of street food vending (FAO, 1989).

The capital required to start street food vending business is minimal, thus permitting the participation of most people who because of economic and social changes or individual characteristics have difficulty in obtaining jobs in the formal sector (Akinyele, 1992). Furthermore, demand for relatively inexpensive ready to eat foods has increased with increase in the proportion of working women who have less time to prepare meals at home (Winarno and Allain, 1991). Other factors such as consumers' limited purchasing power, vendor competition, little or no rental for vending premises, procurement of raw materials from cheap markets or in bulk, have made the prices of street foods to be comparatively low. On the other hand, the fact that street food vendors earn on average higher incomes than the minimum wage in employment, is in itself enough encouragement for more people to join the trade. Studies in Nigeria, Colombia and in some Asian countries confirmed that street food vendors earned more than their country's minimum wage (FAO, 1989). In Nigeria in particular, it was found that 75% of the vendors were realising 3 to 10 times the country's minimum wage (Akinyele, 1992).

Street food vending in Kenya, though not documented is carried out at construction sites, along streets, near market places among others and involves substantial number of people.

2.2.2 Employment potential of the Street Food Industry

Street food industry employs a large number of people.

The city of Bogor in Indonesia has 18,000 street food vendors out of a total population of 250,000 (Winarno and Allain, 1991). Of the active informal sector employees, 26% are employed in street food business. In Senegal 40,000 to 50,000 people were engaged in street food trade in 1979 compared to 6,800 jobs provided by the agribusiness and food industries (Akinyele, 1992). Similarly it was found that street food vendors comprised 29% of the active urban labour force in Central America (Winarno and Allain, 1991).

2.2.3 Characteristics of Street Food Vendors.

People of various ages carry out street food vending. However, the majority are usually between 20 and 50 years old. In Malawi majority of the vendors were found to be in the most active age group of 16-30 years (Mlelemba and Chindamba, 1992). Studies carried out in Asia and Africa showed that most of the vendors are women (FAO, 1989). However, in Islamic countries, there is little visible evidence of female participation in the street food vending business as is the case with many other economic activities. A few countries such as India and Indonesia had more male vendors (over 70%) than female (less than 30%). In Thailand, Nigeria and the Philippines women dominate the trade and constitute 80%, 90% and 79% respectively of the vendors in these countries.

The level of formal education of most vendors and operators of street food establishments has been found to be low, with most having formal schooling of less than eight years (Winarno and Allain, 1991). In Columbia, 56% of the

vendors had elementary education, while the illiteracy rate in Peru and Nigeria was 11.5% and 17% respectively (FAO, 1992; FAO, 1989)). Low illiteracy rates are thought to be contributory factors to the general lack of knowledge on basic hygiene and sanitation among vendors. This has been observed consistently in studies done in Asia and Africa, where manufacturing and food preparation practices were extremely poor (Akinyele, 1992). A study carried out in Pune City (India) however, showed that even the educated are now showing interest in the trade. Out of all the street food vendors, 22.2% were high school graduates while 2.2% were university graduates (FAO, 1989). This business may therefore be a solution to unemployment even among the educated.

2.3 QUALITY OF STREET FOODS.

Good nutrition largely depends on the availability of sufficient quantities of nutritious food that is safe to eat. Ensuring food safety and preserving its nutritional quality depends on precautions and controls that span the entire food production chain (FAO/WHO, 1992).

2.3.1 Nutritional quality of street foods.

Actual food consumption is one of the determinants of nutritional status. Food consumption interacts with health and sanitary conditions to give the desired nutritional status of individuals and communities (FAO/WHO, 1992). Energy and protein requirements are dependant on among other things, the activity of the individual in question.

Literature on the nutritional quality of street foods is scanty. The nutritional value of the foods would, however, depend largely on the type of food, its ingredients, and the proportion of each ingredient in the food. The quantity of food consumed, which would depend on such factors as the affordability by the consumer, would also affect total nutrients received from the food.

In general, a number of studies indicate that nutritional quality of street foods is satisfactory (Akinyele, 1992 and FAO, 1989). In fact Winarno and Allain (1991), argue that certain individuals and families would be worse off nutritionally if there were no street foods in some Asian countries.

A study carried out in India on the nutritional quality of street foods (FAO 1989), indicates that in general, foods with high moisture content were of low nutritional value due to low dry matter contents. Deep fried foods had higher fat contents than similar foods consumed in the homes. Such foods had high energy values and could be used to correct dietary deficiencies (low energy) common in developing countries.

In Bogor (Indonesia), a study revealed that it was possible for a consumer to obtain more than half the Recommended Daily Allowances (RDAs) of protein, iron and vitamin A from one meal of street food that was affordable by many (Anon, 1985). Caloric values of snacks were found to be high in comparison to their costs since fat was used quite a lot in their preparation. Energy and protein of cooked street foods were also found to be much higher than those of

prepackaged processed foods. Fruits provided high levels of vitamins A and C. (FAO, 1989).

The studies described in this chapter are country specific. The general quality of food depends a lot on many factors including the type of ingredients in the foods, and the environmental conditions under which they are prepared.

In Kenya, maize is the most important cereal food. It is normally cooked into thin porridge called *uji* or stiff porridge called *ugali*. Maize may also be cooked in mixtures with beans or mixed with potatoes or green bananas and mashed to produce a dish known by various names in various communities e.g. *irio* (Kikuyu), *isio* (Kikamba), *nyoyo* (Dholuo), etc. Wheat is also popular and is used for making *chapati* (flat unleavened bread), *mandazi* (buns), and oven bread among other foods. These foods are widely consumed in the Kenyan households and are sold in most eating establishments. What is not clear is whether the same foods are sold as street foods in Kenya.

The nutritional quality of foods usually depends on the ingredients that make up the dish. Some of the commonly used ingredients such as beans have been reported to have high protein contents (Imungi and Kabira 1989) which could complement the cereal-based diets consumed by most Kenyans. Beans provide more than 20% protein per 100g dry matter (DM) and a reasonably high percentage of total carbohydrates (over 60 % per 100g DM). Street foods containing beans therefore may be good sources of protein and carbohydrates.

2.3.2 Microbiological quality of street foods .

Studies carried out in Asian and African countries (FAO, 1989), examined the problems of food hygiene and sanitation in street food vending. The studies showed that potential for serious hygiene problems could be attributed to improper practices during preparation and handling of the foods. Problems of food hygiene and sanitation are, however, not confined to street food vending industry alone, but are also common in many formal food establishments. Food-borne illnesses such as cholera, typhoid and dysentery are quite common in developing countries (FAO/WHO, 1992; WHO, 1976).

2.3.2.1 Causes of food contamination.

According to Akinyele (1992), microbial contamination of street foods is an indication of poor sanitary practises in the preparation, handling and storage of the foods. Bacteria may enter the foods through raw materials and cooking utensils, from the environment or are introduced by the food handlers. Once introduced into food, the bacteria multiply rapidly if the food is not stored under conditions that suppress growth (FAO/WHO, 1992; Minor, 1983). Street food vending as with mass catering can therefore lead to food poisoning outbreaks due to microbiological contamination. Vendor´s lack of knowledge and lack of control by the authorities over street foods, can lead to health risks to the consumer (Akinyele, 1992).

Lack of adequate supply of potable water has been found to be a major problem in the street food industry (FAO, 1989).

Water is used for cooking the food, cleaning utensils, and washing hands in the vending places. In Malaysia many vendors travel long distances to fetch water (FAO, 1989). This is also true in many other Asian and most African countries. A study carried out in Ibadan Nigeria showed water to be a major source of street food contamination. Fresh potable water was not readily available. In Botswana, vendors relied on communal water supply that was not easily accessible (Mpuchane and Baatswana, 1992). Due to lack of availability, vendors are therefore forced to economize or re-use the little water available. Re-used water may have enough substrate to serve as culture media for microorganism.

Although the water in Pune city (India) is analyzed everyday and has always met the WHO standards for potable water, the water stored for street food consumer use was heavily contaminated with coliform bacteria (FAO 1989). Of all ice samples, 80% had coliform counts of greater than 180 per 100ml and in 10% of the samples enteropathogenic *Escherichia coli* was isolated. This meant that there was re-contamination by the vendor.

Standing water especially when dirty is a good vector for diseases. Street food vendors seldom, if at all, treat the water they use (Akinyele, 1992).

Personal hygiene is another factor that may contribute to food contamination. Although judging personal hygiene can be very subjective, 75% of vendors in Peru were found to have clothes on, which were below the National cleanliness standards. The educational levels of the vendors were also

reflected in their cleanliness with those of higher educational levels being cleaner. Generally, women were found to be cleaner than their male counterparts (FAO, 1989). In Nepal, 66% of vendors were judged to be wearing dirty clothes, although 80% of the vending areas were judged to be clean. The same study reported presence of dogs in the vending areas. The dogs were observed to lick the dirty plates before they were washed.

Waste water and garbage disposal is another major problem at vending sites. In many cases, there is no proper garbage or spent water disposal system (FAO, 1989). This poses health risks.

Food poisoning outbreaks from consuming street foods as with other catering establishments are not uncommon. Cases of outbreaks of food poisoning as a result of consuming street foods have been documented (FAO 1989).

2.3.2.2 Contamination and incidences of food poisoning in street foods.

Certain levels and types of microbiological contamination in food are a direct indicator of poor sanitary quality (Minor, 1983). Countries that have analyzed street foods for microbiological contamination have found various levels of contamination. In Pune (India), a snack food was found to be contaminated with coliform counts of as high as 2.7×10^7 per gram of food and faecal coliforms as high as 1.7×10^6 per gram of food. Of all the samples analyzed, 13% were positive for *Escherichia coli* (FAO, 1989).

In Cameroon 29% of the samples analysed were found to be contaminated with bacteria. *Staphylococcus Aureus*, *Salmonella* and *Coliforms* were present in 26%, 16% and 13% of the samples respectively (Mbome, 1992). In Nigeria, foods were found to have total bacterial counts of 10^4 to 10^8 per gram. Coliforms were also present in 50 % of the samples (FAO, 1989).

A cholera epidemic occurred in Pune (India) in 1981 and was attributed to contaminated sugarcane juice sold on the streets (FAO,1989). In 1988, 14 people died after consuming rice noodles in Malaysia. During that same year, some 300 people in China became ill after consuming green vegetables bought from street food hawkers. Further, 25 notifications of food poisoning cases were reported in Singapore in 1987. A survey carried out in Zambia in 1991 reported two outbreaks that occurred in 1990 and 1991, both of which were associated with consumption of street foods (Malijani and Kambaila, 1992). Documentation on epidemiological studies to show the significance of these food poisonings is, however, lacking.

Other biological and chemical contaminants can also make food either inedible or unfit for consumption. Heavy metals and other chemical contaminants like aflatoxins, and pesticide residues above authorised levels have been detected in street foods. Winarno and Allain (1991), report of lead contamination in street foods in Indonesia of between 1.0 and 9.63 ppm and aflatoxin levels above the 30 ppb safety margin set by FAO/WHO guidelines. Heavy metals may be introduced into street foods from the old manufacturing and preparation equipment used by vendors.

CHAPTER THREE

METHODOLOGY

3.1 TYPE OF STUDY.

A descriptive study consisting of a cross-sectional survey and laboratory chemical and microbiological analyses of foods was carried out.

3.2 STUDY AREA.

The area of study was Nairobi city. Its population has expanded rapidly from 1.37 million in 1979 to 1.53 million in 1990, and is estimated to reach 2.81 million by the year 2000 (von Brown et al., 1993).

The city has also experienced rapid physical expansion (GOK, 1990). The industrial sector has been expanding hand in hand with the commercial sectors. The growth of Nairobi, like most cities in the developing countries has been largely due to rural to urban migration (GOK, 1992).

Due to problems resulting from high population coupled with slow economic growth, the Kenyan economy has been faced with a low and declining labour productivity and slow growth in employment creation. An employment creation programme whose major component emphasises small scale, informal enterprises is being adopted by the government of Kenya to curb unemployment (GOK/UNICEF, 1992).

Between 1980-1984, self-employment in Nairobi was recorded at 30% (GOK, 1990). Currently, as stated by the government in the development plan of 1989-1993, the percentage of those who are self employed lies between 40-60%.

Included in this category are the *Jua Kali* enterprises, street food vending and hawking.

A survey of wage employment by income groups seemed to indicate that low income earners' (i.e those earning less than Ksh 1,000 per month) constituted the majority of Nairobi employees (60-74 %) in 1987 (GOK, 1989).

In the building and construction sector, labour a major input in the construction industry rose by 9.7% in the 1991-1992 period. Increases in unskilled, semiskilled and skilled labour were 15.5%, 7.7%, and 6.7%, respectively (GOK, 1992).

3.2.1 Study sites.

The study sites were a number of selected building construction sites at the city centre and its environs as shown in Figure 3.1. Selection of the sites was based on results of a preliminary study which showed that the vendors operating in these areas came from almost all parts of Nairobi.

The vendors were operating in the open, with little or no provision of shade, and were made up of two categories namely; those who prepared their foods at the site and those who brought ready cooked foods from their homes.

The customers were mainly construction workers majority of who were casual labourers paid weekly wages.

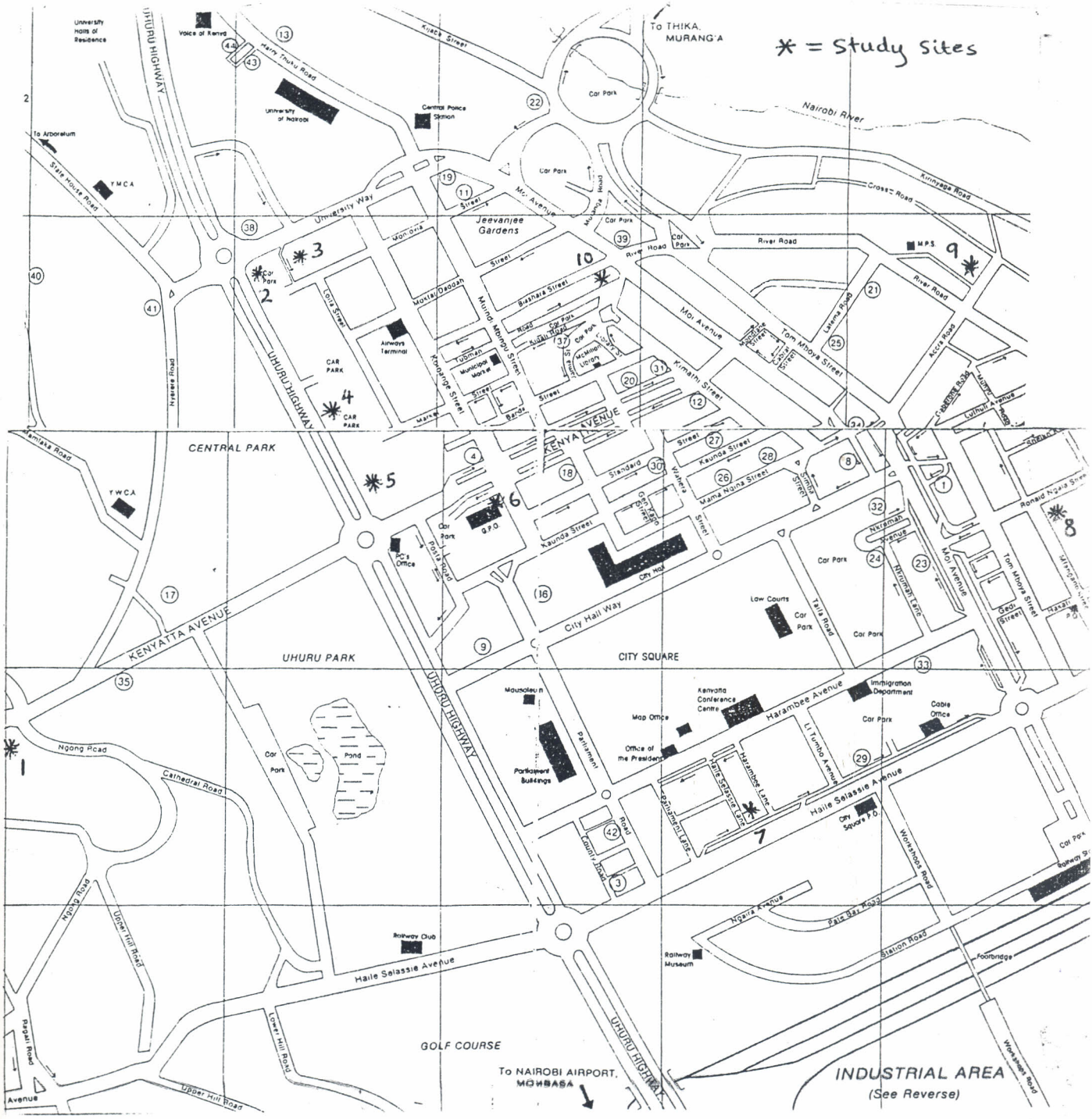

Figure 3.1. Map showing the study sites

3.3 SAMPLING OF THE STUDY AREA.

A multistage sampling plan was used. Nairobi as a province was divided into six regions along existing roads, rivers, and railway lines. The city centre and the surrounding areas were purposively sampled because the results of the pilot study had indicated that street food vendors operating in this area came from almost all parts of the city. This would give a representative sample of vendors in terms of their residential status.

Comprehensive cluster sampling was then used to select the actual study sites. This involved identifying all construction sites within the area selected. Each construction site was treated as a cluster. A total of 12 clusters were identified. Two out of the 12 clusters had been used for the pilot study, and therefore were excluded during the main study leaving 10 clusters for the study. A total of 58 vendors operating in the 10 clusters were interviewed and observed.

3.4 SAMPLING FOODS FOR CHEMICAL AND MICROBIOLOGICAL ANALYSES.

Out of the 10 clusters, five were randomly selected, and from these, food samples for chemical and microbiological analyses were taken.

3.4.1 Sampling foods for chemical analysis.

The common foods sold in each of the five clusters were first identified by determining the percentages of the vendors and hawkers selling each type. Identical foods sold by different vendors in each cluster were pooled and homogenized.

Analysis samples for proximate chemical composition were then picked from this pooled mixture. A serving of each food type was weighed before pooling. Meals (combinations of different food types) were also weighed per serving. For such meals, each of the ingredients (that make up the meal) was weighed and analyzed singly in the laboratory. A total of 60 different food samples were analyzed.

3.4.2 Sampling foods for microbiological analyses.

Sampling foods for microbiological analysis was done per type of food. The most commonly eaten foods were each randomly sampled. For each of these foods, three samples were taken from those prepared at home and three samples from those prepared on site. Three of the foods were prepared both on site and at home, while of the remaining six foods, three were prepared at home only and three were prepared on site only. Altogether therefore, 30 samples were taken and analyzed for coliform counts.

3.5 RESEARCH ACTIVITIES.

Pre-testing of the survey Questionnaires was carried out at vending sites in the Industrial Area and at two construction sites in the city centre. The final questionnaire (Appendix 1) was developed after pretesting the questions on a total of 10 street food vendors from the construction sites and 10 from the Industrial Area. Even though pre-testing was carried out in the two mentioned areas, the final study was carried out at selected construction sites to minimize

variations.

The actual survey covered the period between November 1992 to March 1993. The observations and interviews were done concurrently. Interviews were conducted between 11 a.m. to 2 p.m. each day. This was the time when the foods were ready and service to the customers had started. At the end of each day, the survey forms were screened to check for completeness and accuracy of recording.

3.6 THE SURVEY AND SURVEY TOOLS.

3.6.1 Description of data sets.

Data collection was centred on food vendor characteristics, types, cost, other aspects of street foods and vending.

3.6.2 Food vendor characteristics module.

The questionnaire used was composed of pretested questions. Information was collected on age, sex, marital status, and educational level of the vendors.

3.6.3 Types, cost and other aspects of street foods and vending.

Information was collected on the type of foods sold by the vendors, ingredients used for preparation of each type of food, source of the ingredients, and other aspects such as the time the foods were prepared and who actually prepared them.

The questionnaire was also designed to collect data on methods of food preparation used, the quantities and costs of

the foods, whether prices changed within the course of a month and the average income accrued from street vending and hawking. Information on the source of water used for preparation of the food and whether the vendors had any problems in obtaining it was also collected. Questions were also asked to establish the mode of storage of left over foods, mode of payment by the customers and any problems encountered by the vendors.

3.6.4 Observation schedule.

This was exclusively done by the investigator and was mainly to assess the cleanliness of the vendors, vending area, and vending equipment. Aspects of food handling were also observed. The following qualitative coding of the various categories of observations was used to help quantify the outcomes:

1 = very clean

2 = fairly clean

3 = dirty

4 = very dirty

3.7 CHEMICAL AND MICROBIOLOGICAL ANALYSES OF THE FOODS

3.7.1 Preparation of foods for chemical analyses.

Foods for proximate chemical analyses were weighed per quantity purchased. Same types of foods were pooled and mixed well. A sample of 500gm was weighed out from the pooled mixture for analysis.

3.7.2 Determination of moisture.

A sample of food of 500gm was placed in a large porcelain dish and dried in an air oven overnight at a temperature of between 50-60°C. The loss in weight was calculated. The dried samples were then ground using a laboratory mill to pass through a 50 mm sieve. Five grammes of the powder were further dried at 105°C to constant weight, cooled and weighed. Total moisture content was calculated as a percentage of the original sample.

3.7.3 Determination of crude fat.

Crude fat was determined by extraction in a soxhlet apparatus using petroleum ether (B.p 60-80 °C) as solvent (AOAC, 1984).

3.7.4 Determination of crude protein.

Crude protein of the different types of foods was determined as total nitrogen by the MicroKjeldahl method (AOAC, 1984). The total nitrogen was multiplied by a factor 6.25 to convert to percent protein.

3.7.5 Determination of crude fibre.

Crude fibre was determined by the AOAC methods (AOAC (1984)), which involved digestion of about 2g samples with dilute strong alkali, digestion with dilute strong acid, drying and then incineration at 500°c to destroy organic matter.

3.7.6 Determination of total ash.

Total ash content was determined by incinerating 5g samples in a muffle furnace at 500°C until grey or white ash of constant weight was obtained. The ash was cooled in a desiccator and weighed. Total ash was calculated as a percentage of the sample.

3.7.7 Determination of total available carbohydrates

Total available carbohydrate was calculated as a difference.

3.7.8 Determination of energy content.

The energy content was calculated using the factors of 4 kcal/g for total available carbohydrates, 4 kcal/g for protein and 9 kcal/g for fat (Robinson and Lawler, 1982).

3.7.9 Microbiological analysis.

Foods were sampled aseptically then placed in a cool box at approximately 18°C and transported to the laboratories of the Department of Food Technology and Nutrition, University of Nairobi for analysis for coliform counts. For analysis, a sample of 50g was placed in a sterile blender jar containing 450ml of sterile 0.1% peptone water, then homogenised for two minutes (AOAC, 1984). Serial dilutions in triplicates from 10^{-1} to 10^{-5} were prepared and used for presumptive and confirmatory tests for coliforms. Results were expressed as most probable number of coliform per gramme of food (MPN/gm).

3.8 DATA ANALYSIS.

The data was edited and then entered and cleaned in a computer using a database programme (dBase3+). Means and frequencies of vendor characteristics and the foods were calculated using a statistical package (SPSS). A spreadsheet programme (Quatro-Pro) was used to perform Duncan´s Multiple Range Test on the caloric and protein contents of the meals.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The results and discussions are presented in three parts covering the following aspects:

(1). The survey.

(2). Proximate composition of the foods.

(3). Microbiological quality of the foods.

4.1. THE SURVEY.

4.1.1 Description of the results

4.1.1.1 Food vendor characteristics.

Of the 58 street food vendors interviewed 67.2% were females, while the rest (32.8%) were males (Table 1). Majority of both female and male vendors (i.e. 69.2 and 57.9% respectively) were married. However, a higher proportion of male vendors (41.1%) were single compared to 23.1% of female vendors who were single. None of the male vendors was widowed. These findings seem to imply that although the vending business is carried out by both females and males, majority are females. Female dominance in this trade is probably due to the fact that in Kenya traditionally, cooking food in homes for family consumption is the responsibility of women. Food preparation even for sale therefore, becomes easily carried out by women. This finding is similar to reports of studies by FAO (1989); Akinyele (1992); and Mlelemba and Chindamba (1992).

4.1.1.2 Educational background

More than half of both female (59%) and male (68.4%) vendors had only upto eight years of schooling. However more female vendors (41.0%) had between 9 and 12 years of schooling compared to (31.6%) male vendors who had similar level of schooling. Most food vendors at the construction sites were therefore of low academic qualifications. Elsewhere low levels of schooling among most street food vendors has been reported and has been suggested that this is a contributory factor to the vendor's poor hygienic food handing practices (FAO, 1989; FAO, 1992).

4.1.1.3 Age distribution of vendors

Table 1, shows that majority of the female vendors (38.5%) were aged between 31 and 35 years as compared to 10.5% male vendors in this age group. However majority (42.1%) of the male vendors were aged between 26 and 30 years as compared to 28.2% female vendors in the same age group. None of both female and male vendors were aged below 21 years or above 46 years. The females seemed to be starting the trade at older ages than their male counterparts. It is important to note that majority (73.7%) of the male vendors were aged between 21-30 years, while majority (67%) of the female vendors were aged between 26-40 years. It is possible that women in this group have slightly less family commitments since their children may be much older as compared to the younger females. This is particularly so due to the fact that traditionally most Kenyan women marry young. By the time the women are aged

above 30 years their children are unlikely to be too young to always tie them at home. Alternatively, around this age females could be considered more experienced enough to be able to take care of the family and engage in the trade at the same time as compared to younger women.

4.1.1.4 Site of food preparation

More than half of the vendors prepared their foods in their homes and ferried them using buses or other passenger vehicles from their homes to the bus terminals and by pushcarts or on their heads from the terminals to the vending sites. This would probably be the reason why people who were fairly young and thus strong enough to manage this transportation of the foods and any other problems associated with the trade formed majority of the vendors. It could therefore be possible that particularly for those foods prepared in the homes, the vendors were young employees or relatives but not the actual business owners.

Table 1. Characteristics of street food vendors.

Characteristic	% with characteristic	
	Male	Female
Marital status		
Married	57.9	69.2
Single	42.1	23.1
Widowed	0	7.7
Years of schooling		
0-4 yrs	10.5	10.3
5-8 "	57.9	48.7
9-12 "	31.6	41.0
Age distribution		
<21 yrs	0.0	0.0
21-25 "	31.6	2.5
26-30 "	42.1	28.2
31-35 "	10.5	38.5
36-40 "	10.5	23.1
41-45 "	5.3	7.7
>45 "	0.0	0.0

4.1.2 Types and average cost of foods served.

The most commonly sold foods in the study area were determined from the percentages of the vendors selling each type and are presented in Table 2. The five most commonly sold foods and the proportion of vendors selling them were: *githeri* (82.8%), *chapati* (67.2%), *uji* (24.1%), *ndengu* (23.4%), and *kienyeji* (22.4%).

Although a study was not done on consumer preference of the various foods, the number of vendors selling each food could indicate its popularity with the customers. *Githeri* was sold by majority of the vendors. This was followed closely by *Chapati*. The fact that most vendors were selling *Githeri* is not surprising since besides being cheap, it is popular among many Kenyan families. *Githeri* is also a traditional food particularly for the ethnic group of people living in Central Province which borders Nairobi. It is possible that most vendors and even customers were from this ethnic community. The cost of *githeri* was also comparatively low compared to the prices of other foods.

Chapati was second in popularity among vendors. This food was mainly being prepared by male vendors. This striking observation is similar to what was observed in Nigeria, where men were found to be dealing with foods which did not take long to prepare, while the female vendors dealt with foods that took long to cook (Akinyele, 1992; George, 1992). It is also possible that female vendors dealt with foods such as *githeri* which do not require constant attention like *chapatis* do because food preparation is also performed alongside other

household chores. It was observed that most of the female vendors cooked the foods at home and only brought them to the vending sites during peak hours of vending. They left the vending site as soon as the food was sold out. It is possible that male vendors have more time to spend at the vending sites because they have little else to do in their homes. They therefore prepared foods requiring attention and at the vending sites.

As shown in Table 2, the most costly type of food sold singly was *kienyeji* (KSh 10.60 per serving). Foods eaten in combinations, however, cost much more in terms of the cost of the ingredients. In majority of cases, the costs of foods eaten in combination was a direct summation of the cost of individual ingredients.

Although the prices of the various foods were stated, customers could negotiate with the vendors to pay less or eat on credit. Furthermore, of all vendors interviewed, 43.1% reported upward adjustment of the prices of foods from time to time as deemed necessary. The cause of this price adjustment was given by 64.0% of the vendors as due to changes in prices of ingredients.

The quantity of serving of each food sometimes varied slightly with the customer being served, especially because some customers requested to be given a little more for the money or, for established customers, as tips by vendors. There were also little variations in quantities of serving of the same food from one vendor to another, principally because scoops rather than balances were used.

Although *mandazis* are listed on Table 2 as one of the common foods vended, they were eaten mainly as snacks with or without tea.

Table 2. Main foods sold, proportion of vendors selling and weight and cost per serving.

Type of food	vendors selling (%)	Mean weight of serving (g)*	Cost per Serving (Ksh)*
Githeri	82.9	605(171)	7.90(2.5)
Chapati	67.2	154(19)	7.05(0.80)
Uji	24.1	474(122)	4.00(0.70)
Ndengu stew	23.4	435(96)	7.50(2.30)
Kienyeji	22.4	826(63)	10.60(0.90)
Mboga	15.5	333(26)	3.60(0.50)
Bean stew	15.5	710(102)	6.60(1.30)
Potato/Beef stew	10.3	425(76)	10.00(2.00)
Mandazi	10.3	166(8)	4.00(1.00)
Ugali	6.9	509(59)	6.25(0.90)
Matumbo	5.4	542(2)	8.30(1.50)
Rice	5.2	347(34)	9.00(1.00)

* Means (standard deviations), n = at least 3.

At the time of the study, 1KSh = USD 0.028

4.1.3 Source of ingredients and preparation of the foods.

Almost all vendors (95.8%) purchased from markets all the ingredients used for preparation of the foods. The remaining vendors obtained only some of the ingredients from their own farms. Street food vendors therefore make a positive contribution to the local economy, since these foods are at the end of marketing and distribution chains for agricultural products.

Of the vendors interviewed, 45.8% prepared and sold the foods by themselves, 41.7% were assisted by part-time employees, while 12.5% had full-time employees solely for the business.

Self employment in Kenya is now being encouraged because very few employment opportunities are being generated in the formal sectors of the economy as compared to the number seeking employment (GOK, 1992). Potential for employment seems to exist in the street food vending. This study indicated that upto 12.5% of the vendors had full-time assistants employed in the business. It was clear, however, that only those with low formal education were employed in this sector. It is, however, only a matter of time and very soon, persons with high levels of education will begin to seek livelihood in this form of trade and especially with the current spiralling lack of employment even for university graduates in this country.

4.1.4 Mode of payment by customers.

Majority of the vendors (55.2%) sold their food both cash and on short-term credit to their customers. The credit

facility was probably a tactic by the vendors to retain customers by assuring them of food even when they did not have cash at hand. Of the vendors, 41.4% preferred to sell their food on cash basis only probably afraid of taking the risk of extending credit facilities to customers who had only casual employment and could have their jobs terminated any time. The remaining 3.4% who sold their food on credit only probably had their own means of assessing credit worthiness of their customers. It was possible also that these vendors only dealt with few customers who were properly known to them.

4.1.5 Average income per month to the vendors.

Up to 43.1% of the vendors reported making average profits per month of between KSh 3,000 and KSh 5,000, while 51.7% were making between KSh 1,000 and KSh 3,000, and the remaining 5.2% were realising less than KSh 1,000. These results show that majority of the street food vendors realised from this trade alone, incomes greater than the recommended minimum wage for Nairobi of about KSh 1,000. It was not established whether the vendors were saving their money or using it on daily basis. However, it was clear that each vendor organised his/her income in such a manner that there were always adequate finances to continue operating the business.

4.1.6 Time the foods were prepared.

Most of the vendors (58.6%) cooked the foods in the morning of the day of sale, while 41.4% prepared the foods the

night before. Those who prepared the foods the night before indicated that they wished to ensure that the foods were ready for sale at lunch time. Most of the vendors who reported cooking their foods the night before, were mainly dealing with foods that either take long to cook or those that require pre-treatments such as soaking (e.g *githeri*). It is possible that in these cases, only pre-cooking processes were done the night before, and finish-cooking done the following morning.

4.1.7 Management of left-over foods.

None of the vendors reported storing the unsold foods overnight for sale on the next day. Upto 41.4% of the vendors reported giving their left over foods to the street children for free. This in itself is a positive gesture by the vendors, extending their generosity to the hungry and needy children. Up to 37.9% reported taking their left over foods home for consumption by their families. For these vendors, it might mean that family meals were rarely prepared separate from the foods for vending unless there were no left-overs from the sales. A few (6.9%) reported throwing the left-overs away. This action is difficult to conceptualise, especially since this trade is carried out in the midst of very needy persons. The remaining 13.8% of the vendors did not have any left-over food. This group possibly constituted the more experienced vendors, probably with an established number of loyal customers, and were therefore able to make a correct assessment of the amounts that could be sold completely within the day.

Elsewhere, it has been reported that street food vendors can keep left-over foods for sale the following day (Akinyele, 1992; FAO, 1989). This practise though not bad, could easily lead to increased incidences of food borne illnesses among the consumers if the foods are not stored properly

4.1.8 Source of water for preparation of the food

Water is important in preparation of food. In this study the results revealed that all vendors used tap water for cleaning and cooking at the vending sites. However, 48.7% of the vendors did not have easy access to sufficient water, while the rest (51.7%) had no problems getting sufficient water. It was, however, observed that even with those vendors who indicated having had easy access to sufficient water, water for washing utensils was not frequently changed by majority of them. This water was re-used to the extent that food particles could be seen settled at the bottom of the container or an oily layer could be seen on top of the water. This could imply that either water was not really readily available or that the perception of hygiene by the vendors was low.

Water for washing was stored in plastic jerricans by 96.6% of the vendors, while 3.4% stored it in metal tanks. This same water was also provided to customers for drinking after eating. Most of these storage tanks and jerricans were either dirty or old and cracked, the latter of which made their cleaning difficult. Some of the tanks also had layers of rust lining their inside. The rust could easily react with

chemical food components, resulting in undesirable, even toxic, products. Water stored in such old metal containers in some Asian countries has been reported to accumulate heavy metals in excess of the recommended levels, thus posing risks to the consumers (Winarno and Allain 1991 ; Dowson and Canet, 1991).

4.1.9 Refuse disposal by the vendors

Most of the vendors (63.8%) reported that they threw their wastes in city council bins, although it was observed that the bins were found only in a few points away from the proximity of the vending places. Real truth is that the wastes were dumped near the vending sites. Infact it was observed that the waste water was normally dumped next to the vending sites and left to seep into the ground leaving dirt residue above the ground level. It was therefore normal to see flies buzzing around the vending sites due to the smell from this dirty water residue. The rest of the vendors (36.2%) reported giving their refuse to people for animal feed (especially pigs). Poor waste disposal by street vendors has been reported in other studies. The studies have pointed out that these irresponsible disposal methods could constitute health hazard risks (FAO, 1989; FAO/WHO, 1992).

4.1.10 Hygiene during handling of the foods.

In the present study all the vendors reported not washing their hands before serving the food. Habits of food handlers are potential source of microbial contamination to the food,

especially if the hands are not washed after handling contaminated material or visiting the toilet.

For the vendors who prepared their foods at home then transported it to the vending sites, it was not uncommon to see them arrive and start serving the foods immediately without washing hands. While serving food that was transported from home, contaminants that may have been picked by handler's hands during travelling may therefore, be introduced into the food. The foods were, however, nicely covered during transportation from the homes to the market.

Majority of the vendors (77.6%) used soap for cleaning the utensils but the soapy wash water was not changed frequently enough while the utensils were rinsed in very little water which was also rarely changed. Further, only 15.6% of the vendors used hot water for washing utensils. The remaining 81.0% washed the utensils with cold tap water. Most of the utensils therefore looked oily.

A small proportion (3.4%) of the vendors had their foods prepackaged in polythene paper bags or used Kraft paper and therefore, had no utensils to wash. Some of the Kraft papers had been printed old packages. The ink from these could, however, easily seep into the foods resulting in adulteration. It is also possible that some of the Kraft paper could have been from bags which had been used for packaging material that was not necessarily allowed for consumption.

4.1.11 Problems faced by vendors.

A total of 22.2% of the respondents reported having no

problems at all in the business. Out of those who reported having problems most of them (42.3%) singled out constant harassment by the city council authorities as their main problem. This could probably have been due to the fact that the vendors had no hawking licences or failed to meet health requirements. The rest cited as major problem either cooking fuel scarcity, bad weather conditions (e.g rainy seasons), or insecurity of the business and loss of money due to customers absconding after taking the foods on credit. During rainy weather, the vendors faced problems due to lack of shelter from rain in their vending places. They also did not have shelter from the sun but this could at least be tolerated. Good business was also very much dependant on there being some construction work or such other activity that employs low paid workers. A few non-construction workers were, however, reported to be purchasing these foods. As the cost of living increases in the city without a corresponding increase in income, these foods will become increasingly popular as lunch even for non-construction workers.

4.1.12 The conditions under which the foods are vended

Observations were made on the cleanliness of the clothes of both the vendors and their employee assistants, the cleanliness of the vending area, the cleanliness of the cooking equipment and whether vendors and their assistants used aprons and head gear. These results are shown in Table 3. It was found that 12.1% of the vendors and 3.4% of the assistants wore aprons while the remaining (87.9% of the

vendors and 96.6% of the assistants) did not wear the apparels. Of the vendors, 63.8% had some form of head covering, while only 17.2% of the assistants covered their heads.

The high percentage of vendors and assistants who did not wear aprons and head gear could partly be the reason for the constant harassment by the city council authorities, since this is usually a requirement for licensed food hawkers. Even for those who had them, the aprons and head covers looked dirty. Majority of the vendors who wore head covers were females, probably as part of the normal dress and not necessarily as a fulfilment of the public health requirement in the trade.

Most of the vendors placed the foods on the ground level for serving. The foods were also normally left open as long as selling was going on. The foods were therefore very susceptible to contamination with filth and microorganisms from the ground.

Serving of some foods especially *chapatis* and *mandazis* with bare hands was also a common feature.

Most of the vendors could, however, be rated as fairly clean in all aspects observed.

Table 3. Cleanliness of the vendors and vending environment.

Observed aspects	Proportion of the vendors with the levels of cleanliness observed.				
	Very clean	clean	Fairly clean	dirty	N/A
Clothes (i) Vendors	6.9	25.4	53.9	13.8	
(ii) Assistants	3.6	20.2	60.7	15.5	
Vending area	5.2	10.3	67.2	17.3	
Cooking equipment					
Cooking sticks	3.4	6.9	29.4	8.6	51.7[a]
Chopping boards	3.4	5.2	29.3	10.4	51.7[a]
Cooking pans	5.2	5.2	28.0	9.9	51.7[a]
Eating utensils	4.2	14.8	67.2	10.4	3.4[b]
Serving spoons	4.0	25.9	56.4	10.3	3.4[b]
Cutting knives	3.5	10.4	67.9	14.8	3.4[b]

* Not applicable for the aspect observed

a = Percent of vendors not cooking on site.

b = Percent of vendors with foods prepackaged in polythene bags and old paper.

4.2 PROXIMATE CHEMICAL COMPOSITION OF THE FOODS.

The proximate chemical composition of the various foods per 100 g dry matter is shown in Table 4. Potato/beef stew had the highest protein content of 28.39%, followed by *ndengu* stew and bean stew with 22.47% and 19.74% protein contents respectively. Plain rice had the least protein content of 6.21%.

Moisture contents of foods is reflective of their solids content, the higher the moisture content the lower the dry matter content. All the foods analyzed had moisture contents of over 60%, except chapatis which had 35.14%. *Uji* (porridge) had the highest moisture content of over 90%.

Protein content was highest in potato/beef stew probably due to the meat (beef) which formed one of the major ingredients in the stew. The pulses (*ndengu* bean) stews contained high crude protein contents too. Protein from plants has been found to be of low biological value when compared to protein from animal sources. Potato protein has, however, been found to be of high biological value, infact comparable to that of animal protein (Robinson and Lawler 1982).

The three foods that had the highest crude fat contents were *matumbo*, *chapati* and potato/beef stew with 27.77%, 12.89%, 12.18% Crude fat respectively. *Matumbo* particularly intestines, from a well fattened animal normally contain high levels of fat, which is the main contribution to the high fat levels in this food. *Chapati* and *mandazi* had high fat contents probably resulting from the oil used in the deep frying of these products. Similarly the fat used in cooking of the

potato/beef stew and *mboga* could have made significant contribution to their fat contents of 27.77% and 11.1% respectively, as compared to the levels in the pure uncooked ingredients.

Total ash, which may be used as a general measure of mineral contents of food, was highest in *kitoweo-mboga* (11.46%). Ash content of the rest of the foods ranged from 1.78% (*chapati*) to 8.01% (*ndengu stew*).

Mboga also contained the highest fibre (6.16%) content, obviously from the green vegetables which normally have high fibre contents. Fibre content of *ndengu* stew (5.49%) was probably contributed by carrots and other ingredients that were present. The husk of the pulses also contain high levels of fibre. Fibre contents of the other foods were below 4%.

Rice had the highest soluble carbohydrates of 85.73%. The rice grain is predominantly starch. The rest of the foods had soluble carbohydrate contents of over 50% except *matumbo* which contained 45.19%. Animal products are generally low in carbohydrates, except glycogen if it happens to be present in appreciable quantities.

Table 4. Proximate composition of the foods*.

Type of food	Moisture (% wet basis)	Component in gm per 100g DM				
		Protein	Fibre	Fat	Ash	Sol.carbohyd.
Githeri	70.46(5.50)	14.09(1.17)	3.21(0.87)	5.07(1.39)	4.53(0.98)	73.10(2.84)
Chapati	35.14(1.95)	10.78(0.13)	1.18(0.74)	12.89(0.98)	1.78(0.25)	73.36(2.04)
Kienyeji	70.37(9.50)	10.54(1.03)	2.51(0.25)	5.15(0.90)	5.23(0.76)	76.57(1.38)
Ugali	68.05(1.83)	7.39(0.26)	0.32(0.01)	6.13(0.02)	4.38(1.90)	81.78(0.07)
Rice	75.18(1.85)	8.21(0.09)	0.08(0.03)	2.44(0.18)	3.54(0.03)	85.73(0.27)
Mandazi	28.08(3.42)	11.04(0.14)	0.41(0.40)	10.86(0.39)	1.62(0.08)	76.07(0.15)
Pot/beef stew	82.25(3.42)	28.39(0.08)	1.69(1.64)	12.18(1.51)	7.30(0.06)	50.44(5.25)
Ndengu stew	82.23(1.00)	22.47(0.65)	5.49(0.36)	7.57(1.82)	8.01(1.18)	56.46(0.34)
Matumbo	78.38(1.06)	19.70(2.12)	2.39(1.20)	27.77(5.52)	4.95(1.38)	45.19(7.47)
Mboga	84.17(5.26)	12.81(0.86)	6.16(4.23)	11.32(4.33)	11.46(3.92)	58.25(13.35
Bean stew	82.23(1.12)	19.74(0.62)	5.75(2.32)	3.08(0.42)	5.29(0.11)	66.14(1.52)
Uji	91.11(2.14)	8.62(2.51)	1.14(0.42)	4.57(2.09)	2.13(1.17)	3.54(6.23)

* Mean (SD), n at least 3.

4.2.1 Mean weight of serving and caloric values of the foods.

Table 5 shows the mean weight of serving, and caloric and protein values of the foods. Caloric values per serving on dry matter of the foods was calculated by assuming 4 kcal/g of protein, 4 kcal/g of soluble carbohydrates and 9 kcal/g of fat. *Matumbo* had the highest energy value (597 kcal/serving), due to the high fat, the component with the highest conversion factor in the calculation of the energy content. The high values for *chapati* (451 kcal/serving) and *mandazi* (532 kcal/serving) could also be mainly attributed to the oil absorbed during their frying.

Table 5. Mean size of serving, DM per serving, protein and energy contents per serving of foods*.

Types of food	Mean size of serving (g)	DM per serving (g)	Energy per serving (kcal)	Protein per serving (g)
Githeri	605(171)	178.7(4.30)	706(79)	25.02(4.18)
Chapati	154(19)	99.8(1.00)	451(25)	10.76(0.26)
Kienyeji	826(63)	244.7(7.45)	966(86)	25.79(5.09)
Ugali	509(59)	162.6(3.50)	669(77)	12.02(0.85)
Rice	347(34)	86.2(2.61)	335(26)	7.07(0.16)
Mandazi	166(8)	119.4(1.15)	532(64)	13.18(0.33)
Pot/beef stew	425(76)	75.4(2.21)	317(21)	21.42(0.13)
Ndengu stew	435(96)	77.3(5.60)	296(37)	17.38(1.00)
Matumbo	542(2)	117.2(3.50)	597(67)	23.08(1.40)
Mboga	333(26)	52.7(6.01)	203(19)	6.75(1.77)
Bean stew	710(102)	126.2(2.01)	468(57)	24.91(0.57)
Uji	474(122)	42.1(5.50)	172(15)	3.63(0.20)

* Mean (SD), n = at least 3

4.2.2 Energy and protein contents of the Meals.

The foods discussed above were eaten in the combinations (meals) shown in Table 6. The Table also shows the mean weights of serving for each meal and the corresponding Energy and Protein contents.

In terms of bulk weight, meals based on *githeri* were the largest, with *githeri+matumbo* having the highest weight overall. These were followed closely by *ugali*-based meals, rice-based meals and finally *chapati*-based meals in that order.

The meal which contained the highest protein and energy per serving was *githeri+matumbo* with 48.3g protein and 1302 kcal energy respectively. The meal, however, also contained the highest weight per serving. Generally, the *githeri*-based meals differed significantly ($p<0.05$) in protein contents from the rice-based, *chapati*-based and *ugali*-based meals, which did not differ significantly ($p<0.05$) among each other in protein content. Statistical analyses, however, showed that the differences in protein content per serving among the meals *githeri+matumbo*, *githeri*+Potato/Beef stew and *githeri+ndengu* stew was not significant at 5% level of significance, even though the latter two meals had slightly lower protein contents (Table 6). The protein contents of all the three meals were, however, significantly different ($p<0.05$) from the protein contents of plain *githeri* and *kienyeji* which did not differ significantly in their protein contents.

Rice+*ndengu* stew did not differ significantly ($p<0.05$) from rice served with beef stew in terms of protein content.

Chapati was served with either *mboga*, *matumbo* or beef stew, bean stew or *ndengu* stew.

The protein content of *chapati+mboga* differed significantly from the protein content of all other *chapati*-based meals, which did not differ significantly among themselves in their protein contents.

Ugali on the other hand was commonly served with *matumbo* and *ndengu* stew, and surprisingly rarely with beef stew or mboga. A meal of *ugali* with *mboga* would definitely have been the cheapest. However, it is possible that the two *ugali*-based meals served were within affordable range by customers, while a meal of *ugali* with beef stew was a little more expensive. In any case, this could easily be substituted for a cheaper *ugali+matumbo*.

The protein content of *ugali+ndengu* and *ugali+matumbo* were not significantly different ($p<0.05$) from each other.

Finally *uji* was normally served with plain *githeri* but not necessarily. The protein content of *githeri+uji* was, however, significantly different from the protein content of all other *githeri* based meals except plain *githeri*.

There was more variation in the energy contents of the meals than in the protein contents. Even the meals based on the same staple varied significantly in their energy contents.

Githeri+matumbo still had significantly ($p<0.05$) the highest energy content among all the meals. This value was, however, not significantly different from both the energy contents of *ugali+matumbo* and *chapati+matumbo*, possibly because the fat in *matumbo* formed the main contribution to the

energy contents of these meals. *Githeri+matumbo* had significantly ($p<0.05$) higher energy levels than both *githeri*+beef stew and *githeri+ndengu* stew, which were not significantly different ($p<0.05$) from each other but were both significantly higher from plain *githeri* in energy contents. The energy content of plain *githeri* was not significantly ($p<0.05$) different from that of *kienyeji*.

Ugali served with *matumbo* provided significantly ($p<0.05$) higher energy than when served with *ndengu* stew.

There were no significant differences among the energy contents of *chapati+ndengu* stew, *chapati*+beef stew, *chapati*+bean stew and *chapati+matumbo*, but the latter three meals had significantly ($p<0.05$) higher energy contents than *chapati+mboga*.

There was no significant ($p<0.05$) difference between rice served with *ndengu* stew and rice served with beef stew.

Eating plain *githeri* followed by taking *uji* provided levels of energy significantly ($p<0.05$) lower than the energy provided by *githeri+matumbo*, but the energy was not significantly ($p<0.05$) different from that of either *githeri*+beef stew, *githeri+ndengu*, *kienyeji* or plain *githeri*. Lack of significant difference between the energy contents of plain *githeri* and *githeri+uji* indicated the low contribution of *Uji* due to its very low solids content.

Similar statistical analyses indicated that, *githeri +matumbo* had significantly ($p<0.05$) higher calories compared to the rest of the meals but was not significantly different from *ugali+matumbo* and *chapati+matumbo* in protein content.

Table 6. Mean Energy and protein contents of the meals served*

	Mean(gm) weight of serving	Protein (gm) per serving	DMRT**	Energy (kcal/serving)	DMRT**
Githeri	605(171)	25.60(2.02)	de	706(79)	fghi
Githeri & Matumbo	1147(173)	48.28(7.23)	a	1302(202)	a
Githeri & Beef stew	1030(247)	46.14(10.28)	b	1018(246)	cd
Githeri & Ndengu	1041(268)	42.59(11.01)	abc	1002(265)	cde
Githeri & Uji	1079(49)	28.83(8.08)	d	876(244)	cdefghi
Kienyeji	826(63)	25.81(1.98)	de	966(74)	cdefg
Rice & *Ndengu* stew	783(130)	24.47(4.56)	de	640(99)	hi
Rice & Beef stew	772(110)	28.02(3.85)	d	664(83)	hi
Chapati & Ndengu stew	588(118)	28.18(5.24)	d	750(123)	cdefghi
Chapati & Beef stew	612(112)	31.74(4.53)	d	766(74)	cd
Chapati & Mboga	401(53)	15.54(2.49)	e	596(91)	i
Chapati & Matumbo	694(21)	33.87(1.47)	cd	1050(59)	abc
Chapati & Bean stew	865(122)	35.72(4.99)	cd	922(125)	cdefgh
Ugali & Matumbo	1051(61)	35.11(1.51)	cd	1276(95)	ab
Ugali & Ndengu	945(156)	29.42(5.29)	d	967(144)	cd

* Mean (SD), n =at least 3.

** Any two means down the column having a common letter are not significantly different at the 5% level of significance

DMRT = Duncan's Multiple Range Test (Pair comparison between means).

4.2.3 Energy and Protein per meal versus the Recommended Daily Allowance (RDA) of the buyers.

The customers of the foods were mainly construction casual labourers. The RDA values for people who perform "Heavy Work" as laid down by the WHO standards were used (West, 1987). The RDA for protein used for the two age categories (18-30 years and 30-60 years) was 49g. The RDA for energy for the two age groups were 3550 kcal and 3400 kcal respectively. Contributions to the RDAs of energy and protein by each food per serving are shown in Table 7.

Three meals that contributed the highest to the RDA of energy for both age categories were *githeri+matumbo*, *ugali+matumbo* and *chapati+matumbo* (36.7%, 35.9%, and 29.6% respectively). This was probably due to the high fat content of the *matumbo*. *Chapati+mboga* contributed the lowest RDA for energy in all age categories. All meals, however, contributed less than 50% RDA for energy for all age groups, showing that unless the remaining percent RDA in energy was satisfied during dinner, it is most likely that the categories of workers studied consumed insufficient energy each day.

The meals with the highest percentage contribution to protein RDA were *githeri+matumbo*, *githeri*+potato/beef stew, and *githeri+ndengu* stew (98.5%, 94.2% and 86.9% respectively). Except for *chapati+mboga* and rice+*ndengu* stew, all the other meals contributed more than 50% of the protein RDA for all age groups giving a fair chance that RDA for protein would be satisfied if a similar dinner was consumed. Ordinary Kenyans consume mainly two meals per day, lunch and dinner and it can

be assumed that the bulk of RDA for most nutrients would be satisfied from the two meals.

Table 7. Percentage contribution of the meals to energy and protein to RDAs of the buyers*.

	Energy			Protein	
		% RDA Contribution for ages			
Meal	kcal/serving	(18-30) years	(30-60) years	gm/serving	% RDA contr.
Githeri	706(179)	19.9	20.8	25.60(2.02)	52.2
Rice + *Ndengu*	783(130)	22.1	23.3	24.47(4.56)	49.9
Rice + *Pot/Beef stew*	664(83)	18.7	19.5	28.02(5.24)	57.2
Chapati + Ndengu	750(123)	21.1	22.1	28.18(5.24)	57.5
Chapati + Pot/Beef stew	766(74)	21.4	22.5	31.74(4.53)	64.8
Kienyeji	966(74)	27.2	28.4	25.81(1.98)	52.7
Chapati + Mboga	596(91)	16.8	17.5	15.54(2.49)	31.7
Chapati + Matumbo	1050(59)	29.6	30.9	33.87(1.47)	69.1
Ugali + Matumbo	1276(95)	35.9	37.6	35.11(1.51)	71.6
Ugali + Ndengu	967(144)	27.3	28.5	29.42(5.29)	60.0
Chapati + Bean stew	922(125)	25.9	27.1	35.72(4.99)	72.9
Githeri + Uji	876(244)	24.7	25.8	28.83(8.08)	58.8
Githeri + Ndengu	1002(265)	28.2	29.5	42.59(11.01)	86.9
Githeri + Pot/Beef stew	1018(246)	28.7	29.9	46.14(10.28)	94.2
Githeri + Matumbo	1302(202)	36.7	38.3	48.28(7.23)	98.5

* RDA's for Energy 18-30 years = 3550 Kcal.

30-60 years = 3400 Kcal.

Protein for all ages = 49g.

4.3 MICROBIOLOGICAL QUALITY OF THE FOODS

The coliform counts of the various foods are shown in Table 8. Results show that the coliform counts of the foods prepared at home and those prepared on site were not significantly different from each other ($p<0.05$) in terms of coliform counts.

The levels of coliform counts in the foods studied were comparable to the levels reported elsewhere (FAO, 1989). Foods that have been properly cooked should have low levels of viable bacterial counts, unless there is recontamination after cooking.

High coliform counts are usually indicative of re-contamination of food particularly with faecal matter. However, under normal circumstances, coliforms are also found existing on vegetation, and in the soil (WHO, 1976). In the present study it was noted that vendors sold the foods in the open. It is therefore possible that the high coliform levels could have been introduced through dust being blown into the food from the high activity at the construction sites. The contamination could also have been from the water used to wash the utensils.

Table 8. Coliform counts of various foods expressed as most probable numbers/gramme of food (MPN/g).

	Foods prepared at home		Foods prepared on site	
Type of food	Sample	Coliform counts (MPN/g)	Sample	Coliform counts (MPN/g)
Githeri	1	9.3×10^5	1	9.5×10^4
	2	1.1×10^7	2	4.3×10^5
	3	2.4×10^6	3	9.3×10^5
Uji	1	4.6×10^5	1	1.6×10^5
	2	2.4×10^5	2	1.5×10^6
	3	2.1×10^5	3	9.5×10^4
Chapati	1	9.3×10^8	1	2.1×10^5
	2	1.6×10^5	2	1.5×10^6
	3	6.4×10^5	3	9.3×10^3
Bean stew	1	4.3×10^5		
	2	1.5×10^3		
	3	4.3×10^4		
Kienyeji	1	1.5×10^6		
	2	1.1×10^7		
	3	4.6×10^6		
Pot/Beef stew			1	2.9×10^5
			2	1.5×10^5
			3	9.3×10^4
Ndengu stew			1	9.3×10^5
			2	2.3×10^3
			3	4.3×10^4

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS.

5.1 CONCLUSIONS.

The study established that street food vending is a business of both males and females but with the females predominating. Male vendors seemed to prefer preparing their foods on site, while female vendors normally brought ready-to-eat foods from their homes.

All vendors displayed low standards of hygiene in handling the foods, probably because they all had little formal schooling. It was also possible that the lack of sufficient cleaning water resulted in low hygiene in the vending places.

The study identified the major types of street foods sold at construction sites of Nairobi as *githeri, ugali, chapati* and rice served with various stews viz *matumbo, ndengu* stew, beef stew and *mboga*. These foods though diversified were not different from those normally consumed in Kenyan households.

There were basically two categories of street foods, those prepared in the homes and brought to the site for vending, and those prepared at the vending site.

Most of the meals provided more than 50% of the RDA for protein, but all meals provided less than 50% of the RDA for energy.

The coliform counts of most foods were found to be high suggesting contamination of the food with faecal material probably from the environment around the vending site or from the water used for washing the utensils.

Finally, street food vending is a business with ample potential for growth and expansion as a provider of affordable meals for most Kenyan workers.

5.2 RECOMMENDATIONS.

The foods were analyzed for proximate composition and total viable coliforms. In order to have a more elaborate view of street foods, analysis should be done on the specific nutrients such as vitamins and minerals.

A survey should be carried out to determine the number of times a consumer takes the street foods and whether there are any other meals taken in order to ascertain the contribution of street foods to the nutrient intake of the individuals.

Studies on the quality of the water used for preparation of the food and for washing utensils should be made in order to determine the contribution of the water to the hygiene standards of the food.

Due to high coliform counts, detailed microbiological studies should be undertaken to determine the potential for food poisoning by street foods.

A survey should also be carried out in other vending areas besides the construction sites for comparison purposes.

Realizing the socio-economic significance of street foods as well as their potential for health hazards, the city authorities should take early steps in recognising and assisting this industry in order to be able to initiate necessary measures to upgrade its quality.

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APPENDIX 1.

The types and quality of street foods survey questionnaire.

INSTRUCTIONS:

MAKE SURE YOU ADMINISTER THE QUESTIONS TO THE STREET FOOD VENDOR AT THE SELECTED SITES.

WRITE CLEARLY AND IN LEGIBLE HANDWRITING. USE ERASER TO CHANGE.

DO NOT READ OUT INFORMATION THAT IS ENLOSED IN [].

Name of interviewer _____

Province _____

Ward _____

CLUSTER NO. |__|__|

INTERVIEWER: ¦_____DATE:¦__¦__¦__¦

PART 1.

DEMOGRAPHY:

1. Name of the vendor_____

2. Gender 1= Male 2= Female ¦____¦

3. Age of the vender (in years) ¦___¦___¦

4. Area of residence _____

6. Number of years in school [Fill in the actual number as said by the respondent]

¦___¦___¦

7. Marrital status

1= Married.

2= Single.

3= Other and specify.

¦___¦

_____

CLUSTER NO. ¦___¦___¦

INTERVIEWER _____ DATE.¦__¦__¦__¦

PART 11.

[Ask the following questions and fill in the table bellow.]

1. What foods do you sell?
2. What are the ingredients of each of these foods?
3. How much of each ingredients do you use in making the food?
4. Where do you get each of these ingredients (use codes:
   1= bought,
   2= own farm, ¦___¦
   3=others and specify
5. If bought , how much money do you pay per quantity of each ingredient ?

Type of food	Ingredients	Amount of each ingredient used	Source	Cost/ quantity
				debes kg

Other units specify_____

CLUSTER NO. ¦___¦___¦

INTERVIEWER_____DATE. ¦__¦__¦__¦

[Ask the respondent the following questions and fill in the blanks.]

6. Who cooks the food(s) that you are selling?

1= self, 2= others and specify.

_____ ¦___¦

7. When did you cook the foods that you are selling today?

1=last night, 2= This morning, 3=others specify

_____ ¦___¦

8. If [last night ask:] Why do you cook them at night?

_____

_____

9. Do you cook these types of foods every day?

1=YES, 2=NO ¦___¦

10. If NO which other types of foods do you cook?. ..

[List]

_____

_____

_____

_____

_____

CLUSTER NO ¦____¦

INTERVIEWER _____ DATE ¦__¦__¦__¦

11. How do you prepare/ cook each of the foods [listed above]

Type of food	Method of preparation	comments	

[Use,1= Boiling, 2= Frying, 3=Others & specify]

[For question 12&13 use the table bellow.]

12. How much of each type of food do you serve?

[Weigh the quantity served and record in grams].

13. What is the cost per amount of food served?

Type of food	Amount served (g)	Cost per quantity served (Ksh)

14. Does the price of each of these food items change within the course of a month.

1=YES, 2=NO ¦____¦

[If yes] Ask why?

_____

CLUSTER NO ¦____¦

INTERVIEWER_____ DATE ¦__¦__¦__¦

---

15. What do you do with the food that remains unsold?.

use , 1= store for the next day,

2= Take home for consumption, ¦___¦

3= others& specify.]

16. [If stored for the next day] ask: How do you store the foods that remain e.g (cold storage etc)

---

17. Where do you get the water that you use for

i). cooking ¦____¦

ii). Washing utensils ¦____¦

iii). Drinking(by buyers) ¦____¦

Use , 1= tap, 2= river, 3= others and specify]

¦_____¦

18. Do you have any problems in obtaining this water that you use.

1= YES, 2= NO ¦____¦

19. What do you use to store the water that you use ?

[Put down what the respondent says].

¦_____¦

20. Where do you dispose wastes?

e.g Potato peels, etc.

¦_____¦

21. Do you have toilet fascilities here ? [If not] ask: Where do you go when in need ?

¦_____¦

CLUSTER NO ¦____¦

INTERVIEWER_____ DATE ¦__¦__¦__¦

22. What is the mode of payment by the customers?

[Tick the right response]

1= credit only

2= cash only

3= Both by cash and credit.

23. Do you have any problems in this business ?

¦_____¦

¦_____¦

24. How much on avarage do you earn from vending per month?

[Use] 1= Ksh 1,000 to Ksh 3,000.

2= Ksh 3,001 to Ksh 5,000.

3= less than Ksh 1,000

CLUSTER NO ¦____¦

INTERVIEWER_____ DATE ¦__¦__¦__¦.

PART 111.

FOR OBSERVATION.

[Please interviewer observe the following and fill in the spaces.]

[Use the following levels of cleanliness] 1= Very clean
2= Fairly clean
3= Dirty
4= Very dirty

2. Cleanliness of the:

i) Vendors and personnell [please check the following].

1) Clothes
2) Whether the put on aprons.
3)

ii) Vending area and equipments used for preparation and serving of food .

[Check list] -cooking sticks
-chopping boards
-cutting knives
-cooking pans
-eating utensils and serving spoons

_____

_____

_____

3. How the vendors handle food,ie:

-use of spoons for serving ¦_____¦
-Frequency for changing water for washing ¦_____¦
-Use of hot water for cleaning utensils ¦_____¦
-Use of soap etc for washing utensils ¦_____:
-Where they pour dirty water ¦_____¦
-Whether the food is re-heated before serving ¦_____¦
-washing of hand before they serve food ¦_____¦

APPENDIX 2

Analysis of Variance: Duncan's Multiple Range Test

The following are the steps based on Gomez & Gomez (1984).

1. Calculate the Total, T_i, for each meal served and the Grand Total, G, for all meals served as:

   $T_i = 3 \times \text{mean}$

   $G = \sum T_i$

   Thus:

MEAL	PROTEIN		ENERGY	
	mean (g)	Ti	mean (kcal)	Ti
1 Githeri	25.60	76.80	706	2118
2 Rice + Ndengu Stew	24.47	73.41	640	1920
3 Rice + Beef Stew	28.02	84.06	664	1992
4 Chapati + Ndengu Stew	28.18	84.54	750	2250
5 Chapati + Beef Stew	31.74	95.22	766	2298
6 Kienyeji	25.81	77.43	966	2898
7 Chapati + Mboga	15.54	46.62	596	1788
8 Chapati + Matumbo	33.87	101.61	1050	3150
9 Ugali + Matumbo	35.11	105.33	1296	3888
10 Ugali + Ndengu	29.42	88.26	967	2901
11 Chapati + Bean Stew	35.72	107.16	922	2766
12 Githeri + Uji	28.83	86.49	876	2628
13 Githeri + Ndengu	42.59	127.77	1002	3006
14 Githeri + Beef Stew	46.14	138.42	1018	3054
15 Githeri + Matumbo	48.28	144.84	1302	3906

	Protein	Energy
G	1437.96	40563
$\sum T_i^2$	147372.55	115710813

2. Calculate degrees of freedom (df) as:

   Total df = 3 x t - 1

   Meal df = t - 1

   Error df = t x 2 = total df - meal df

where t = total number of meals = 15

Thus Total df = 44

Meal df = 14

Error df = 30

3. Calculate correction factor, CF, as:

$$CF = G^2/(3xt)$$

Thus for protein CF = 45949.53

for energy CF = 36563488

4. Calculate the sums of squares ,SS, as:

$$\text{Total SS} = \sum X_i^2 - CF$$

$$\text{Meal SS} = (\sum T_i^2/3) - CF$$

$$\text{Error SS} = \text{Total SS} - \text{Meal SS}$$

where X_i = measurements of each meal given by the tables below:

(i) For proteins :

1 Githeri	23.58	25.60	27.62
2 Rice + Ndengu Stew	19.91	24.47	29.03
3 Rice + Beef Stew	24.17	28.02	31.87
4 Chapati + Ndengu Stew	22.94	28.18	33.42
5 Chapati + Beef Stew	27.21	31.74	36.27
6 Kienyeji	23.83	25.81	27.79
7 Chapati + Mboga	13.05	15.54	18.03
8 Chapati + Matumbo	32.40	33.87	35.34
9 Ugali + Matumbo	33.60	35.11	36.62
10 Ugali + Ndengu	24.13	29.42	34.71
11 Chapati + Bean Stew	30.73	35.72	40.71
12 Githeri + Uji	20.75	28.83	36.91
13 Githeri + Ndengu	31.58	42.59	53.60
14 Githeri + Beef Stew	35.86	46.14	56.42
15 Githeri + Matumbo	41.05	48.28	55.51

(ii) For energy

1	Githeri	627	706	785
2	Rice + Ndengu Stew	541	640	739
3	Rice + Beef Stew	581	664	747
4	Chapati + Ndengu Stew	627	750	873
5	Chapati + Beef Stew	692	766	840
6	Kienyeji	892	966	1040
7	Chapati + Mboga	505	596	687
8	Chapati + Matumbo	991	1050	1109
9	Ugali + Matumbo	1201	1296	1391
10	Ugali + Ndengu	823	967	1111
11	Chapati + Bean Stew	797	922	1047
12	Githeri + Uji	632	876	1120
13	Githeri + Ndengu	737	1002	1267
14	Githeri + Beef Stew	772	1018	1264
15	Githeri + Matumbo	1100	1302	1504

Thus

	protein	energy
ΣX_i^2	50123.34	39244753
Total SS	4173.81	2681265
meal SS	3174.65	2006783
Error SS	999.16	674482

5. Calculate the mean square, MS, for each source of variation by dividing each SS by its corresponding df:

Meal MS = meal SS / (t-1)

Error MS = error SS / tx2

Thus

	protein	energy
Meal MS	226.76	143342
Error MS	33.31	22483

6. Calculate the F value for testing the significance of the meals difference as :

F = meal MS / error MS

Thus

for protein F = 6.81

for energy F = 6.38

7. Obtain the tabulated F values (from Appendix E of Gomez & Gomez (1984)) with:

f_1 = meal df = t - 1 = 14

f_2 = error df = t x 2 = 30

Thus

tabulated F value = 2.04 at 5% level of significance

tabulated F value = 2.74 at 1% level of significance

8. Compare the computed F value of step 6 with the tabulated F values of step 7 and decide on the significance of the difference among the meals using the following rules:

(a) If the computed F value is larger than the tabulated F value at 1% level of significance, the difference between the meals is said to be highly significant;

(b) If the computed F value is larger than the tabulated F value at the 5% level of significance but smaller or equal to the tabulated value at 1% level of significance, then the difference between the meals is said to be significant;

(c) If the computed F value is smaller than or equal to the tabulated F value at the 5% level of significance, then the difference between the meals is said to be non-significant.

Thus from steps 6,7, & 8, the difference between the meals is highly significant in both protein and energy.

9. Compute the grand mean and the coefficient of variation, cv, as:

grand mean = G / (3xt)

cv = (100 x $\sqrt{}$(error MS)) / grand mean

[cv indicates the degree of precision with which the meals are compared; The accepted value is between 6 and 20% for such studies as the one being

analysed].

Thus

for protein: grand mean = 31.95; cv = 18

for energy: grand mean = 901; cv = 17

and so the difference between the meals in both proteins and energy is not due to experimental error or chance.

10. A significant F test verifies the existence of some differences among the meals but does not specify the particular pair (or pairs) of meals that differ significantly. To obtain this information, Duncan's Multiple Range Test (DMRT) is done. The steps are as follows:

11. Rank all the means in decreasing order.

Thus

For proteins:

meal	mean(g)
1 Githeri + Matumbo	48.28
2 Githeri + Beef Stew	46.14
3 Githeri + Ndengu	42.59
4 Chapati + Bean Stew	35.72
5 Ugali + Matumbo	35.11
6 Chapati + Matumbo	33.87
7 Chapati + Beef Stew	31.74
8 Ugali + Ndengu	29.42
9 Githeri + Uji	28.83
10 Chapati + Ndengu Stew	28.18
11 Rice + Beef Stew	28.02
12 Kienyeji	25.81
13 Githeri	25.6
14 Rice + Ndengu Stew	24.47
15 Chapati + Mboga	15.54

For energy:

meal	mean (kcal)
1 Githeri + Matumbo	1302
2 Ugali + Matumbo	1296
3 Chapati + Matumbo	1050
4 Githeri + Beef Stew	1018
5 Githeri + Ndengu	1002
6 Ugali + Ndengu	967
7 Kienyeji	966
8 Chapati + Bean Stew	922
9 Githeri + Uji	876
10 Chapati + Beef Stew	766
11 Chapati + Ndengu Stew	750
12 Githeri	706
13 Rice + Beef Stew	664
14 Rice + Ndengu Stew	640
15 Chapati + Mboga	596

12. Compute the standard error of the mean difference for any pair of meal means as:

$$s_d = \sqrt{(2s^2 / 3)}$$

where s^2 = error MS calculated in step 5.

Thus s_d = 4.71 for protein

s_d = 122 for energy

13. Compute the (t-1) values of the shortest significant range as:

$$R = r_p s_d / \sqrt{2} \quad \text{for } p = 2, 3, \ldots\ldots t$$

where t = total number of meals

s_d= standard error calculated in step 12

r_p= tabulated values of the significant Studentized ranges obtained from Appendix F of Gomez & Gomez (1984)

p = distance in rank between the pairs of treatment means to be compared (i.e. p = 2 for the two means with consecutive rankings and p = t for the highest and lowest means).

Thus the r_p values with error df = 30 and the 5% level of significance are obtained as:

p	r_p	R_p protein	R_p energy
2	2.89	9.63	250
3	3.04	10.12	263
4	3.12	10.39	270
5	3.20	10.66	277
6	3.25	10.82	281
7	3.29	10.96	285
8	3.32	11.06	287
9	3.35	11.16	290
10	3.37	11.22	292
11	3.39	11.29	293
12	3.40	11.32	294
13	3.42	11.39	296
14	3.43	11.42	297
15	3.44	11.46	298

14. Identify and group together all meal means that do not differ significantly from each other.

(a)- Compute the **difference** between the largest meal mean and the largest R_p value (R_p value at p = t) computed in step 13 and declare all meal means whose values are less than the computed difference as significantly different from the largest meal mean.

- Next compute the **range** between the remaining meal means (i.e. those means whose values are larger than or equal to the difference between the largest mean and the largest R_p value) and compare this range with the value of R_p at p = m where m is the number of meals in the group.

(i) If the computed range is smaller than the corresponding R_p value, all the m meal means in the group are declared not significantly different from each other, and the same letter, say "a", is given to these means;

(ii) If the computed range is larger than the corresponding R_p value, then at least one meal mean in the group is significantly different from the largest meal mean. Hence calculate the difference between each of these meal means and the largest meal mean and compare this difference with the corresponding R_p value. If the difference is smaller than the corresponding R_p value, then the meal mean is not significantly different from the largest meal mean. The same letter, say "a", is then given to the largest meal mean and all the meal means that are not significantly different from it.

(b)- Compute the **difference** between the second largest meal mean and the second largest R_p value (R_p value at p = t-1) computed in step 13 and declare all meal means whose values are less than the computed difference as significantly different from the largest meal mean.

- For the m_1 remaining meal means whose values are larger than or equal to the computed difference, compute its **range** and compare this range with the appropriate value of R_p (i.e. R_p at $p = m_1$).

(i) Declare all meal means within the range not significantly different from each other if the range is smaller than the corresponding R_p value. The same letter, say "b", is given to these means;

(ii) If the computed range is larger than the corresponding R_p value, then at least one meal mean in the group is significantly different from the second largest meal mean. Hence calculate the difference between each of these meal means and the second largest meal mean and compare this difference with the corresponding R_p value. If the difference is smaller than the corresponding R_p value, then the meal mean is not significantly different from the second largest meal mean. The same letter, say "b", is then given to the second largest meal mean and all the meal means that are not significantly different from it.

(c) The process is continued with the third largest meal mean, then the fourth, and so on, until all meal means have been properly compared.

Thus for protein

1. largest meal mean = that of githeri+matumbo
   difference = 36.82
   m = 3; range = 5.69; R_3 = 10.12
   Hence the meal means not significantly different from each other are those of githeri+matumbo, githeri+beef stew and githeri+ndengu and the same letter "a" is given to them.
2. second largest meal mean = that of githeri+beef stew
   difference = 34.72
   m = 4; range = 11.03; R_4= 10.39
   m = 3; range = 10.42; R_3= 10.12
   m = 2; range = 3.55; R_2= 9.63
   Hence githeri+beef stew and githeri+ndengu are not significantly different from each other and the same letter "b" is given to them.
3. third largest meal mean = that of githeri+ndengu
   difference = 31.2
   m = 5; range = 10.85; R_5= 10.66
   m = 4; range = 8.72; R_4= 10.39
   m = 3; range = 7.48; R_3= 10.12
   m = 2; range = 6.87; R_5= 9.63
   Hence githeri+ndengu, chapati+bean stew, ugali+matumbo and chapati+matumbo are not significantly different from each other and the same letter "c" is given to them.
4. fourth largest meal mean = that of chapati+bean stew
   difference = 24.4
   m = 11; range = 11.25; R_{11}=11.29
   Hence chapati+bean stew, ugali+matumbo, chapati+matumbo, chapati+beef stew, ugali+ndengu, githeri+uji, chapati+ndengu stew, rice+beef stew, kienyeji, githeri and rice+ndengu stew are not significantly different from

each other and the same letter "d" is given to them.

At this point, the same process can be continued with the fifth largest meal and so on. However because the mean of chapati+mboga is the only one outside the groupings already made, it is simpler just to compare chapati+mboga mean, using the appropriate R_p values, with the rest of the means (namely: ugali+matumbo, chapati+matumbo, chapati+beef stew, ugali+ndengu, githeri+uji, chapati+ndengu stew, rice+beef stew, kienyeji, githeri and rice+ndengu stew). These comparisons are made as follows:

m = 10; range = 18.33; R_{10}= 11.22

m = 9; range = 16.20; R_9= 11.16

m = 8; range = 13.88; R_8= 11.06

m = 7; range = 13.29; R_7= 10.96

m = 6; range = 12.64; R_6= 10.82

m = 5; range = 12.48; R_5= 10.66

m = 4; range = 10.27; R_4= 10.39

m = 3; range = 10.06; R_3= 10.12

m = 2; range = 8.93; R_2= 9.63

Hence kienyeji, githeri, rice+ndengu stew and chapati+mboga are not significantly different from each other and the same letter "e" is given to them.

Because the last meal in the array (chapati + mboga) has been reached, the process of grouping together all meal means that do not differ significantly from each other is completed.

The results are presented in the following table:

For protein

meal	mean(g)	DMRT
1 Githeri + Matumbo	48.28	a
2 Githeri + Beef Stew	46.14	ab
3 Githeri + Ndengu	42.59	abc
4 Chapati + Bean Stew	35.72	cd
5 Ugali + Matumbo	35.11	cd
6 Chapati + Matumbo	33.87	cd
7 Chapati + Beef Stew	31.74	d
8 Ugali + Ndengu	29.42	d

9	Githeri + Uji	28.83	d
10	Chapati + Ndengu Stew	28.18	d
11	Rice + Beef Stew	28.02	d
12	Kienyeji	25.81	de
13	Githeri	25.6	de
14	Rice + Ndengu Stew	24.47	de
15	Chapati + Mboga	15.54	e

For energy

1. largest meal mean = that of githeri+matumbo

   difference = 1004

   m = 4; range = 284; R_4= 270

   m = 3; range = 252; R_3= 263

   m = 2; range = 6; R_2= 250

   Hence the meal means not significantly different from each other are those of githeri+matumbo, ugali+matumbo and chapati+matumbo and the same letter "a" is given to them.

2. second largest meal mean = that of ugali+matumbo

   difference = 999

   m = 4; range = 294; R_4= 270

   m = 3; range = 278; R_3= 263

   m = 2; range = 246; R_2= 250

   Hence ugali+matumbo and chapati+matumbo are not significantly different from each other and the same letter "b" is given to them.

3. third largest meal mean = that of chapati+matumbo

   difference = 754

   m = 8; range = 284; R_8= 287

   Hence chapati+matumbo, githeri+beef stew, githeri+ndengu, ugali+ndengu, kienyeji, chapati+bean stew, githeri+uji and chapati+beef stew are not significantly different from each other and the same letter "c" is given to them.

4. fourth largest meal mean = that of githeri+beef stew

   difference = 724

   m = 8; range = 268; R_8=287

   Hence githeri+beef stew, githeri+ndengu, ugali+ndengu,

kienyeji, chapati+bean stew, githeri+uji, chapati+beef stew and chapati+ndengu stew are not significantly different from each other and the same letter "d" is given to them.

5. fifth largest meal mean = that of githeri+ndengu
   difference = 709
   m = 7; range = 252; R_7=285
   Hence githeri+ndengu, ugali+ndengu, kienyeji, chapati+bean stew, githeri+uji, chapati+beef stew, and chapati+ndengu stew are not significantly different from each other and the same letter "e" is given to them.

6. sixth largest meal mean = that of ugali+ndengu
   difference = 675
   m = 7; range = 261; R_7=285
   Hence ugali+ndengu, kienyeji, chapati+bean stew, githeri+uji, chapati+beef stew, chapati+ndengu stew and githeri are not significantly different from each other and the same letter "f" is given to them.

7. seventh largest meal mean = that of kienyeji
   difference = 676
   m = 6; range = 260; R_6=281
   Hence kienyeji, chapati+bean stew, githeri+uji, chapati+beef stew, chapati+ndengu stew and githeri are not significantly different from each other and the same letter "g" is given to them.

8. eighth largest meal mean = that of chapati+bean stew
   difference = 635
   m = 7; range = 282; R_7=285
   Hence chapati+bean stew, githeri+uji, chapati+beef stew, chapati+ndengu stew, githeri, rice+beef stew and rice+ndengu stew are not significantly different from each other and the same letter "h" is given to them.

At this point, the same process can be continued with the ninth largest meal and so on. However because the mean of chapati+mboga is the only one outside the groupings already made, it is simpler just to compare chapati+mboga mean, using

the appropriate R_p values, with the rest of the means (namely: githeri+uji, chapati+beef stew, chapati+ndengu stew, githeri, rice+beef stew and rice+ndengu stew). These comparisons are made as follows:

m = 7; range = 280; R_7= 285

m = 6; range = 170; R_6= 281

m = 5; range = 154; R_5= 277

m = 4; range = 110; R_4= 270

m = 3; range = 68; R_3= 263

m = 2; range = 44; R_2= 250

Hence githeri+uji, chapati+beef stew, chapati+ndengu stew, githeri, rice+beef stew, rice+ndengu stew and chapati+mboga are not significantly different from each other and the same letter "i" is given to them.

Because the last meal in the array (chapati + mboga) has been reached, the process of grouping together all meal means that do not differ significantly from each other is completed.
The results are presented in the following table:
For energy:

meal	mean (kcal)	DMRT
1 Githeri + Matumbo	1302	a
2 Ugali + Matumbo	1296	ab
3 Chapati + Matumbo	1050	abc
4 Githeri + Beef Stew	1018	cd
5 Githeri + Ndengu	1002	cde
6 Ugali + Ndengu	967	cdef
7 Kienyeji	966	cdefg
8 Chapati + Bean Stew	922	cdefgh
9 Githeri + Uji	876	cdefghi
10 Chapati + Beef Stew	766	cdefghi
11 Chapati + Ndengu Stew	750	cdefghi
12 Githeri	706	fghi
13 Rice + Beef Stew	664	hi
14 Rice + Ndengu Stew	640	hi
15 Chapati + Mboga	596	i