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PATTERNS AND DETERMINANTS OF FRESH FRUIT AND VEGETABLE INTAKE AMONG PUPILS OF BASIC SCHOOLS IN THE AMANSIE WEST DISTRICT OF THE ASHANTI REGION

BY

AMANKAWEN GIFTY

SEPTEMBER, 2016

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A THESIS PRESENTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY (POSTHARVEST TECHNOLOGY)

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DECLARATION

I, Amankawen Gifty, do hereby declare that this thesis 'Patterns and Determinants of consumption of fresh fruits and vegetables among basic school student in the Amansie West District of the Ashanti Region' was carried out by me under the supervision Mr. Patrick Kumah and Mrs. Patience Dzifa Kaledzi, lecturers of the Department of Horticulture, Kwame Nkrumah University of Science and Technology. This work is the result of my own original work and that no part of it has been published and presented for another degree in this university or elsewhere, except for the permissible citation/references from other source, which have been duly acknowledged.

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DEDICATION

This thesis is dedicated to my dearest husband George Agbanga, my children Gideon, Tracy and Michelle and to my mother Faustina Abdulai.

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I am highly indebted to many people for the successful completion of this work. I first and foremost give glory to the Almighty God for His grace. I also owe tones of gratitude and appreciations to my supervisors; Mr. Patrick Kumah and Mrs. Patience Dzifa Kaledzi, of the Department of Horticulture, KNUST for making time to go through the work and correcting mistakes that led to the success of the work. I am really grateful to them.

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ABSTRACT

The benefits of fruits and vegetable consumption have been numerously documented. However, large proportions of children both in and out of school do not fulfill the World Health Organization's (WHO) recommendation of eating fresh fruits and vegetables. Therefore a study was conducted to determine the patterns and determinants of consumption of fresh fruits and vegetables among basic school students in the Amansie West District in the Ashanti region. The study sought to determine the availability of fresh fruits and vegetables to students, evaluate the frequency of consumption and quality of fresh fruits and vegetables, to assess the effect of the consumption of fresh fruits and vegetables on the health of students and to evaluate the determinants of fruit and vegetable consumption among students. Questionnaires were administered to about

314 students in Basic schools of the Amansie West District and analysed using SPSS. Laboratory analysis conducted on fruits and vegetables from both the farm and market was analyzed using the student T-test. From the results, students (56.1%) consumed fruits while 74.2% consumed vegetables. Fruits and vegetables, respectively were found to be readily available to students from their parent farm (53.82; 71.97%), market (19.75%; 4.78%) and garden (12.74%; 2.23%).Majority of students (66.6%) consumed fruits once a day while few (29.6 %) consumed vegetables once a day. The major determinants for both fruit and vegetable consumption among the pupils was familiarity with the fruit and vegetables (94.6%) whereas Taste (61.8%) and food safety (40.4%) were the major quality determinants for fruits and vegetables, respectively. Logistic regression also showed that students were 0.7 times less likely to fall sick for every vegetable eaten and 2 times less likely for every fruit eaten when all other factors were controlled. From the health record of the Amansie West District hospital of the age range of respondents and their eating habit of fruits and vegetables including the treatment given to the fruits and vegetables before

consumption could be contributory factors to the high reports of diarrhoea in the District. However, from the laboratory analysis the microbial load levels of Total Plate Count, Total Mould Count, Total Coliform and *E. coli* present on fruit and vegetable samples from the laboratory analysis were within the acceptable range for human consumption (less than 3log10cfu/g). It can therefore be concluded that student in the district consumed more fruits than vegetables due to their familiarity with fruits. Educating them and making more fruits and vegetables available to them may improve consumption and thereby their health.

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CHAPTER ONE

1.0 INTRODUCTION

The benefits of fruits and vegetable consumption have been numerously documented. It is clear that meals rich in vegetables and fruits are beneficial in human heath (Krolner *et al*., 2009). For instance, it is reported that vegetables and fruits contained less fat while providing sufficient vitamins good for health (Striegel-Moore *et al*., 2006).There is evidence that bioactives in vegetables and fruits help protect against such diseases like cancers and hypertension. Generally, it is advisable to eat enough vegetables and fruits to avoid contracting Non Communicable Diseases (NCDs) (Krolner *et al*., 2009).

It was due to the reason above that; the World Health Organization (WHO) came out with recommendations for the intake of vegetables and fruits by at least 400g per day per person. This recommendation specify at least serving of fruits (160g) two times a day and serving of vegetables (240g) three times with at least one serving of vegetables containing leafy or orange and dark green vegetable (nutrient-rich vegetable) (StriegelMoore *et al*., 2006).

Studies have shown that there are large proportions of children both in and out of school who do not achieve the World Health Organization's (WHO) recommendation of consuming at least 400 grams of fresh fruits and vegetables daily. To promote an intake of vegetables and fruits` among children, there is the need to find out factors which influence their eating habit (Krolner *et al*., 2009). This calls for both qualitative and quantitative studies in multidisciplinary research.

The University of Ghana, FAO and the Ghana Institute of Horticulturists held a workshop in 2012 on the theme 'Producing and Consuming Fruits and vegetables: The Health and Wealth of the Nation'. The Ministry of agriculture is also working on programmes to enhancing post-harvest management of fruit and vegetables for prolonging

shelf-live and market stability. Though efforts have been made, much is required in the area of systematic education for behavioural change. It is reported that in Ghana vegetables and fruits intake is quite low at 74 kg per capita per year. It is however higher in urban areas than in rural settings notwithstanding huge home grown production, as many as 63% of families do not meet the intake daily (Bruno, 2009).

Over the years, subsequent governments have tried to improve upon academic performance of school children. Some of the measures introduced with the aim of improving quality education include the Best Teacher Awards, capitation grants, the upgrading of teacher training colleges to diploma awarding institutions, the establishment of additional training colleges the introduction of the school feeding programme. The study sought to identify the determinants of the consumption of fresh vegetables and fruits as well as the effects of FV consumption on their health using pupils in basic schools in the Amansie West District of the Ashanti Region.

The general objective of the study was to find the effects of consumption of fresh vegetables and fruits on the general wellbeing of students of basic schools. Specifically, the study sought to:

1. determine the availability of fresh fruits and vegetables to students;
2. evaluate the consumption frequency and quality of fresh vegetables and fruits;
3. determine the effect of consumption of fresh fruits and vegetables on the health of students; and
4. assess the determinants of fruit and vegetable intake among students.
5.

CHAPTER TWO

2.0 LITERATURE REVIEW

Fresh vegetables and fruits are essential foods for promoting health because they contain minerals, vitamins, and bio-functional components as vital nutrients and are also very low in calories and fat than other foods. Some studies have associated the decline rate of a number of cancers (stomach, colon, pancreas and cancer of the llung (Hall *et al*., 2009)) and also diabetes, cataract, cardiovascular disease and obesity (Bogers *et al.,* 2004) with an increased consumption of vegetables and fruits.

In one of its publications, the World Health Organization (WHO) made an elaborate discussion on nutrition, prevention of chronic diseases and diet and concluded that the consumption of at least 5 portions or 400g of vegetables and fruits per an individual per day (WHO, 2003). This recommendation specify at least serving of fruits (160g) two times a day and serving of vegetables (240g) three times with at least one serving of vegetables containing leafy or orange and dark green vegetable (nutrient-rich vegetable) (Striegel-Moore *et al*., 2006)

2.1 MEANING OF A FRUIT/VEGETABLE

A fruit can be defined according to Oxford English Dictionary, as 'the *part of a plant consisting of one or more seeds and flesh that is eaten as food especially the latter when it is juicy / pulpy*'. Consumers define a fruit as 'a plant part with nice flavours, which are either sweet naturally or sweetened before eating. The horticultural produce includes fruits, vegetables, flowers and other ornamentals and medicinal plants.

Fruits and vegetables can be classified according to their use or arbitrary. Botanically, most crops that are considered as vegetables are fruit vegetables example pepper, tomato and species of melon. Other fruits and vegetables are highly variable, they may be roots, stem,

leaves, immature or fruits. All fresh crops have high content of water and are easily dried up and injured mechanically (Jobling, 2002).

2.2 FRUIT AND VEGETABLE PRODUCTION IN GHANA

Ghana is a commercial producer of tropical fruits, with a lot of its citrus cultivated in the Ashanti Region. It is estimated that the United Kingdom alone imports over 2,000 tons of fruits from Ghana annually. Fruit production in Ghana has experienced a tremendous increase between 2005 and 2011. The Food and Agricultural Organisation (FAO) statistics indicate that pawpaw production in the country, for instance, has witnessed a gradual increase from 3,575 tons in 2005 to 48,000 tons in 2011. Banana production in the country more than doubled between 2005 and 2011. During this period the country produced 26230 and 75000 tons 2005 and 2011 respectively. The country produced 424,000 tons of pineapple from 2005 to 2011. Ghana's climate and soil composition support the growth of fruits in the tropics. This country is blessed with different types of fruits like pineapples mangoes citrus and coconut. There are therefore greater opportunities to process these fruits into juice and other products for domestic and foreign use (FAO, 2009).

On the average 582,857.14 tons of oranges were produced annually between 2005 and 2011. Mangoes, Mangosteen and Guavas witnessed an overall increase in production of 11.74%, from 75,000 tons in 2009 to 85,000 tons in 2011(FAO, 2009).

The vegetable industry, on the other hand, in this country can be grouped into three categories: (1) small commercial farming in the major towns of Tamale, Accra Takoradi and Kumasi

2) rural cultivation where products are purchased by middlemen or contractors and transported to the cities; (3 home/ backyard farming. Statistics in Ghana indicate that a lot of money is spent on the importation of vegetable products and vegetables products

because other vegetables like Irish potatoes cannot be produced in the country (FAO, 2009).

Bad techniques in husbandry, unavailability of seeds at the right time, insufficient use of fertilizers, unreliable rainfall, insufficient irrigation facilities, weak extension service and lack of organized vegetable processing and marketing are many factors that hinder vegetable production in Ghana. The Ministry of Agriculture and the USAID provide seeds for production, however other agencies make available seeds in selected stores to many growers in the country which are usually not tested and often do not do well when planted. Again, people who take farming or gardening as part-time activity buy these seeds (FAO, 2009).

The most common vegetables produced in Ghana are: tomato *(Lyco-persicon esculentum*), onion (*Allium cepa*), shallots (*llium Aescalonicum*), okra *(Hibiscus esculentus*), eggplant (*Solanum melongena)*, local spinach (*Amaranthus spp*), sweet and chilli pepper *(Capsicum annuum*), and hot pepper *(C. frutescens*). These vegetables are bought by both urban and rural folks. Vegetables that are exotic are mainly grown for the foreigners in the country. Exotic vegetables (cauliflower and carrots) have low yield and poor quality. However lettuce and cucumber are becoming very common in the cities and are doing well all year round. Hot pepper, okra and eggplant are easy to cultivate because the climatic conditions are favourable (FAO, 2009).

2.3 POSTHARVEST LOSSES OF FUITS AND VEGETABLES

Postharvest physiology can be defined as the aspect of science that looks at the physiology of the tissues of a living plant after they are detached from the parent plant.

It is important to delay ripening of fruits so as to prolong their storage to prevent respiration of fruit tissue. This knowledge will enable scientists to understand and appreciate the

general basic underpinnings and processes of respiration, leading to postharvest storage techniques including wax skin coatings, cold storage and gaseous storage. Furthermore, ripening can be facilitated by treating with ethylene.

High proportion of postharvest waste is attributed to poor storage infrastructure; processing and marketing contribute to postharvest waste ranging between 10 and 40%. Some amount of waste occurred in many instances as a result of limited resources at the disposal of small farmers to handle their produce through the value chain including postharvest handling and marketing. Hot and humid climate conditions speeds up rotting of fresh horticultural produce. Postharvest management and processing of vegetables and fruits also affect their yields in the world. (Kader, 1992).

In order to reduce food losses and increase food availability, there was a World Food Conference convened in Rome in 1974. Also on the durability of grains of crops, the Special Action Program for Food Loss Prevention, of the Food and Agriculture Organization of the United Nations (FAO) initiated to take a look. Fruit and vegetable cultivation is of a greater importance only when produce reach the final consumer in good state and at a reasonable price. (FAO, 2009).

To achieve an increase in production, it is very necessary to know what quantity of the yield that gets to the final consumer through the various channels of marking. Postharvest management should be comprehensively integrated in production since loses in postharvest reduce food availability. It is more advisable to reduce food loss because it is less costly than increasing the production of food. Food availability can significantly be guaranteed if losses in postharvest is minimised. Successful production is said to be achieved if the amount of waste produce is estimated to be zero through the process to the final consumer. (Kader, 1992).

2.3.1 Causes of Postharvest Losses

There are two factors that cause postharvest losses; these are external and internal factors. The external factors may be parasitic diseases and mechanical injury while the internal factors include physiological deterioration. (Jobling, 2002).

Fresh vegetables and fruits have a very low resistance to physical damage due to their tenderness in texture and also amount of moisture in them is quite high. Forms of injuries such as impact wounds, bruises and cuts are caused by mishandling, low standard packaging techniques and bad packing during transportation (Kader, 1992).

One major cause of postharvest losses in vegetables and fruits is the invasion of fungi, bacteria, insects and other organisms. Fresh produce lack natural defensive mechanisms in their tissues and also have abundance of moisture and nutrients that calls for attack and fast spread of microorganisms on fresh produce. Due to the rapid reduction in pesticides availability because of consumer concern for food safety, it has become very difficult to control postharvest decay (Jobling, 2002).

Vegetables and fruits detached from the parent plants are deem to maintain their normal physiological process and therefore are considered living after harvest. As such low or high temperature, injury, undesirable environmental conditions and mineral deficiency sometimes occur along the line due to enzymatic activities causing senescence and ripening (Jobling, 2002).

2.3.2 Management of Fruits and Vegetables after Harvest

After harvesting, practices like disinfection, drying, cleaning, washing, packing and storage are carried out. This is called Postharvest management. These take away undesirable elements and improve appearance of produce, and also making sure that the products meet the required quality assurance for produce in the category i.e. fresh and

processed products. Other postharvest practices include control and management of temperature, packaging selection and use, humidity and the application of fungicides (FAO, 2009).

After the vegetables and fruits are detached from the parent plant, vegetables and fruits like other produce attained increase value at different stages of the value chain tot eh final consumer. This added value can only be maximized through better postharvest management techniques. This has to be beneficial to the whole community. For instance, it has been revealed that about 5 to 25% of vegetables and fruit that leave the farm gate are thrown away and never eaten by the consumer (Kader, 1992).

2.4 HARVEST HANDLING

As soon as a crop is detached from the parent plant, deterioration starts to take place. Therefore postharvest treatment is needed to determine final quality if a produce can be consumed fresh, or in a processed form. Spoilage of a product is usually quickened through bruising as a result of physical damage. Therefore avoiding physical damage is an essential goal postharvest handling. Maintaining the right moisture of the produce as well as the desire chemical composition are other objectives of postharvest handling. Good sanitation practices are also critical to lessen pathogenic infection on fresh produce. After the practices on the field, some postharvest processes are expected to happen in a number of ways including a system that will provide some shade and running water in a very hygienic shed. The process should include and make way for sorting and packing to be automated in stages in a packing house (Simson and Strauss, 2010).

To produce high quality fresh produce, postharvest handling should be given more attention though there are more challenges in maintaining the freshness produce from the field to the dining table. Storage quality and life are also affected by some environmental

factors like temperature, frost, soil type, and rainy weather at harvest. Management practices also do have some effect on postharvest quality of produce. Excess water or too little of it, physical damage on produce can result in their susceptibility to postharvest diseases (Simson and Strauss, 2010).

The safety of food starts right from the farm gate and therefore needs to be given serious attention, as most diseases which are food borne are traceable to the farm gate. Harvesting is best during early morning when the weather is cool, and produce are to be kept under shade in the field. Produce that are to be stored are to be free from cuts, bruises, spots and rots. Bruises and other mechanical damage allow entrance of decay organisms as well as affect appearance of produce. When care is taken during harvesting, the physical damage to produce are lessened thus less diseases and enhancement of quality. Recently there has been the introduction of conveyors to help improve quality and speed in the harvesting process for some vegetable produce. This is to save labour and also quality time for other operations (Jobling, 2002).

2.5 OPERATIONS OF PACKING HOUSES

In the place or room where packing is done, it is necessary to reduce physical injury to the produce by not allowing them to drop or engaging in any form of mishandling. Also shaded areas are conducive for pack house operations. Local material such as woven mats, shade cloth and plastic tarps can be used to create shade to reduce air temperatures around the produce (8–17 °C). Below are the steps of the operations in the packing house (Jobling, 2002).

2.5.1 Operation by dumping

Dumping is the first handling step and it can be done in two ways; by wet or dry method. The wet method is by dipping the harvested goods in water to reduce bruising, injury,

abrasions on produce. The dry dumping is done by using soft brushes fitted on moving conveyor belts that help to remove dust and dirt on fruits (Jobling, 2002).

2.5.2 Operation by pre-sorting

Misshapen fruits, injured and decayed fruits are removed by pre-sorting. Pre-sorting helps reduce the spread of infection on healthy produce. It will also save energy and money because unwanted ones are eliminated and not to be handled, packed, cooled or transported (Jobling, 2002).

2.5.3 Operation by washing/cleaning

To control build-up of inoculums on produce, chlorine in its solution form (100–150 ppm) should be to wash produce during pack house operations to acquire the best of safe produce, the wash solution should have between 6.5 and 7.5 as its PH range (Jobling, 2002).

2.5.4 Operation by grading/sizing

Grading can either be manual or automatic. Size grading according to size is carried out in a subjective manner by using measures that are standardised and sizing rings are used to grade round produce. (Simson and Strauss, 2010).

2.6 PRECOOLING

Immediately after harvesting, pre-cooling of the produce is very necessary to improve upon their shelf life. The management and elimination of heat on the produce from the field is the main purpose of pre-cooling. The various methods of pre-cooling are summarized below:

2.6.1 Room cooling

This is the method in which harvested produce are put in a cool place whereby fresh air is blown over and over again in circulation through containers, sacks, cartoons or bins containing the produce. The procedure is slow and but low cost. (Simson and Strauss, 2010).

2.6.2 Forced air cooling

This method of cooling is used for many horticultural produce and it is believed to be quicker for pre-cooling than other methods. For this method to be effective, adequate vents are created in the storage containers where it is easy to push or pull air through them. The arrangements of stacks in the room should be done in such a way as to allow uniform cooling. This can be effectively achieved when pallet bins are stacked spaciously as cooling will depend on airflow and the difference in temperature between the surrounding air and the produce as well as the sizes of the produce (Burchett, 2003).

2.6.3 Hydro-Cooling

In this type of method, cold water is used and it is not a new technique but of one of the traditional procedures that is use to cool fruits and vegetables before packaging. This method is not appropriate for already packed produce which are quite tight and do not permit water to flow through them. Again some containers may not be water friendly or will require acquisition of expensive containers that will be purposely designed for water retention. The method reduces water loss and also retains great moisture in the produce. Hydro-cooler in this method is in two folds: the immersion method and the shower method (Burchett, 2003).

2.6.4 Vacuum Cooling method

In this procedure, the space to be used for packing and cooling the produce usually a steel chamber is pumped out of every air as packing of produce is completed or loaded. Cooling by vacuum is achieved by evaporation of water at low air pressure from the product. When air is removed the atmospheric pressure surrounding the produce reduces thereby lowering boiling temperature. Because pressure continues to drop heat is removed from the produce as water boils. Cooling by vacuum causes around 1% loss of weight in produce. (Burchett, 2003).

2.6.5 Icing Method

This is a method whereby ice is put in the produce harvested for immediate cooling. A difficulty in this procedure is that with time the ice flakes begins to melt as it contacts the produce thereby slowing the rate of cooling. High relative humidity is expected to be kept around the product as it been laced with ice. Ice packaging can even be better when the ice is crushed into little flakes or into fine form. Liquid icing is able to evenly distribute a cooling effect to the whole container giving a better contact with the produce.

Ice packaging is method is commonly used with only packaging materials that are resistant to water damage such as plastic. Once fruits are harvest some changes occur in them and some of these changes may not be desirable but as these changes cannot be stopped completely, they can be minimised to extend the fruit life (Burchett, 2003).

2.7 TREATMENTS OF POSTHARVEST

The role of postharvest treatments is to extend the marketable and storage life of horticultural produce. Some of the postharvest treatments include:

2.7.1 Using Chlorine Solution for washing

To control inoculums build up in the process of packing, chlorine treatment (100–150 ppm available chlorine) is used in water to wash the produce. A PH of 6.5 and 7.5 should be maintained for best results (Burchett, 2003).

2.7.2 Growth regulator/fungicide treatments

In order to promote fresh fruit there should be an effective use of growth regulators or fungicides like GA3. Also by the application of chemicals such silver nitrate and cycloheximide ethylene production is inhibited (Burchett, 2003)..

2.7.3 Application of Calcium

The postharvest applications of $CaCl_2$ or Ca $(NO_3)_2$ helps in promoting the marketable and storage life of fruits by making sure that the firmness and quality of fruits are maintained. It is good to apply calcium to delay aging and ripening and to reduces decay and eliminate other defects in their physiological make up and soar up the amount of calcium which will improve their nutritional value. The postharvest application of $CaCl_2$ (2–4 %) or Ca $(NO_3)_2$ for 5–10 min prolongs the shelf life of pear till about 60 days ,up to 30 days for plum and up to half a year for apple at 0 to 2 degrees celcius with good colour as well as great quality. Chilling injury is lessen by calcium and reduces disease incidence in stored fruit (Burchett, 2003).

2.7.4 Thermal method

This method includes (a) treatment by use of hot water: before storage and marketing activities are carried out fruits are immersed in hot water to control postharvest associated diseases and also to give the fruits peels very appealing colour. (Burchett, 2003).

2.7.5 Treatment with Vapour Heat (VHT)

Fruit flies are effectively controlled or managed by the use of this method after harvest of fruits. The process involves injecting steam to heat the boxes of fruits stacked in the treatment room. Temperature in the room and time for exposure should be properly managed in a way that will not damage the fruit but at the same time kill insects at their various stages of development such as pupa, larva, adult or even eggs. Such fruits as mango, papaya, pineapple and citrus are treated for 8 hours in air saturated at 43 ºC and maintaining the temperature for 6 more hours. For exported mangoes, VHT is very necessary. (Burchett, 2003).

2.7.6 Fumigation Method

This type of method is used to control diseases for grapes during postharvest. This can be successfully done by putting produce of boxes into a room filled with gas to the appropriate concentration using a cylinder. Another way is to place a special sodium metabisulphite pads into each box of fruits to release SO_2. The main purpose of fumigation is to curtail *Botrytis cinerea* and used for reasons of litchis skin discoloration.
(Unusan, 2004).

2.7.7 Irradiation Method

The use of radioisotopes can be employed through the exposure of radiations to the crop. Micro-organisms control and prevention of cells reproduction in vegetables and fruits are effectively carried out by ionizing radiation. Radiation comes with gamma-rays which are measured in Grays (Gy) Gy = 100 rads (Gould, 2004).

2.7.8 Waxing Method

Waxing as a postharvest practice is used in replacement of hitherto existing waxes that were lost during the processes of sorting and also harvesting to ensure that some amount

of water is retain in the produce in the marketing stages. Waxing helps in closing up smaller cuts on vegetables and fruits surfaces. It is important to allow the coat of wax to properly dry before packing is done. If the process is masterly carried out, it gives the produce a very attractive look and also extends the storage life span of vegetables and fruits (Unusan, 2004).

In the final analysis, it must be noted that postharvest management comes immediately after harvest; these include cleaning and other processes such as cooling as well as sorting and of course packing. Once a produce is detached from the ground, or separated from its parent plant, it begins to deteriorate. The quality of the end produce is largely determined by quality of postharvest treatment employed whether for fresh consumption or for processing. (Gould, 2004).

2.8 QUALITY OF VEGETABLES AND FRUITS

After produce are harvested, their quality can only be maintained but not improved so it is necessary to harvest produce at the right stage. Many attributes can be used to determine quality of produce, some of these are, the use of the senses (sight, smell and touch).The firmness and ripeness can be determined by touching fruits like pineapples and water melon. The consumption of most vegetables and fruits are in many instances the value of nutrients they give the consumer. Other attractions for consumption are usually colours, shapes and also flavours. Therefore the quality of horticultural produce can be maintained by storing high quality produce, not over loading storage rooms, ensuring adequate ventilation and by removing damaged ones to avoid spreading further defects (Unusan, 2004).

It has been revealed by other studies that vegetables and fruits are very good sources of phytochemicals, micronutrients and fibre, it is also revealed that, consumption of fruits and

vegetables have the greater chances of preventing obesity, diabetes and other conditions related to respiration, cancer as well as cardiovascular illnesses. The reductions in major chronic diseases are associated to the presence of bioactive nonnutrient plant compounds in vegetables and fruits as well as other foods from plants called Phytochemicals (Gould, 2004).

2.9 FACTORS DETERMINING FRUIT AND VEGETABLE CONSUMPTION AMONG ADOLESCENTS

A study was conducted in Turkey to find out vegetable and fruit consumption patterns among students in the university examined important gender differences associated vegetable and fruit consumption. Findings of the study indicated that vegetables are more likely to be eaten by females at lunch and dinner and will further go for a fruit during lunch or dinner or was carried out to investigate the consumption fruits and vegetables among breakfast instead of a desert. Males were very less likely to go in for fruits in compared with female students. The study also revealed that income high adult income earners were more likely to eat more vegetables and fruits than low income earners. The study did not find any variations in vegetable and fruit in relation to income among adults. Low income adults showed less interest to consume more vegetables and fruit because of the limitations in price and storage (Unusan, 2004).

A study was carried out to examine vegetable and fruit consumption among adolescents in America. It was identified by the authors that vegetable and fruit consumption is strongly correlated to availability of vegetables at home and taste preferences of vegetables and fruit. The meals patterns of the family, food security at home, the income or social status of the family largely constitute home availability. Attitudes towards nutrition or health and of course home availability of vegetables and fruits make up taste preferences. The study also showed that where home availability of these produce is absent or little, consumption

was also low irrespective of preferences of taste. In sharp opposite, where produce home availability is high consumption increased even when there were low taste preferences (Neumark-Sztainer *et al*., 2006).

An environmental intervention review was carried out with the view of promoting the intake of vegetables and fruits by young people. Factors such as availability of vegetables and fruits, their price and their effective promotion were found by the study to increase or decrease consumption of same among children (French and Stables 2003). Another investigation on the impact of brand factors on fruit intake decisions among children. The results revealed that the adoption of brand characters such as Dora the
Explorer or Sponge Bob raised appetite to buy healthy fruit-based products (Burchett, 2003).

Many other studies confirmed that the advertisement of food on both radio and television greatly influences children's choices desire a particular food type or type of brand (Herrero, 2008). It is very easy to persuade children by the use of adverts, which then influences the kind of request they put to their parents or guardians. A number of health related topics are learned by children in the media but researchers have downplayed the impact of such information describing it as limited and disjointed. The results do have very clear implications for promoting healthy product intake for children. Factors like familiarity with food, exposure and accessibility to food have an influence on choices of vegetables and fruits by children (Burchett, 2003).

A research to investigate social factors that affect the consumption of vegetables and fruits among children revealed that education by both parents and teachers in relation to intake of vegetables and fruits, children preferences and availability of the foods at home and at school which are actually "ready to eat", largely influence vegetable and fruit

consumption. The research further revealed how children and their parents positively respond to issues geared towards the promotion of vegetables and fruits intake yet parents eventually were unwilling to actively participate in such activities (Bower and Ferguson, 2008).

Bower and Ferguson (2008) carried out a research in basic schools in Edinburgh (United Kingdom) to investigate how children perceive "fruit snacks" and fresh fruit as meals in school. Results of the study revealed that children largely perceive fruits as available, healthy, friendly and affordable however they are convenient for snack in school since they acquire bruises easily. A solution to managing the fast quality deterioration of vegetables and fruits require some minimal procession of these vegetables and fruits. There are no much technological advancements that can eliminate the quality defect (Bower and Ferguson, 2008).

Other researches have again proved that vegetables and fruits consumption among children has been traced into adolescence and this is also sustained through to adulthood (Mikkila *et al*., 2004). The eating behaviours of children largely be usually influenced by factors that are socially related and can be control to consumption levels the general society. As usual children are highly influenced by the taste of food that is given to them for consumption, and may be tempted to go for those that seem sweeter and taste better rather than foods that are more nutritious (Pérez-Rodrigo *et al*., 2005). A study was carried out to find out how food preferences, the results highlighted the impact of environmental factors on genetic factors to affect a children eating behaviours because a child gets his genes from the parents whiles patterns of eating also starts in early life which then makes it difficult to separate genetic factors from environmental factors. Food preferences are sometimes developed in early stages of life through to adulthood arising from how parents

select foods for infants. Again infant feeding method such bottle feeding or breast feeding also affect them in their later feeding or eating practices (Birch, 1998; 1999).

Some comparative research showed for minority speaking Swedish and some Fins from Finland showed that the minority speaking Swedish has high life expectancy condition of health than the Fins yet both the Swedish and Fins were all living in similar conditions, though the Swedish is a well ahead of the Fins in terms of their socio-economic standing that could impact positively on their eating life styles whether as children or later in their lives as adults.(Volanen, 2006; Hyyppa and Maki , 2001)**.**

A study carried out in 9 countries in Europe on predictors affecting daily fruit and vegetable consumption has revealed bringing fruits to school with personal preferences as that which has the strongest influence on the level of intake. Others included national recommendations, positive liking and preference, parental modelling and demand (Birch, 1999). In a similar study in relation to fruit and vegetable intake among European and American children, it has been revealed that gender could have influence on the level of consumption. An 18 study in the USA, confirmed that only 6 of the investigations revealed that consumption differences exist between males and females. Other seventeen investigations carried out in Europe had fourteen of them revealed that gender is very important factor in Europe. Girls were eating more fruits and vegetables than boys on daily basis (Currie *et al.*, 2004).

It has also been revealed, it is more beneficial for children when they make their own choices on their diet than when parents enforce diet on them. Parents who dominate in their children's eating habit stand the risk of creating adverse consequences as a result on their diet behavior. It is better for parents to educate children on diet and after same is adequately provided to allow children choose from (Birch, 1999). A thorough revision of some twenty

one surveys on eating behavior of children between 6 and 12 years showed that factors such as vegetables and fruit availability and accessibility and taste preferences were consistent and directly affect intake. However exposure to television advertisement, watching television and getting a snack bar at school resulted in no much consumption of vegetables and fruit (Blanchette and Brug, 2005).

A further research was carried out in Canada to examine forms of vegetable and fruit consumption and highlight the social and demographic factors linked to low intake has shown that vegetable and fruit intake has direct relationship with educational level of household and general income of household. Reasons for consumption of fruit and vegetable for purposes of health were considered less important however taste preferences including availability and liking determines consumption greatly. Parents were also considered as great influencing factors as their intake behavior served as example for children while at the same time the rule of the family may also influence variability and availability of vegetables and fruits especially at the household level
(Pérez-Rodrigo *et al.*, 2005).

2.10 RELATIONSHIP BETWEEN NUTRITION AND COGNITIVE DEVELOPMENT

Recently some studies have shown that nutrition influence students' thinking skills, behaviour, and health and all factors that impact academic performance. Meals that are highly saturated with fats can negatively affect learning and memory, nutritional deficiencies during early stages of life can also negatively affect the cognitive development of school children (Rasmussen *et al* 2006).

Another study found out that 5th grade school child with poor nutritious diets performed badly in literary assessment. Another research disclosed that 5th grade students who ate more fast food performed worse in math and reading subjects (Li and O'Connell, 2012). Similarly, a study that analyzed a healthy eating campaign that banned junk food from

schools and introduced healthier, freshly prepared school meals found that participating students performed better in English and science tests than students who did not take part in the campaign (Belot and James, 2009).

Nutrition also indirectly affects academic performance. Poor nutrition can cause students to become susceptible to illness resulting in absence in school (Gómez-Pinilla, 2008). Accessibility to nutrition that includes protein, carbohydrates, and glucose has been revealed to improve students' cognition, concentration, and energy levels (Bellisle, 2004; Sorhaindo and Feinstein, 2006).

In contrary to the above, nutritional deficiencies (zinc, vitamins B, Omega-3 fatty acids, and protein) in early stages can affect the cognitive development of school children (Sorhaindo and Feinstein, 2006). Studies also suggest that diets high in Trans and saturated fats can negatively affect the brain, influence learning and memory (Gómez-Pinilla, 2008).

Other research has also disclosed a link between nutrition and behaviour. It found out that access to nutrition, especially breakfast, can enhance a student's psychosocial wellbeing, reduce aggression that usually leads to decrease discipline in school (Birch, 1999).

A variety of micronutrients to perform cognitive functions is necessary for the human brain. A lack of any macro- or micro-nutrients causes malnutrition and consequential cognitive impairment, the extent of which depends on the duration and degree of the malnourishment and the timing of its occurrence in development. Macronutrient malnutrition (starvation) is rare in America but the diets of school children lack quality as evaluated by adequate and varied intake of fruits and vegetables and moderation of saturated fats and extra-calorie foods (Birch, 1999).

Therefore, it can be inferred that student's brains are often malnourished, as they are undersupplied with micronutrients needed for effective cognition. Improvements in the nutritional quality of students' diets are linked with academically beneficial gains, but have not been repeatedly and causally correlated to increased academic achievement. Concrete links between food consumption – neither at large nor in specific foods – and academic performance have not been discovered. In general, however, it is clear that consistently eating enough quantity and variety of nutrient-dense foods will improve children's diet quality, and consequentially reduce the potential for the cognitive impairments associated with malnutrition (Gómez-Pinilla, 2008).

2.11 RELATIONSHIP BETWEEN FRUITS AND VEGETABLES AND HEALTH

Vegetable and fruit active phytochemicals which give much of the taste and colour in vegetable and fruit are also termed non-nutrient secondary metabolites. These chemicals when eaten help consumers improve their health status significantly in the prevention of diseases. Thus the best way to get the full benefits of these chemicals is to ensure an increased consumption of variety of vegetable and fruit (Shils *et al*., 2005). Some other researches revealed that phytochemicals in meals can protect regular consumers from cardiovascular diseases, cancers and neurodegenerative disorders such as stroke, Alzheimer's and diseases (Mattson and Cheng, 2006). Similar study carried out on mouse model showed that supplements of blueberry can prevent memory and deficiencies related to Alzheimer's disease (Shils *et al*., 2005).

Resent trial research results showed that, major antioxidants that are approved to protect against antioxidants depletions and cardiovascular difficulties in people suffering from diabetes include ascorbic acid, flavonoids and carotenoids (Pietta, 2000). Similar studies have also shown that phytochemicals help prevent obesity. Irrespective of the benefits related to health of vegetable and fruit, the WHO has revealed that, as a result of bad intake

of vegetables and fruits, the number of people who die stood at 2.7 million while those fall within disabilities stood at 26.6 million yearly as a result of rampant chronic diseases such as cancers and cardiovascular disease (Shils *et al*., 2005).

Major causes of mortality and morbidity are stroke and myocardial infarction in urban areas and meals play an important part in the etiology of the disease (WHO, 2003). A research on adolescents Finns between ages 3-18 years discovered that lifetime lifestyle without vegetables and fruits intake leads in young children arterial stiffness (Mikkila, 2004).

Following the above studies, the 2005 Finnish Nutrition Recommendation put vegetables and fruits as one of the important components of dietary recommendation. This recommendation was aimed at increasing the consumption of vegetables and fruits among the populace. It was aimed at reducing the numerous cases of obesity among both children and adults in Finland. For instance 66% of men and 49% of women were at least mildly obese (Pietimen *et al*, 2006). Since fruits vegetables are low energy foods, they mitigate and balance the over weight problems. Obesity is found to be the major risk factor that causes type-2 diabetes in adults.

According to Pietinen *et al*, (2006), 60 to 80 percent of type-2 diabetes would not have occurred if the population was kept at normal weight. High consumption of high energy foods without incorporating vegetables and fruits results in insufficient essential nutrients. When this becomes a habit, it poses serious consequences later in life by making the individual vulnerable to nutrition related chronic diseases (Bruno, 2009).

The above findings confirmed earlier review studies on the association of fruit and vegetable consumption and coronary heart disease which reported that 9 out of 10 ecological studies, two out of three case-control studies and six out of 16 cohort studies

found significant protective association with consumption of fruit and vegetable or surrogate nutrients. The same study further reported that, there three out of five ecological factors studies and six out of eight cohorts studies found significant protective association from stroke with consumption of fruit and vegetable or surrogate nutrients.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 INTRODUCTION

The chapter discusses the various methods, techniques as well as procedures used in this research. It also captures the research design, study area and population, collection of data, the sampling method and analyses.

3.2 THE STUDY AREA

The students of basic schools in the Amansie West District of the Ashanti Region constituted the population for the study. They included both boys and girls in Junior High School (JHS) form one to three who were currently enrolled in basic schools. In the study five(5) basic schools were selected from both private and public schools, these schools included; Pakyi Islamic JHS, Apostolic Preparatory JHS, Vision Academy JHS, Pakyi Presby JHS and Pakyi Number one District Assemblies (D/A) JHS. The specific characteristics of the students that were examined in this study were their fruit and vegetable eating patterns and their health records indicating the number of times they have fallen sick.

3.3 SOURCES OF DATA

The study made use of both primary and secondary data. The primary data was obtained from questionnaires which were administered to the students. This centred on their fruits and vegetables eating habits, the sources of vegetables and fruits and the types available. It also included the frequency of vegetable and fruit intake. The secondary data included the health records of students obtained from hospitals.

3.3.1 Data collection instruments

The Data collection involved in the study was by the administration of questionnaire to students in the Junior High Schools in the study area. Questionnaires were sent to the selected schools and students were made to answer the questions independently with some explanations to any difficult questions.

3.3.2 Sampling Techniques and Size

The student population of the selected schools was about 1012 students. Since it was difficult to study the entire population of Basic Schools in the Amansie West District, a sample size of three hundred and fourteen (314) students was used.

The systematic random sampling method was used to select 30% of the population for the study. This was because, according to Thornhill 2007, a third of a relatively large population above one thousand is considered large enough for statistical test of significance about the population. The use of systematic random sampling is also meant to eliminate bias associated with accidental sampling of respondents.

Table 3.1: Population of students from the selected Junior High Schools

School	Year /class	Boys	Girls	Total
Pakyi Islamic JHS	JHS1	38	27	65
	JHS2	25	37	62
	JHS3	50	37	87
	TOTAL	**113**	**101**	**214**
Pakyi Presby JHS	JHS1	57	62	119
	JHS2	57	51	108
	JHS3	32	38	70
	TOTAL	**146**	**151**	**297**
Apostolic Preparatory JHS	JHS1	30	23	53
	JHS2	27	22	49

	JHS3	26	22	48
	TOTAL	**83**	**67**	**150**
Vision Academy JHS	JHS1	16	10	26
	JHS2	6	19	25
	JHS3	15	15	30
	TOTAL	**37**	**49**	**86**
Pakyi No.1 D/A JHS	JHS1	46	30	76
	JHS2	50	53	103
	JHS3	47	39	86
	TOTAL	**143**	**122**	**265**
GRAND TOTAL	**ALL 5 SCHOOLS**	**522**	**490**	**1012**

Table 3.1 constitutes the population size and sampling frame for the study. They comprised 1012 pupils from five Junior High Schools within the Amansie West District of the Ashanti Region.

Table 3.2: Distribution of respondents according to schools

School	Year /class	Boys	Girls	Total
Pakyi Islamic JHS	JHS1	12	9	21
	JHS2	8	12	20
	JHS3	15	12	27
	TOTAL	35	33	68
Pakyi Presby JHS	JHS1	18	19	37
	JHS2	18	16	34
	JHS3	10	12	22
	TOTAL	46	47	93
Apostolic Preparatory JHS	JHS1	9	7	16
	JHS2	9	7	16
	JHS3	7	7	14
	TOTAL	25	21	46
Vision Academy JHS	JHS1	5	3	8

	JHS2	2	6	8
	JHS3	5	5	10
	TOTAL	12	14	26
Pakyi No.1 D/A JHS	JHS1	14	9	23
	JHS2	15	16	31
	JHS3	15	12	27
	TOTAL	44	37	81
GRAND TOTAL	**ALL 5 SCHOOLS**	**162**	**152**	**314**

3.3.3. Questionnaire Design

A self-administered questionnaire was crafted and used to elicit responses from research participants. The questions were predominantly multiple response type with options for respondents to choose from open ended questions. The questions were based on the socio-demographic characteristics of respondents, their fruits and vegetable eating habits and the sources of fruits available to students. Others included the determinants of choice of fruits and vegetable consumption among students and questions bordering on their health status. The language used in crafting the questions was simple and straight forward to promote understanding among the respondents since they are basic school students. The questionnaires were hand delivered by the researcher and the responses monitored. This was to ensure that students who probably did not understand some items in the questionnaire could seek clarification from the researcher.

3.3.4 Data Processing and Analysis

The data were collected using the questionnaires which were coded and entered into the Statistical Package for Service Solutions (Version 16.0) for analysis. The data were cleaned by running initial frequencies to determine wrong entries and multiple entries or any errors of omission. The results were all organised into frequency tables, pie charts and

bar graphs. For the Logistic regression, data collected on fruits and vegetable eating and the health status of respondents were recoded into 1 and 0 corresponding to responses that show presence of the variable and lack of it respectively.

3.3.5 Experimental Design

The study was conducted using a Completely Randomized Design (CRD) for both vegetables and fruits.

3.4 LABORATORY WORK

Thirty six (36) predominant fruit (mango, banana and orange) and vegetable (tomato onion and cabbage) samples were collected from two sources that respondents mostly acquired their fruits and vegetables. The samples were put in labelled transparent polyethylene bags and transported from the study area to the KNUST Laboratory of the Biological Sciences Department for microbial analysis (Total coliform, total mould, Total plate count, *Escherichia coli* and faecal coliform).The various methods used in the laboratory test included:

3.4.1 Total Plate Count

Samples were separated and counted by pour plate count and grown on plate count Agar (PCA). All petri plates were labelled with sample date, number dilution and other information. One (1) ml of homogenate fruit or vegetable was pipetted with dilution which was chosen for plating into a petri dish. 10 – 12 ml of molten PCA (cooled to 42 - 45c) ^{o} were poured into each petri dish in 15 minutes from the time of preparation of original dilution. The dishes were incubated at 35c for 24 ^{o} hours. After incubation all colonies were counted and recorded as Total plate Count.

3.4.2 Total Mould Count

Slides of samples were made with a knife. A portion of a well-mixed sample was placed upon a central disk. The samples were evenly spread over disk and covered with glass cover to give a uniform distribution. The slide was placed under a microscope and examined at 0.15mm³. A 200x magnification was used to confirm identity of mould filament for calculation.

3.4.3 *Escherichia Coli (E-Coli)*

Positive tubes were each identified and a drop was transformed into a 5 ml test tube into trypton water and inoculated at ^{o} 44c for 24 hours. Kovac's reagent drop was added to the tube of trypton water. All tubes showing a ring of red colour after gentle agitation denoted the presence of indole and recorded as presumptive thermotolerant coliforms (EColi) count per 100 mls were calculated from most probably number (MPN) tables.

3.4.4 Total Coliform

Total Coliform was enumerated by the Solid Medium Method whereby 1ml of the fruits and vegetable homogenate or samples were pipetted and each diluted into each of the marked duplicated petri dishes.10ml of Violet Red Bile Agar (VRBA) at 48c ^{o} was poured into each petri dish and swirled plates to mix. An overlay $_{o}$ of 5ml VRBD was made to allow dilution to solidify. Dishes were incubated at 35c for 24 hours. All colonies that were purple red in colour were counted.

3.4.5 Feacal Coliform

A transfer of a loopsful from each gas positive tube of Lauryl Sulphate Triptose (LST) to a separate tube of Brilliant Green Lactose Bile Broth (BGLB) broth was made. An incubation of the BGLB broth tubes at ^{o} 35c for 48 hours. The formation of gas

confirms the presence of coliform bacteria. Record the number of positive tubes that were confirmed as positive for coliform.

3.5 DATA ANALYSIS

The student T-test was used in analysing the data collected. The means were separated at 1% probability level (p=0.01

CHAPTER FOUR

4.0 RESULTS

4.1 SURVEY WORK

4.1.1 Demographic Characteristics of Respondents

The demographic characteristics of respondents that were examined in this study included their sex, age and year of study (Table 4.1). With regard to the sex distribution of the students, 53.5% and 46.5% were males and females, respectively.

In terms of age, the modal age (43.3%) of the pupils was 15 years. This was followed by those aged 13 years (27.7%) and then 16 years or more (15.9%). The least age group was those of 14 years (13.1%).

Regarding year of study, JHS 2 students constituted the largest percentage with 39.2% followed by JHS 3 (98 pupils) with 31.2% and JHS 1 (93 pupils) representing 29.6% of the sample.

Table 4.1 Demographic characteristics of respondents

Variable	Category	Frequency	Percent
Sex	Male	168	53.5
	Female	146	46.5
	Total	314	100.0
Ages	13 years	87	27.7
	14 years	41	13.1
	15 years	136	43.3
	16 years plus	50	15.9
	Total	314	100.0
Year of study	JHS1	93	29.6
	JHS2	123	39.2
	JHS3	98	31.2
	Total	314	100.0

4.1.2 Number of Meals per Day

Table 4.2 shows that 70.7% (222 respondents) of the respondents usually ate three meals a day while the remaining 29.3% (92 pupils) had two meals a day

Table 4.2 Number of meals per day

Number	Frequency	Percent
Two	92	29.3
Three	222	70.7
Total	314	100.0

Source:

4.1.3 Types of Fruits Consumed at Meals

From Table 4.3, the most consumed fruit by the respondents was orange (79.6%). The second most consumed fruit was banana (58%) followed by mango (52.5%), water melon (51.9%), pawpaw (40.4%), coconut (12.4 %) while the least consumed fruit was guava (2.2%).

Table 4.3 Types of fruits consumed at meals

Fruit	Response	Frequency	Percent
Mango	Yes	165	52.5
	No	149	47.5
	Total	314	100.0
Pawpaw	Yes	127	40.4
	No	187	59.6
	Total	314	100.0
Orange	Yes	250	79.6
	No	64	20.4
	Total	314	100.0
Water melon	Yes	163	51.9
	No	151	48.1
	Total	314	100.0
Coconut	Yes	39	12.4
	No	275	87.6

	Total	314	100.0
Banana	Yes	182	58.0
	No	132	42.0
	Total	314	100.0
Guava	Yes	7	2.2
	No	307	97.8
	Total	314	100.0

4.1.4 Sources of Fruits and Vegetables

The sources of fruits available to the pupils are presented in Figure 1. Most of the fruits consumed by the pupils were obtained from their farms (53.82%) while 19.75% indicated that they brought their fruits from the market by way of purchasing. The other respondents got their fruits from neighbours (13.69%) and gardens (12.74%).

The figure 4.1 also showed that respondents had three main sources of vegetables. The commonest of these was the farm (71.97%), 4.78% bought theirs from the market and 2.23% obtained their vegetables from gardens. About 21% of the respondents indicated that the question was not applicable to them because they do not consume vegetables.

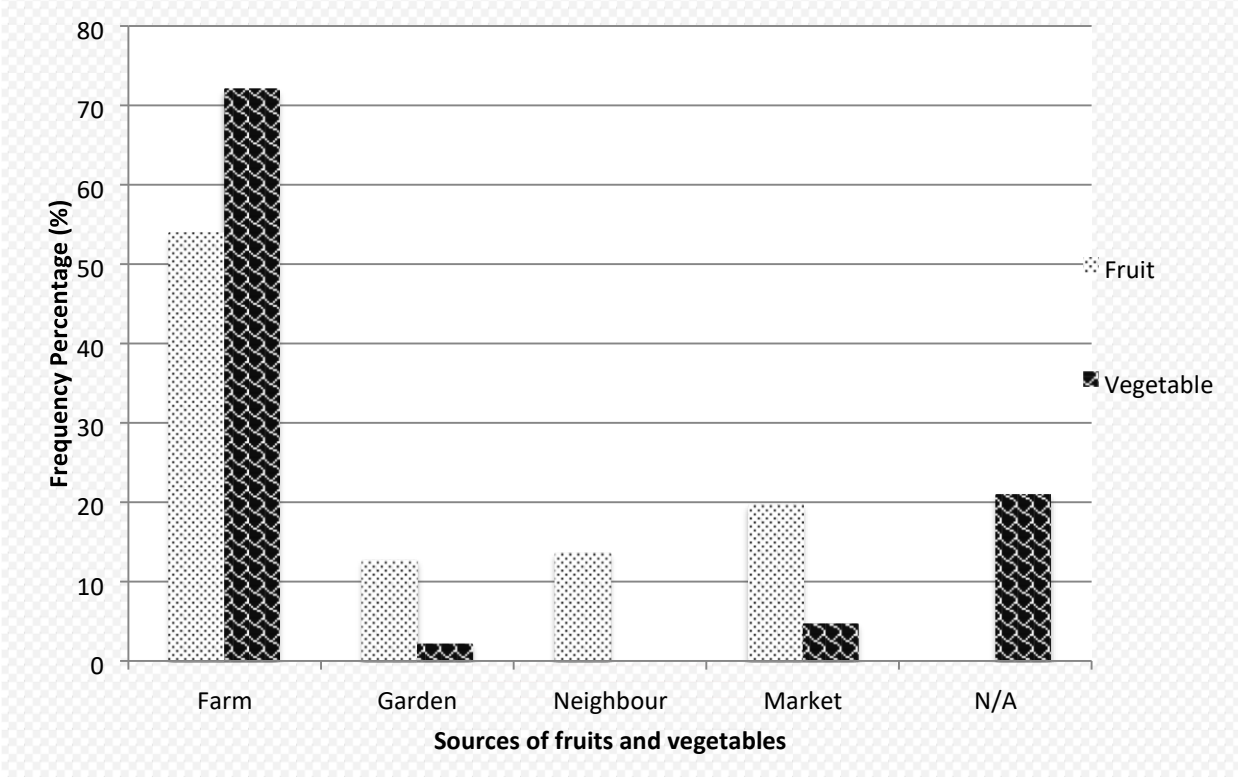

Figure 4.1 Sources of fruits and vegetables consumed

4.1.5 Processing of Fruits for Consumption

From Figure 4.2, majority of the respondents (65.92%) reported that they washed the fruits before consumption. Another group of respondents (17.52%) reported that they squeezed out the juice from the fruits for consumption while the remaining 16.56% cut their fruits before consuming it.

Processing fruits for consumption

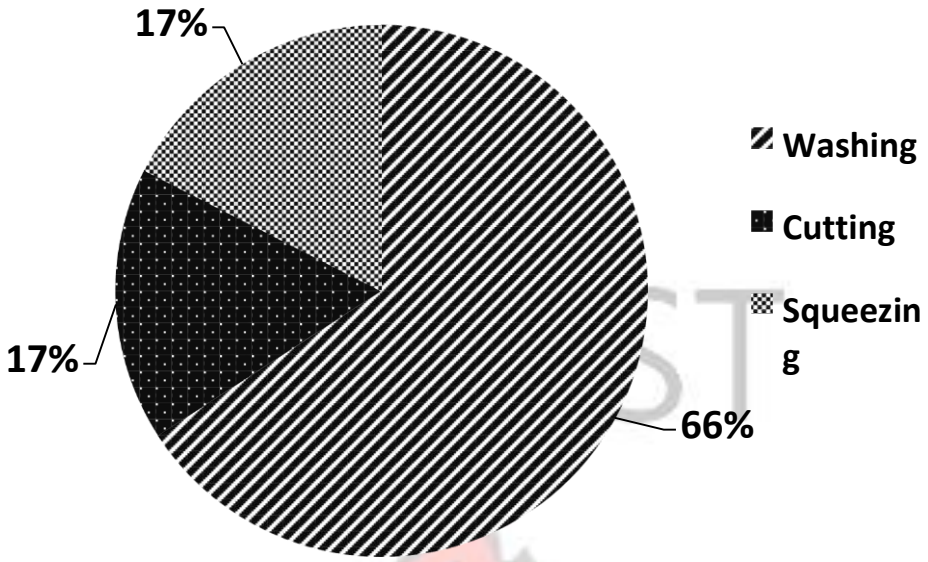

Figure 4.2 Processing fruits for consumption

4.1.6 Fruit and Vegetable Intake among the Respondents

Apart from fruit consumption which was found to be prevalent in the area, the responses from pupils indicated that vegetable consumption equally abound. Majority of them (74.2%) indicated that they always ate vegetables, 12.7% sometimes ate vegetables but not all the times while 13.1% of the respondents did not eat vegetables at all (Table 4.4).

Majority (176 pupils) always ate fruits at meals representing 56.05% another 112 pupils (35.67%) indicated that they sometimes ate in fruits at meals while 23 students representing 7.32% ate fruits during meals only once in a while.

Table 4.4: Fruit and vegetable consumption according to class and sex of respondents

		FRUITS				VEGETABLES			
Class Se	Yes	No	Some-times	OnceONle while	Yes	No	Some-times	Once a **x**	
JHS1	M	14(7.9%)	0(0.0%)	12(10.7%)	0(0.0%)	22(9.4%)	4(9.8%)	0(0.0%)	0(0.0%)
	F	50(28.4%)	0(0.0%)	17(15.2%)	0(0.0%)	33(14.2%)	34(82.9%)	0(0.0%)	0(0.0%)
JHS2	M	71(40.3%)	0(0.0%)	37(33.0%)	0(0.0%)	103(44.2%)	0(0.0%)	5(12.5%)	0(0.0%)

JHS3	F	0(0.0%)	0(0.0%)	15(13.4%)	0(0.0%)	7(3.0%)	0(0.0%)	8(20.0%)	0(0.0%)
	M	19(10.8%)	3(100%)	6(5.4%)	6(26.1%)	31(13.3%)	1(2.4%)	2(5.0%)	0(0.0%)
	F	22(12.5%)	0(0.0%)	25(22.3%)	17(73.9%)	37(15.9%)	2(4.9%)	25(62.5%)	0(0.0%)
TOTAL		**176(100%)**	**3(100%)**	**112(100%)**	**23(100%)**	**233(100%)**	**41(100%)**	**40(100%)**	**0**(0.0%)
GRAND TOTAL		**314**				**314**			

4.1.7 Vegetables Consumed by Respondents

Vegetables which were widely consumed among respondents included tomatoes (85.4%), onions (73.9%) and cabbage (52.5%) in descending order of importance. On the other hand, the least consumed vegetable was cucumber (26.4%) and then carrot (4.8%).

Table 4.5 Types of vegetables consumed by respondents

Vegetable	Response	Frequency	Percent
Cabbage	Yes	165	52.5
	No	149	47.5
	Total	314	100.0
Carrot	Yes	15	4.8
	No	299	95.2
	Total	314	100.0
Tomatoes	Yes	268	85.4
	No	46	14.6
	Total	314	100.0
Onions	Yes	232	73.9
	No	82	26.1
	Total	314	100.0
Cucumber	Yes	83	26.4
	No	231	73.6
	Total	314	100.0

4.1.8 Treatment of Vegetables for Consumption

In response to how they treated their vegetables before consumption, 64.33% of the respondents indicated that they washed their vegetables compared to 18.15% who reported ground the vegetables (Figure 4.5). The remaining 17.52% cut their vegetables before consumption

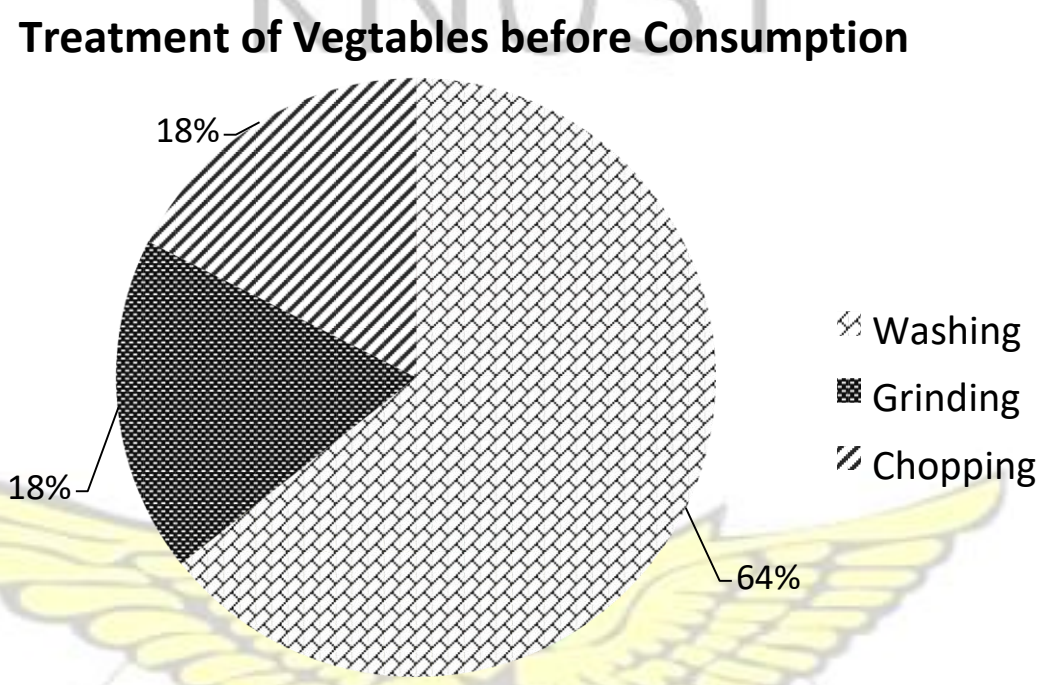

Figure 4.3 Treating vegetables for consumption

4.1.9 Frequency of consumption of fruits

Most of the respondents (66.6%) consumed fruits only once a day, 13.4% consumed fruits more than three times in a day while 20.1% consumed fruits twice in a day. Table 4.6: Daily consumption rate of fruits

Consumption rate of fruits	Frequency	Percent
Once	209	66.6
Twice	63	20.1
More than three times	42	13.4
Total	314	100.0

4.1.10 Frequency consumption of vegetables

From Table 4.7, 29.6%of students consumed vegetables once a day, 44.3% consumed vegetables twice per day, 19.4% consumed vegetables three times per day while 6.7% consumed vegetables more than three times per day.

Table 4.7: Daily consumption rate of vegetables

Consumption rate of vegetables	Frequency	Percent
Once	93	29.6
Twice	139	44.3
Thrice	61	19.4
More than three times	21	6.7
Total	314	100.0

4.1.11 Quality of fruits consumed

Respondents (55.7%) asserted that the fruits they took in were sometimes pale and at other times fresh while 44.3% indicated that the fruits they took in were always fresh. Table 4.8 Quality of fruits eaten

Quality	Frequency	Percent
Sometimes pale, other times fresh	175	55.7
Always fresh	139	44.3
Total	314	100.0

Cross tabulation between storing fruits before usage and number of days fruits were stored is shown in Table 4.9. Most of the respondents (61.2%) stored fruits for 1-2 days before consumption, 38.8% stored their fruits for 3-4 days, 85.7% kept the fruits up to two days whereas 14.3% could store their fruits up to four days before consumption.

However, 63.1% of the respondents do not store fruits but consumed them immediately.

Table 4.9 Cross tabulation: storing fruits before usage * Number of days fruits were stored

	How long do you store your fruits before

		consumption?		
		1-2 days	3-4 days	Total
Do you store your fruits before usage?	Yes Count	71	45	116
	% within Do you store your fruits before usage?	61.2%	38.8%	100.0%
	% within How long do you store your fruits before consumption?	26.4%	100.0%	36.9%
	% of Total	22.6%	14.3%	36.9%
	No Count	198	0	198
	% within Do you store your fruits before usage?	100.0%	.0%	100.0%
	% within How long do you store your fruits before consumption?	73.6%	.0%	63.1%
	% of Total	63.1%	.0%	63.1%
Total	Count	269	45	314
	% within Do you store your fruits before usage?	85.7%	14.3%	100.0%
	% within How long do you store your fruits before consumption?	100.0%	100.0%	100.0%
	% of Total	85.7%	14.3%	100.0%

4.1.12 Quality of Vegetables

Vegetables were consumed fresh by the majority of respondents (58%) whereas a few pupils described their vegetables consumed as always pale (13.1%). In addition to these two categories, 29% of the respondents ate their vegetables sometimes pale and sometimes fresh.

Table 4.10 Quality of vegetables consumed

Quality	Frequency	Percent
Always pale	41	13.1
Sometimes pale, other times fresh	91	29.0
Always fresh	182	58.0
Total	314	100.0

4.1.13 Determinants of vegetable and fruit intake

The major determinant of vegetables and fruits intake among the pupils was familiarity with the commodities (94.6%). Parental advice to children to consume fruits (80.9%) and advertisement on radio and TV (51.3%) followed. The least determinant of fruits and vegetable consumption among pupils in the study area was price/cost (33.1%). Table 4.11 Determinants of fruit and vegetable consumption among pupils

Variable	Response	Frequency	Percent
Availability	Yes	233	74.2
	No	81	25.8
	Total	314	100.0
Advertisement	Yes	161	51.3
	No	153	48.7
	Total	314	100.0
Familiarity with the fruits	Yes No	297 17	94.6 5.4
	Total	314	100.0
Price/cost affordability of the fruits	Yes	104	33.1
	No	210	66.9
	Total	314	100.0
Encouragement by parents	Yes No	254 60	80.9 19.1
	Total	314	100.0

4.1.14 Quality Determinants of Fruit and Vegetable Consumption among Pupils

The highest quality determinant of fruit consumption was taste (61.8%) whilst the lowest determinant for fruit was price (5.7%). Health was the highest determinant for consumption of vegetable at (40.4%) whilst the least determinant was price at (2.9%) (Table 4.12).

Table 4.12 Quality determinants of fruit and vegetable consumption among pupils

Determinant	Fruit	Vegetable
Price/cost	18 (5.7%)	9 (2.9)
Taste	194 (61.8%)	103 (32.8)
Freshness	28 (8.9%)	17 (5.4)
Food safety	33 (10.5%)	127 (40.4)
Colour/smell	41 (13.1%)	58 (18.5)
Total	314 (100)	314 (100)

4.2 EFFECTS OF FRUITS AND VEGETABLE CONSUMPTION ON HEALTH OF PUPILS

When respondents were asked whether they fell sick after consuming some rates of fruits and vegetables (FV's), 70% indicated they did fell sick after consuming less than 1 cup of FV's per time while 30% did not. For those who consumed one cup of FV's per time, 33.3% responded they did fall sick, 29.9% did not while 36.8% sometimes fell sick.

Most (39.7%) of respondents felt sick after consuming two cups of FV's per time, 29.7% did not fall sick whereas 30.6% sometimes fell sick. All (100%) respondents fall sick after consuming more than 2 cups per time.

Table 4.13 Cross tabulation: Students who consumed fruits and vegetables per time* the number of times in falling sick

Count		**Amount of FVs consumed per time**					
		Less than 1 cup	One cup	Two cups	More than 2 cups	N/A	Total
Have you ever fallen sick?	Yes	70(7)	33.3(29)	39.7(48)	100(55)	100(41)	180
	No	0	29.9(26)	29.7(36)	0	0	62
	Sometimes	30(3)	36.8(32)	30.637	0	0	72
Total		10	87	121	55	41	314

4.2.1 Logistic Regression to Assess the Impact of Eating Fresh Fruits and Vegetables on the Health of Students

Direct logistic regression was used to assess the effect of eating fresh vegetables and fruits on the health of students. Thus, vegetables and fruits were the two independent variables in the model. The model was statistically significant, X^2 (2, N=314) = 62.217, p<.001. The model as a whole explained between 18.0% (Cox and Snell R Squared) and 24.1% (Nagelkerke R Squared) of the variance in health status and correctly classified 65.3% of all cases. As shown in Table 4.13, out of the two independent variables (fruits and vegetables), it is only the eating of fruits that made a statistically significant contribution to the model recording an odds ratio [Exp(B)] of 2.05. The odds ratio for eating vegetables of .701 is less than 1 indicating that for every additional vegetable eaten, respondents were .70 times less likely to fall sick, controlling for other factors in the model.

Table 4.14 Logistic regression predicting the likelihood of reporting sick.

							95.0% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	eatfruits(1)	.720	.269	7.139	1	.008	2.054	1.211	3.482
	eatveg(2)	-.355	.389	.834	1	.361	.701	.327	1.502
	Constant	-.264	.203	1.697	1	.193	.768		

a. Variable(s) entered on step 1: eatfruits, eatveg.

4.2.2 Health Record of Respondents over a five year period in Amansie West District

Table 4.14 shows record of some diseases reported by patients between the ages of 10 and 17 years in Amansie West District Hospital. Generally, diarrhoea, intestinal worms, typhoid and anaemia which are related to low consumption of fruits and vegetables reduced

gradually year after year (2010 to 2013) for both male and female. However, diseases increased for both male and female in 2014

Table 4.14: Diseases reported by the age group of students (10- 17) at the Amansie West District Hospital.

DISEASES	YEARS									
	2010		2011		2012		2013		2014	
	M	F	M	F	M	F	M	F	M	F
Diarrhoea	489	1058	406	623	305	541	171	315	213	493
Intestinal worms	313	581	258	583	157	337	84	128	128	551
Typhoid	77	150	44	69	137	314	140	131	131	191
Anemia	108	147	108	301	49	145	45	90	90	162

*F=Female, M=Male

Table 4.15: Average means of diseases related to low fruit and vegetable intake over a five year period

Diseases	Male	Female	Mean of means
Diarrhoea	317	606	461
Intestinal worms	188	436	312
Typhoid	106	171	138
Anemia	80	169	125

4.3 MICROBIAL STUDY ON FRUITS AND VEGETABLE SAMPLES

4.3.1 Fruits Samples

4.3.1.1 Banana

There were no significant differences ($p>0.01$) between banana obtained from students' home and the market for total coliforms. However, banana obtained from student's home had 2.96×10^5cfu/1000ml of total coliforms while banana from the market had 2.50×10^5cfu/1000ml.

For total moulds, no significant differences ($p>0.01$) were observed for banana from student's home and the market. Banana obtained from students' home and the market was 9.53×10^4cfu/1000ml and 1.43×10^5cfu/1000ml.

Total plate count recorded in banana from students' home and the market were not significantly different ($p>0.01$) from each other. Banana from students' home recorded 3.30×10^5cfu/1000ml of total plate count while banana from the market recorded 3.59×10^5cfu/1000ml of total plate count.

4.3.1.2 Mango

For total coliforms, no significant difference ($p>0.01$) were observed for mango from students' home and the market. Mango obtained from students' home, however, recorded 3.03×10^6cfu/1000ml while mango obtained from the market had 7.63×10^6cfu/1000ml. There were no significant differences ($p>0.01$) between mango obtained from students' home and the market for total mould. Mango obtained from students' home had 6.14×10^4cfu/1000ml of total mould while mango from the market recorded 3.92×10^4cfu/1000ml of total mould.

Total plate count recorded in mango obtained from both the students' home and the market were not significantly different ($p>0.01$) from each other. Mango from students' home recorded 2.01×10^5cfu/1000ml of total plate count while mango from the market recorded 2.39×10^5cfu/1000ml of total plate count.

4.3.1.3 Orange

There were no significant differences ($p>0.01$) between orange obtained from students' home and the market for total coliforms. However, orange from students' home had 4.33×10^4cfu/1000ml of total coliform while orange from the market had 8.43×10^4cfu/1000ml of total coliform.

Total mould recorded in orange from students' home and the market were not significantly different ($p>0.01$) from each other. Orange from students' home recorded 7.07×10^4cfu/1000ml of total moulds while orange from the market recorded 4.63×10^4cfu/1000ml of total mould.

For total plate count, no significant differences ($p>0.01$) were observed between orange from students' home and that of the market. Orange from students' home and the market were 2.78×10^5cfu/1000ml and 1.95×10^5cfu/1000ml of total plate count

Table 4.16 Microbial Study on Fruit Samples

TREATMENT	TOTAL COLIFORM	TOTAL COLIFORM	TOTAL E. COLI	FEACAL COLIFORM	MOULD PLATE COUNT
STUDENT'S HOME	2.96×10^5	9.53×10^4	3.30×10^5	Nil	Nil
MARKET	2.50×10^5	1.43×10^5	3.59×10^5	Nil	Nil
P(0.01)	0.7151	0.3243	0.5041		
STUDENT'S HOME	3.03×10^6	6.14×10^4	2.01×10^5	Nil	Nil
			BANANA		
			MANGO		
MARKET	7.63×10^6	3.92×10^4	2.39×10^5	Nil	Nil
P(0.01)	0.0613	0.3765	0.1367		
STUDENT'S HOME	4.33×10^4	7.07×10^4	2.78×10^5	Nil	Nil
			ORANGE		

MARKET	8.43×10^4	4.63×10^4	1.95×10^5	Nil	Nil
P(0.01)	0.6254	0.2527	0.3030		

4.3.2 Vegetable Samples

4.3.2.1 Cabbage

There were no significant differences ($p>0.01$) between cabbage from student's home and cabbage from the market for total coliforms. Cabbage from students' home recorded 3.85×10^7cfu/1000ml while cabbage from the market recorded 2.93×10^7cfu/1000ml for total coliforms.

For total mould, there were no significant differences ($p>0.01$) between cabbage obtained from student's home and cabbage obtained from the market. Meanwhile, cabbage from student's home had 1.12×10^5cfu/1000ml and cabbage from the market had 6.16×10^4cfu/1000ml for total mould.

Total plate count recorded no significant differences ($p>0.01$) between cabbage from students' home and cabbage from the market. However cabbage obtained from students' home recorded 3.14×10^5cfu/1000ml while cabbage obtained from the market recorded 2.47×10^5cfu/1000ml of total plate count.

Ecoli was recorded in cabbage but there were no significant differences ($p>0.01$) between cabbage obtained from students' home and cabbage obtained from the market. However Ecoli recorded in cabbage from students' home was 1.33×10^4cfu/1000ml while cabbage obtained from the market 3.0×10^4cfu/1000ml for Ecoli.

Feacal coliform was also present in cabbage but there were no significant differences ($p>0.01$) between cabbage obtained from students' home and cabbage obtained from the

market. Cabbage from students' home and the market were 5.96 × 10^5cfu/1000ml. and 7.20 × 10^5cfu/1000ml. for feacal coliform

4.3.2.2 Onion

Onion from students' home and onions from the market showed no significant differences (P>0.01) for total coliforms. Onion from students' home recorded 1.83 × 10^5cfu/1000ml for total coliforms while onion from the market recorded 2.33 × 10^5cfu/1000ml for total coliforms.

For total mould, no significant differences (P>0.01) were observed between onion from students' home and the market. Onions obtained from students' home and market were 3.42 × 10^4cfu/1000ml and 2.61 ×10^4cfu/1000ml.

Total plate count recorded in onion from student's home and the market were not significantly different (P>0.01) from each other. Onion from student's home recorded 5.52 × 10^5cfu/1000ml of total plate count while onion from the market recorded 1.68 ×10^5cfu/1000ml of total plate count

4.3.2.3 Tomato

For total coliform, no significant differences (P>0.01) were observed for tomato from students' home and the market. Tomato obtained from student's home and the market were 4.60 × 10^6cfu/1000ml and 2.73 × 10^6cfu/1000ml

There were no significant differences (P>0.01) between tomato obtained from student's home and market for total mould, however, tomato obtained from students' home had 5.26 × 10^4cfu/100ml of total mould while tomato from the market had 6.62× 10^4cfu/1000ml of total mould.

Total plate count recorded in tomato from student's home and market were not significantly different (P>0.01) from each other. Tomato from student's home recorded 3.31×10^5cfu/100ml of total plate count while tomato from the market recorded 3.58×10^5cfu/1000ml of total plate count

Table 4.17: Microbial Study on Vegetables

TREATMENT	TOTAL COLIFORM	TOTAL COLIFORM	TOTAL E. COLI COUNT	FEACAL COLIFORM	MOULD PLATE
STUDENTS' HOME	3.85×10^7	1.12×10^5	3.14×10^5	1.33×10^4	5.96×10^5
MARKET	2.93×10^7	6.16×10^4	2.47×10^5	3.0×10^4	7.20×10^5
P (0.01)	0.7613	0.2939	0.0258	0.6384	0.7876
STUDENTS' HOME	1.83×10^5	3.42×10^4	5.52×10^5	Nil	Nil
			CABBAGE		
			ONION		
MARKET	2.33×10^5	2.61×10^4	1.68×10^5	Nil	Nil
P(0.01)	0.7027	0.5892	0.1809		
STUDENTS' HOME	4.60×10^6	5.26×10^4	3.31×10^5	Nil	Nil
			TOMATO		
MARKET	2.73×10^6	6.62×10^4	3.58×10^5	Nil	Nil
P(0.01)	0.4955	0.2408	0.7393		

CHAPTER FIVE

5.0 DISCUSSION

5.1 INTRODUCTION

This chapter discusses the findings of the data analysis in line with the objectives of the research with comparison with other existing data, theories and findings from other research studies.

5.1 SURVEY

5.1.1 Demographic Characteristics of Respondents

The majority of the respondents were males. This suggest that the efforts at girl child education still needs to continue and be intensified for an even distribution or gender balance in education especially at the basic level. The 2010 Population Census (Ghana) showed that women outnumber men in the country. One would therefore expect to find more girls in schools than boys as a reflection of the population distribution in terms of gender. However, this was not the case in the Amansie West District of the Ashanti Region.

With regards to age, the modal age group among the respondents was found to be 15 years with a range from 13 to 16 years. This was an indication that most students enrolled in primary one at the age of six years which is the statutory age for enrolment into primary school.

5.1.2 Number of Meals per day

The study showed that over 70% of the respondents ate three times a day. This indicates that, the area does not have the problem of food shortages which necessitated government intervention with the school feeding programme. However, with almost

30percent of them eating twice daily, this cannot be described as good enough since they are children. It means that on daily basis about 30% of the respondents were inadequately

fed and this can affect their growth and academic performance. This is because studies Li and O'Connell (2012) showed that poor feeding can affect students' cognition, concentration and energy levels thus leading to poor academic achievement.

5.1.3 Fruits and Vegetables Intake among Respondents

The majority of respondents affirmed that they took fruits and vegetables at meals. Meals are mostly carbohydrate concentrated. The common fruits found in the study area included mango, pawpaw, orange, banana and water melon with the least being guava and coconut. The most consumed of these fruits was orange. Sources of fruits for majority of the respondents was their farm and this may be attributed to the fact that the Amansie West District is predominantly a farming community where some of these fruits are planted and others grow naturally out of the wild. Characteristic of most rural communities in Ghana is the principle of reciprocity where people share with their neighbours their farm produce. Therefore, it was not surprising to find out that the second source of fruits in order of importance was sharing and gifts from friends and neighbours.

5.1.4 Determinants of fruits and vegetable consumption among students

The study showed that the major determinant of fruits and vegetable consumption among the respondents was familiarity. This corroborates research findings by Burchett (2003) that familiarity with the fruits and vegetables among children promotes consumption. Parental advice to children to consume fruits was the second determining factor of fruits and vegetable consumption among students in the Amansie West District of the Ashanti Region and this confirms validating earlier studies by Birch (1999) and De-Bourdeaudhuij *et al.* (2008). This means that parents and teachers in loco parentis have a duty to ensure that their wards cultivate the habit of eating fruits and vegetables as part of their meals.

Furthermore, the study revealed that advertisement on radio and TV contributed significantly to fruit and vegetable eating behaviour among students. This again confirms studies by Herrero (2008) that promotion through advertisements, both print and electronic media fosters the consumption of fruits and vegetables among children. This again calls for the Ministry of Education and Agriculture to use media houses to promote fruit eating among the populace. This will boost the fruits and vegetable markets for farmers and equally yield benefits in terms of good health among students especially. All things being equal, this will reduce absence from school caused by sickness and thus promote academic achievement.

Contrary to earlier findings in this study was the fact that the least determinant of fruits and vegetable consumption among pupils in the study area was price/cost. This contradicts findings by French and Stables (2003) that price was a significant determinant of fruits and vegetable consumption among children. This is, however, understandable in the sense that the study area is a farming community where most people farm fruits in addition to other food crops. Consequently, they do not have to buy their fruits and vegetables for consumption just like other farm products. French and Stables (2003) studies were conducted in urban settings in Europe where branding of fruits and vegetable consumption was influenced through branding into names like Dora the Explorer or Sponge Bob. This increased the desire to purchase healthy fruit-based products and this could be the relevance of fruit based drinks sold in Ghanaian markets with brand names such as Pure Heaven, Ceres, Don Simon Multifruita among others.

Children are fascinated by taste of foods and consumables in general. This is the reason why even pharmaceutical companies coat their drugs with sweets to make it pleasurable to children. It was therefore, not surprising to find out from the study that taste was the highest quality determinant of fruit and vegetable consumption among children when all the

factors were compared. This means that the more pleasant the taste of the fruit, the more likely students will prefer it to others. This finding was again in line with the findings of earlier research by Neumark-Sztainer *et al*. (2006) that taste was a significant determinant of fruit preference among children in America in addition to availability.

5.2 EFFECT OF FRUIT AND VEGETABLE INTAKE AND HEALTH OF STUDENTS

From the studies (Logistic regression, respondents who reported eating fruits were two times healthier than those who did not this might be attributed to the fact that vegetables and fruits are essential foods good for promoting health conditions because they contain vital nutrients like proteins, vitamins, minerals and bio-functional components while also being low in fat, sodium and calories compared to many other foods. Neumark-Sztainer *et al*. (2006). It is established the presence of bioactives in vegetables and fruits aid in the prevention of variety of diseases including hypertension, coronary heart diseases and cancers Neumark-Sztainer *et al*. (2006). Thus, consumption of more vegetables and fruits will help protect consumers from Non-communicable Diseases (NDC's). It was therefore encouraging to know that the most of the respondents consumed more fruits and vegetables as it was a farming community. However, sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce. Therefore, improper vegetable and fruit handling during production, packaging as well as storage might affect the health of respondents when consumed.

The hospital record also showed that diseases associated to vegetable and fruit intake reduced from 2010 to 2013 for both male and females except 2014. This might be due to the National epidemic diseases. However, the improved reduction in these diseases might be attributed to awareness of benefits of consumption of fruits and vegetables over the years Neumark-Sztainer *et al*. (2006).

5.3 MICROBIAL STUDY ON FRUITS AND VEGETABLES

5.3.1 *Escherichia coli (E. coli)*

Fruits and vegetables can be possible means for the transmission of bacterial and other pathogens that may cause human illness and in several cases food borne pathogens, have been isolated from fruits and vegetables which might have been contaminated during harvesting, postharvest handling and distribution. Recently several cases of outbreaks caused by contaminated fruits and vegetables have been reported in most developing countries (Mukherjee *et al*., 2006). Fruits and vegetables are widely exposed to microbial contamination through contact with soil, dust, water and by handling at harvest or during postharvest processing (Eni *et al*., 2010).

The laboratory test revealed that, only cabbage samples recorded the presence of *E-Coli* but the range (less than 3 log 10 cfu/g) was within the acceptable range for human consumption. The presence of *E-Coli* in cabbage samples might be attributed to the source of water used for watering was might not be from the best source. Two factor analysis of variance for E. coli showed no significant ($p< 0.01$) difference between the two sources. It was also discovered that *E. coli* was associated with cabbage and this is due to the fact that leafy vegetables provide more surface for contamination.

5.3.2 Total Plate Count (TPC)

Total plate count is used as an indicator of the number of bacteria in fruits and vegetables. All fruits and vegetables selected from the various sources for the microbiological analysis recorded the presence of TPC. This is supported by a statement by Sagoo *et al*. (2003), that fruits and vegetables handled in the natural environment cannot be completely free from microbes and besides the processing stages of fresh fruits and vegetables such as handling, cutting, grating, shredding and slicing are all potential sources of contamination which may further increase the microbial load of the produce. A number of food borne diseases

outbreaks have been attributed to unsatisfactory further processing operations (Sivapalasingam *et al*., 2004). According to the Centre for Food Safety, the total viable count should not exceed 1.0x10. Thus, they were within the acceptable range (less than 3 log 10cfu/g) for human consumption.

In several instances, typhoid fever outbreaks have been linked to eating contaminated sewage (Beuchat, 2002). The increased consumption of contaminated fresh fruits and vegetables are taken outside the home (during school hours) as most students spend long hours outside the home. Therefore, students should be educated on proper treatment of the vegetables such as washing with only water, vinegar in water or salt water, before consumption.

5.3.3 Total Coliforms

From the study, fruits and vegetables recorded the presence of coliforms but were within the acceptable range and safe for consumption. However, despite the presence of some levels of the coliforms on the samples under study, it is important to note that these samples did not show any visible signs of spoilage. Thus, outward appearance may not be a good criterion for judging the microbial quality of fruits and vegetables. All fruits and vegetables should therefore be adequately treated before consumption. It should be done with vinegar in water to decontaminate the fruits and vegetables.

5.3.4 Feacal coliforms

Feacal coliforms number was relatively high but within the acceptable range in cabbage samples but absent in all other samples. The source of water for production of cabbage could have been the source of contamination for the produce. Respondents should therefore be mindful of where they obtain their fruits and vegetables.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The study found out that fruits and vegetables were readily available to students of the Amansie West District in the Ashanti Region. This is due to the fact that the area is a farming community where most parents grow fruits and vegetables in farms and gardens. Other fruits too, grow naturally in the wild. Yet the availability of fruits and vegetables to some students depends on the purchasing power of their parents and the benevolence of neighbours.

Regarding the regularity or frequency of fruits and vegetables consumption among students, the study concludes that fruits and vegetables consumption is a habit among the respondents since the majority of them indicated that they ate fruits and vegetables almost on daily bases and more than once in a day. However, the quality of those fruits and vegetables, their treatment and processing during postharvest needs improvement to yield maximum benefits for consumers.

In addition, the study revealed that several factors affected the consumption of fruits and vegetables among the respondents namely; taste, price/cost, quality, health, colour and smell. However, with regard to vegetables, health reasons were the most determining factor for their consumption whereas taste was a major determinant of fruit consumption.

The laboratory test results showed that, Total Plate Count, Total Mould Count, Total Coliform, were all present on the fruits and vegetables samples but the microbial load levels were within the acceptable range for human consumption (less 3log10cfu/g).
Feacal Coliform and *E. Coli* were present in only cabbage samples.

Generally, the consumption of fruits and vegetables were found to show positively on the health of students. Therefore, students who ate more fruits (56.05%) and vegetables (74.2%) were found to be healthier than those who ate less fruits (35.67%) and vegetables (12.7%).

6.2 RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made for policy and implementation.

1. All fruits and vegetables should be adequately washed with vinegar in water to decontaminate before consumption by periodically organising personal and environmental hygiene education and food safety programmes students.
2. The Ministry of Health in collaboration with the Ministry of Education could organise periodically-in- service training on food safety and good nutrition in the various schools to educate them on the importance of fruits and vegetables intake to their general wellbeing.
3. The Ministry of Food and Agriculture (MOFA) could do more sensitization on fruit and vegetable consumption by students to the School Feeding Programme officials so that fruit and vegetable consumption would be included in the menu to enhance effective learning of students.

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APPENDICES

APPENDIX A: LOGISTIC REGRESSION ANALYSIS

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	314	100.0
	Missing Cases	0	.0
	Total	314	100.0
Unselected Cases		0	.0
Total		314	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
No	0

Yes	1

Categorical Variables Codings

		Frequency	Parameter coding (1)	Parameter coding (2)
Do you eat vegetables at meals?	Yes	233	.000	.000
	2	41	1.000	.000
Do you eat fruits as part of your meals?	3	40	.000	1.000
	No	139	.000	
	Yes	175	1.000	

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	62.217	3	.000
	Block	62.217	3	.000
	Model	62.217	3	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	366.317[a]	.180	.241

a. Estimation terminated at iteration number 20 because maximum i
been reached. Final solution cannot be found.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.000	2	1.000

Contingency Table for Hosmer and Lemeshow Test

	Have you ever fallen sick? = no	Have you ever fallen sick? = yes	Total

		Observed	Expected	Observed	Expected	
Step 1	1	26	26.000	14	14.000	40
	2	56	56.000	43	43.000	99
	3	52	52.000	82	82.000	134
	4	0	.000	41	41.000	41

Classification Table[a]

Observed		Predicted		
		Have you ever fallen sick?		
		No	Yes	Percentage Correct
Step 1	Have you ever fallen sick? No	82	52	61.2
	Yes	57	123	68.3
	Overall Percentage			65.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	eatfruits(1)	.720	.269	7.139	1	.008	2.054	1.211	3.482
	eatveg(2)	-.355	.389	.834	1	.361	.701	.327	1.502
	Constant	-.264	.203	1.697	1	.193	.768		

a. Variable(s) entered on step 1: eatfruits, eatveg.

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			Have you ever fallen sick?		Percentage Correct
	Observed		No	Yes	
Step 0	Have you ever fallen sick?	No	0	134	.0
		Yes	0	180	100.0
	Overall Percentage				57.3

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.295	.114	6.690	1	.010	1.343

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	eatfruits(1)	27.146	1	.000
		eatveg(2)	9.339	1	.002
	Overall Statistics		47.300	3	.000

APPENDIX B: SURVEY QUESTIONNAIRE

Background of respondents

1. Sex

a. Male

b. Female 2. Age

a. 12

b. 13

c. 14

d. 15

e. Any other specify.....

3. Year of study

a. JHS1

b. JHS2

c. JHS3

4. Father's occupation: .....

5. Mother's occupation: .....

6. Guardian's occupation: ..... (For students living with guardians).

7. Number of members of family.....

8. Number of siblings.....

The availability of fresh fruits and vegetables to students

9. How many meals do you take in a day?

a. One

b. Two

c. Three

d. Any other. Specify: .....

10. Do you eat fruits as part of your meals?

a. Yes

b. No

c. Sometimes

d. Once a while

11. Which of these fruits do you mostly eat?

a. Mango

b. Pawpaw

c. Orange

d. Water melon

e. Coconut
f. Banana
g. Guava
h. None of the above

12. Where do you get the fruits from to eat?
a. From the farm
b. From the garden
c. From our neighbours (gifts)
d. Bought from the market
e. Not applicable

13. Do you process the fruits before eating?
a. Yes
b. No
c. Not applicable

14. If yes what kind of processing is carried out on fruits before consumption?
a. Washing
b. Cutting
c. Squeezing
d. Not applicable

15. Do you often eat vegetables at meals?
a. Yes
b. No
c. Sometimes
d. Once a while

16. If you eat vegetables, what amount do you eat per time?
a. Less than a cup
b. One cup
c. Two cups
d. More than two cups
e. Not applicable

17. Which of these vegetables do you mostly eat?
a. cabbage
b. Carrot

c. Tomato

d. Onion

e. Lettuce

f. Cucumber

g. None of the above

18. Where do you get the vegetables from to eat?

a. From the farm

b. From the garden

c. From our neighbours (gifts)

d. Bought from the market

e. Not applicable

19. Do the vegetables undergo some treatments before eating?

a. Yes

b. No

c. Not applicable

20. If yes what type of treatment?

a. Washing

b. Grinding

c. Chopping

d. Not applicable

21. Is it tedious to process the vegetables before consumption?

a. Yes

b. No

c. Not applicable

22. Why do you treat the vegetables before consumption?

a. To remove germs

b. To remove impurities

c. To remove both germs and impurities

23. What type of problems do you encounter during processing? .....

The frequency of consumption and quality of fresh fruits and vegetables

24. How many times do you eat fruits in your daily meals?

a. Once

b. Twice

c. Thrice

d. More than three times

e. Other. Specify: ……..

25. How many times do you eat fruits in a week?

a. Once per week

b. Twice per week

c. Thrice per week

d. 4 – 6 times per week

e. Other. Specify: …….

26. Indicate your consumption of the following fruits per week:

Fruit	Frequency of consumption per week						
	Nil	1	2	3	4	5	6
Mango							
Pawpaw							
Orange							
Water melon							
Coconut							
Banana							
Guava							

Any other. Specify: ……

27. Indicate your consumption of the following fruits per day

Fruit	Frequency of consumption per day			
	Nil	1	2	3
Mango				
Pawpaw				
Orange				
Water melon				
Coconut				
Banana				
Guava				

Other: ……

28. How would you describe the fruits you mostly eat?

a. Always pale
b. Sometimes pale, other times fresh
c. Always fresh

29. The following are some determinants of fruit consumption, tick only one of your most preferred choice?

a. Price/cost
b. Taste
c. Quality
d. Health
e. Colour/smell

30. Do you store your fruits before usage?

a. Yes
b. No

31. Give reason for your answer to the above question:

……

32. How long do you store fruits before consumption?

a. 1 to 2 days
b. 3 to 4 days
c. 5 to 6 days
d. One week
e. Two weeks
f. More than two weeks

33. How many times do you eat vegetables in your daily meals?

f. Once
g. Twice
h. Thrice
i. More than three times
j. Other. Specify: ……..

34. How many times do you eat vegetables in a week?

a. Once per week
b. Twice per week
c. Thrice per week
d. 4 – 6 times per week

e. Other. Specify: …….

35. How would you describe the vegetables you mostly eat?

d. Always pale

e. Sometimes pale, other times fresh

f. Always fresh

g. Indicate your consumption of the following vegetables per week:

Vegetable	Frequency of consumption per week						
	Nil	1	2	3	4	5	6
Cabbage							
Carrot							
Tomato							
Onion							
Lettuce							
Cucumber							
Ayoyo							
Kontommire							
Other							

36. Indicate your consumption of the following vegetables per day

Vegetable	Frequency of consumption per day			
	Nil	1	2	3
Cabbage				
Carrot				
Tomato				
Onion				
Lettuce				
Cucumber				
Ayoyo				
Kontommire				
Other				

37. The following are some determinants of vegetable consumption, tick only one of your most preferred choice?

f. Price/cost

g. Taste

h. Quality

i. Health

j. Colour/smell

38. Do you store your vegetables before usage?

c. Yes

d. No

39. Give reason for your answer to the above question:

……

……

40. How long do you store vegetables before consumption?

g. 1 to 2 days

h. 3 to 4 days

i. 5 to 6 days

j. One week

k. Two weeks

l. More than two weeks

The effect of the consumption of fresh fruits and vegetables on the health of students

41. Have you ever fallen sick during the year?

a. Yes

b. No

c. Sometimes

42. What sickness were you diagnosed with?

.....

43. How many times have you fallen sick this academic year?

a. Once

b. Twice

c. Thrice

d. None

e. Other. Specify: .....

44. If you have fallen sick more than once kindly indicate the type of sickness and the order in which you have fallen sick.

....

Determinants of fruit and vegetable consumption among students

45. Which of these factors influence you to eat fruits and vegetables?

Factors	Yes	No
Availability		
Adverts		
Familiarity		
Cost/Price		
Parents eat fruits		

APPENDIX C: STATISTICAL ANALYSIS OF FRUITS AND VEGETABLES

BANANA Two-Sample T Tests for Tcoliform by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	250000	170880	98658	
Std	3	296667	115470	66667
Difference		-46667	145831	119070

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference Method	**Variances**	**DF**	**T**	**P**
Lower	**Upper**							
Pooled	Equal	4	-0.39	0.7151	-594879	501545		
Satterthwaite	Unequal	3.5	-0.39	0.7177	-650637	557304		

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	2.19	0.3135

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt	**N**	**Mean**	**SD**	**SE**
Mkt	3	143520	60044	34666
Std	3	95350	43761	25266
Difference		48170	52537	42897

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference Method	**Variances**	**DF**	**T**	**P**
Lower	**Upper**							
Pooled	Equal	4	1.12	0.3243	-149330	245670		
Satterthwaite	Unequal	3.7	1.12	0.3297	-162563	258903		

Homogeneity of Variances DF F P

Folded F Test 2,2 1.88 0.3469

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecount by trt

trt N Mean SD SE Mkt

3 359467 14503 8373.0

Std 3 330133 67763 39123

Difference 29333 49001 40009

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method Variances DF T P Lower Upper

Pooled Equal 4 0.73 0.5041 -154872 213539

Satterthwaite Unequal 2.2 0.73 0.5341 -316155 374822

Homogeneity of Variances DF F P

Folded F Test 2,2 21.83 0.0438

Cases Included 6 Missing Cases 0

ORANGE Two-Sample T Tests for Tcoliform by trt

trt N Mean SD SE Mkt

3 84333 126674 73135

Std 3 43336 45088 26032

Difference 40997 95077 77630

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method Variances DF T P Lower Upper

Pooled Equal 4 0.53 0.6254 -316419 398413

Satterthwaite Unequal 2.5 0.53 0.6407 -515470 597464

Homogeneity of Variances DF F P

Folded F Test 2,2 7.89 0.1124

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt N Mean SD SE Mkt

3 46350 12033 6947.3

Std 3 70710 29220 16870

Difference -24360 22345 18245

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method Variances DF T P

Lower Upper

Pooled Equal 4 -1.34 0.2527 -108360 59640

Satterthwaite Unequal 2.7 -1.34 0.2846 -145650 96930

Homogeneity of Variances DF F P

Folded F Test 2,2 5.90 0.1450

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecount by trt

trt N Mean SD SE Mkt

3 195533 94414 54510

Std 3 278167 75977 43866

Difference -82633 85693 69968

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

		99% CI for Difference	Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	-1.18	0.3030	-404773	239506			
Satterthwaite	Unequal	3.8	-1.18	0.3058	-415062	249795			

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	1.54	0.3931

Cases Included 6 Missing Cases 0

MANGO Two-Sample T Tests for Tcoliform by trt

trt	N	Mean	SD	SE
Mkt	3	7.63E+06	2.89E+06	1.67E+06
Std	3	3.03E+06	1.10E+06	633333
Difference		4.60E+06	2.18E+06	1.78E+06

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

		99% CI for Difference	Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	2.58	0.0613	-3.61E+06	1.28E+07			
Satterthwaite	Unequal	2.6	2.58	0.0958	-7.77E+06	1.70E+07			

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	6.93	0.1262

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt	N	Mean	SD	SE Mkt
3	39227	13223	7634.1	
Std	3	61427	36352	20988

Difference -22200 27352 22333

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference		**Method**	**Variances**	**DF**	**T**	**P**
Lower	**Upper**									
Pooled	Equal	4	-0.99	0.3765	-125023	80623				
Satterthwaite	Unequal	2.5	-0.99	0.4058	-180588	136188				

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	7.56	0.1168

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecou by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	239167	30617	17676	
Std	3	201767	16683	9631.9
Difference		37400	24655	20130

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference		**Method**	**Variances**	**DF**	**T**	**P**
Lower	**Upper**									
Pooled	Equal	4	1.86	0.1367	-55282	130082				
Satterthwaite	Unequal	3.1	1.86	0.1574	-76797	151597				

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	3.37	0.2289

Cases Included 6 Missing Cases 0

CABBAGE Two-Sample T Tests for Tcoliform by trt

trt	N	Mean	SD	SE
Mkt	3	2.93E+07	1.19E+07	6.89E+06
Std	3	3.85E+07	4.73E+07	2.73E+07
Difference		-9.17E+06	3.45E+07	2.82E+07

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	-0.33	0.7613	-1.39E+08	1.20E+08
Satterthwaite	Unequal	2.3	-0.33	0.7728	-2.42E+08	2.23E+08

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	15.75	0.0597

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt	N	Mean	SD	SE Mkt
3	61590	33616	19408	
Std	3	112487	64838	37434
Difference		-50897	51643	42167

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	-1.21	0.2939	-245035	143242
Satterthwaite	Unequal	3.0	-1.21	0.3138	-296965	195172

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	3.72	0.2119

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecou by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	247067	30961	17875	
Std	3	314333	13261	7656.4
Difference		-67267	23816	19446

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-3.46	0.0258	-156798	22265				
Satterthwaite	Unequal	2.7	-3.46	0.0475	-193781	59247				

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	5.45	0.1550

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Ecoli by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	13333	23094	13333	
Std	3	30000	51962	30000
Difference		-16667	40208	32830

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

				99% CI for Difference Method	**Variances**	**DF**	**T**	**P**	**Lower**	**Upper**
Pooled	Equal	4	-0.51	0.6384	-167817	134484				
Satterthwaite	Unequal	2.8	-0.51	0.6494	-225885	192552				

Homogeneity of Variances DF F P

Folded F Test 2,2 5.06 0.1649

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Fcoliform by trt

trt N Mean SD SE Mkt

3 596667 288675 166667

Std 3 720000 682862 394250

Difference -123333 524230 428032

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method Variances DF T P Lower Upper

Pooled Equal 4 -0.29 0.7876 -2.09E+06 1.85E+06

Satterthwaite Unequal 2.7 -0.29 0.7940 -2.93E+06 2.68E+06

Homogeneity of Variances DF F P

Folded F Test 2,2 5.60 0.1516

Cases Included 6 Missing Cases 0

ONION Two-Sample T Tests for Tcoliform by trt

trt N Mean SD SE Mkt

3 233333 195021 112596

Std 3 183333 80829 46667

Difference 50000 149276 121883

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	**Variances**	**DF**	**T**	**P**			
Lower	**Upper**						
Pooled	Equal	4	0.41	0.7027	-511163	611163	
Satterthwaite	Unequal	2.7	0.41	0.7123	-757445	857445	

Homogeneity of Variances	**DF**	**F**	**P**
Folded F Test	2,2	5.82	0.1466

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	26187	15061	8695.3	
Std	3	34273	18551	10711
Difference		-8086.7	16897	13796

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	**Variances**	**DF**	**T**	**P**			
Lower	**Upper**						
Pooled	Equal	4	-0.59	0.5892	-71605	55431	
Satterthwaite	Unequal	3.8	-0.59	0.5905	-73474	57301	**Homogeneity of**
Variances	**DF**	**F**	**P**				
Folded F Test		2,2	1.52	0.3973			

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecou by trt

trt	**N**	**Mean**	**SD**	**SE** Mkt
3	168067	15588	8999.5	
Std	3	552300	410903	237235
Difference		-384233	290761	237405

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	-1.62	0.1809	-1.48E+06	708804
Satterthwaite	Unequal	2.0	-1.62	0.2466	-2.73E+06	1.96E+06

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	694.90	0.0014

Cases Included 6 Missing Cases 0

TOMATO Two-Sample T Tests for Tcoliform by trt

trt	N	Mean	SD	SE
Mkt	3	2.73E+06	1.43E+06	825295
Std	3	4.60E+06	4.07E+06	2.35E+06
Difference		-1.87E+06	3.05E+06	2.49E+06

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	-0.75	0.4955	-1.33E+07	9.61E+06
Satterthwaite	Unequal	2.5	-0.75	0.5183	-1.99E+07	1.61E+07

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	8.12	0.1097

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tmould by trt

trt	N	Mean	SD	SE Mkt
3	66217	10319	5957.8	
Std	3	52660	13592	7847.1
Difference		13557	12067	9852.5

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	1.38	0.2408	-31805	58919
Satterthwaite	Unequal	3.7	1.38	0.2456	-34121	61234

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	1.73	0.3657

Cases Included 6 Missing Cases 0

Two-Sample T Tests for Tplatecou by trt

trt	N	Mean	SD	SE Mkt
3	358500	109047	62959	
Std	3	331633	71579	41326
Difference		26867	92236	75310

T-Tests for Mean Difference

Null Hypothesis: difference = 0

Alternative Hyp: difference <> 0

99% CI for Difference Method	Variances	DF	T	P	Lower	Upper
Pooled	Equal	4	0.36	0.7393	-319869	373603
Satterthwaite	Unequal	3.5	0.36	0.7420	-360343	414076

Homogeneity of Variances	DF	F	P
Folded F Test	2,2	2.32	0.3011

Cases Included 6 Missing Cases 0