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Student Name: Crystal Mendoza

Project Supervisor: Dr. Patricia Dyett

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Department of Agricultural Economics & Extension
Faculty of Food and Agricultural

**THE UNIVERSITY OF THE WESTINDIES, ST AUGUSTINE CAMPUS
DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION**

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Analysis of Macronutrients from Foods Consumed at the University of the West Indies.

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Crystal Mendoza

Supervised by Dr. Patricia Dyett

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Abstract:

Background:Fast food consumption has become very popular, since most students live a hectic lifestyle and do not have time to prepare traditional home cooked meals. These fast foods meals tend to be high in fat, protein and calorie content and frequent consumption of these meals can lead to a person becoming overweight or obese.

Objectives:The purpose of this study was to identify the popular meals at the University of the West Indies: to quantify the macronutrient component of meal samples from seven different on campus food establishments: and to compare the macronutrient content of similar meals samples from three different days: as well as to compare different fast food meal sample with one traditional meal sample.

Methodology:Seven types of popular foods provided by the different food establishments on campus were analyzed for their proximate ash, fat, protein (Nx6.25), crude fiber and soluble carbohydrate content, using the standard procedure (AOAC) 2000.

Results:Proximate analysis showed that the fat content was high in fried chicken, cheese pie and meat pizza ranging from a mean of 18.25g -33.32g/100g. Mean protein content was high in meat pizza, fried chicken and roti with a range from 12.69g-13.84g/100g. The lowest protein content was in chicken sub which had 9.34g/100g. Mean crude fiber was the highest in roti with 2.25g/100g and soluble carbohydrate had many variations in their results the highest amount was in vegetarian pizza with the amount of 32.60g/100g.

Conclusion:The results of this study highlighted that the fat was the macronutrient consumed in the largest amount in the most popular food consumed. It was also found that cheese pie had more soluble carbohydrates than vegetarian pizza on day one but had less on day three. KFC had more fat and protein than roti on day one, it can therefore be concluded that such findings demonstrate a need for healthy food choices and chronic disease prevention.

Chapter One

Introduction:

1.1 Background:

Fast food consumption has become a prominent feature of the diet of many people both young and old in developed and developing countries. Fast foods can be defined as foods prepared using quick cooking methods. It is usually served buffet style and purchased in a takeout eating venue without service (Rosenheck, 2008). More foods are being consumed outside the home because of the busy lifestyle of most people, this means that fast food contributes greatly to population intakes of energy, fat, sugar and salt. Fast food tends to be high in energy, saturated fat and salt. It is also lower in micronutrient content when compared to traditional meals and is eaten in larger serving sizes. Examples of these foods are; pizza, burger/ sandwiches, KFC and other fried foods. As a result of these fast foods consumption, overweight and obesity is increasing as well as other health risks associated with excess body weight such as type two diabetes and cardiovascular diseases. Monteiro (2009) explains “that the rise in nutrition-related diseases has led some to focus attention on the quality of products provided by the food industry.” Meal portion size should also be investigated since different food establishments use varying portion sizes. There is also the option of upsizing a meal for an additional price, therefore the result is an even larger intake of energy, fat, sugar and salt in the diet.

Fast foods are especially popular amongst school children. Children in developed countries like the U.S.A are reported as being overweight and obese. Results from a food consumption questionnaire showed low test scores because of an increased fast food consumption. (Tobin et al 2011). Foods being consumed by adolescents were not consistent with the Dietary Guidelines for Americans. Most adolescents had high intakes of calcium rich foods and fatty foods along with low consumption of fruits and vegetables (Mary et al 2002). This is one of the reasons that exemplify the importance of analysis of key nutrients.

Thus persons can make informed decisions when purchasing meals.

Nielsen (1998) defined food analysis as “a discipline that deals with the development, application and study of analytical procedures for characterizing the properties of foods and their constituents”. According to (Gaithersburg 1995), “chemical analysis of food is a critical part of a quality assurance programme in food processing. It is also important in the formulation and development of new products, evaluation of processes for making food products and identification of the source of problems with unacceptable products.” This information is important because it can be used to economically produce foods that are consistently safe, nutritious, and desirable and for consumers to make informed choices about their diet.

The analysis of Protein, carbohydrate, fat and fibre is very important as our bodies need them in appropriate amounts to function properly. These nutrients are labelled macro-nutrients because requirements for these nutrients are larger than that of micronutrients. Protein, carbohydrates and fat are the only nutrients that provide energy from food. This energy is measured in calories. Energy in our food is necessary for all body activities such as growth, body functions such as thinking, digesting and metabolizing food, breathing, and circulating blood and oxygen. According to the USDA carbohydrate provides 4 calories per gram; protein provides 4 calories per gram and fat provides 9 calories per gram. Food contains a mixture of nutrients that help the body to function in many different ways, a nutrient can perform one or several functions in the body. “Adequate amounts of both macro and micro nutrients are needed for proper growth, development, good health and prevention of diseases” FAO (2011).

Carbohydrates are the macronutrient that we need in the largest amounts. According to Mahan et al, (2012) carbohydrates provide approximately half the total calories in the diet. Carbohydrate is the body's main source of fuel and is used easily by the body for energy. Information from McKinley Health Center (2008) stated that “it is needed to provide energy for the central nervous system, the kidneys, the

brain, the muscles (including the heart) to function properly.” Carbohydrate can be stored in the muscles and liver and later used for energy, it is also important in intestinal health and waste elimination. Carbohydrates are found in three forms: sugar, starch and fibre, each form serves different purposes in the diet. The first Sugar is quickly absorbed into the body and used for energy, it improves the flavour, texture and appearance of foods, however it is recommended to limit consumptions of sweets (FAO(2011)). Starch provides the most amounts of calories and it is recommended to use the unrefined starch rather than the refined starch, because important nutrients are lost during the refining process.

“Dietary fiber refers to nondigestible carbohydrates and lignin that are intact and intrinsic in plants and functional fiber consists of nondigestible carbohydrates that have been isolated, extracted, or manufactured and have beneficial physiological effects in human”(Groff et al 2005). Fiber has been proven to slow the absorption rate of carbohydrates, thus regulating blood glucose in diabetic patients. It lowers serum cholesterol levels that cause heart disease and helps prevent irritable bowel syndrome and constipation (Groff et al 2005). In the chemical analysis of foods, crude fiber is usually reported on. “Crude fiber values reflect part of the dietary fiber and have been reported to recover 20% of the hemicellulose, 10 to 15% of the lignin and 50 to 80% of the cellulose”(Steven N Heller and Hackler 1978).

“Proteins help to sustain life by repairing damaged cells and tissues other important roles are enzyme formation, transportation and immunoproteins” Mahan et al (2012). It is important for clotting blood and for keeping the immune system strong by developing antibodies to fight diseases. FAO (2011) noted that “without protein to help fluids remain in their appropriate place in veins, arteries and cells, liquid can leak out into body extremities feet and legs and the abdominal cavity, example Kwashiorkor.” Protein is usually converted to energy when the body stores are low, however this use of protein takes away from its main function since it involves the breakdown of organs to supply the energy. The body obtains protein from animal products such as meat, dairy and fish and from plant sources such as legumes, grains and nuts.

Some fats such as essential fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are important for health; they are good for brain development and are inflammatory in nature. Fats provide the body with energy and are needed for the absorption of fat soluble vitamins A, D, E and K. Fats protect the cells and internal organs and allow us to store calories to use when food is not available. Fats stay in the stomach longer than other foods, making us feel full; it regulates body temperature and adds flavour to food, however fats generally have a bad reputation because of the link to obesity and cardiovascular diseases. Consuming large amounts of total fats, saturated fats (mainly red meats and full cream dairy products), cholesterol (animal and meat products) and Transfat (baked goods, package foods example cakes and cookies, margarines and fast food) can lead to cardiovascular diseases. “Early research results led to the conclusion that saturated fatty acids increase cholesterol levels and Polyunsaturated fats examples nuts, seeds, whole grain wheat, fish and leafy greens help reduce cholesterol levels, monounsaturated fats example avocados, olive oil, whole milk products and milk were assumed to be neutral”(Groff et al 2005).

Consuming the right amount of fat is an important part of a healthy diet that meets individual energy and nutrient needs. Nutrients in food support every system and function in the body, poor nutrition is detrimental to health and therefore it is important to eat balanced meals to get the right amounts of nutrients to prevent food related diseases and to enjoy maximum quality of life.

1.2 Rationale:

The human brain is a very important organ and just like the rest of the body it requires energy to help maintain its function. Gomez (2011) recognized that “brain cells use a form of sugar called glucose to fuel cellular activities and this energy comes from the foods we consume daily and is regularly delivered to brain cells (called neurons) through the blood.” Therefore people who don’t consume adequate nutrients in their diet may experience unfavourable changes in their brain function. Macronutrients such as fats, carbohydrates and protein help contribute to the nutritional state of the brain. Therefore consuming the right types and amounts of these nutrients will determine the level at which the brain functions.

Robin(1997)Stated that “deficiencies in intakes of a number of vitamins and minerals are accompanied by impairments in brain functioning and behavioural disturbances.”Rosenthal and Amiel(2001) stated in their journal article that “Hypoglycemia impairs simple brain functions and is associated with task-specific localized reductions in brain activation because the brain is normally dependent on glucose for oxidative metabolism and function.”

University students live a fast pace life, most of them live away from home and do not do much cooking, they want something quick and close. Since the brain is the powerhouse of the central nervous system, responsible for thinking and learning, feeling, deciding, acting and reacting, the food that is supplied as the energy for our brain to function, determines the operating environment for the brain. Therefore, the right types and amounts proteins, fats, vitamins and minerals are essential to brain structure and function, as is adequate fluid. Therefore it is important to the researcher to conduct this study, since the results of this can be used to plan educational meals and educate the population about healthier food choices.

1.3 Problem Statement:

Students (consumers) purchase a variety of meals on campus; including fast foods and traditional meals. But it is not known whether fast foods are less healthy than traditional meals served in terms of macronutrient content.

1.4 General Objective:

a) To analyse the macro-nutrient content of the more popular meals at the St. Augustine University campus

Specific Objectives:

b) To identify the more popular meals at the St. Augustine University campus

c) To quantify the macro-nutrients of selected meals using standard chemical analysis method.

- d) To compare consistency in macronutrient content of similar or same meals on different days
- e) To compare the macronutrient content of one traditional meal sample with different fast food meals

1.5 Hypotheses

- a) There is a consistent amount of macronutrients contained in similar foods served on a daily basis
- b) Fast food contain different macronutrient content than traditional meal samples

1.6 Scope:

The study will be conducted over a three month period at the University of the West Indies St Augustine Campus. It involves chemical analysis of popular meals purchased from different establishment at the university.

Chapter 2

Literature Review

2.1 Introduction:

A balanced diet is one which contains food from the various food groups in the correct amounts. This is associated with achieving proper growth and development. Eating a balanced diet is especially important when one is studying. If food is eaten in the correct amounts the nutrients is utilized properly in the body. Conversely if excess is consumed, then it may have negative effects on the body example, overweight and obesity. In today's society most people have a hectic lifestyle. Thus dietary changes and nutritional status of individuals have changed. This change may be the driving force for the increased number of overweight, obese and chronic diseases cases.

Health Implications

Obesity is a health problem worldwide. Musaiger et al (2007) in his study discovered that, "the range of overweight and obesity in the Arab Gulf Region is from 25 to 45%." Overweight is defined as a body mass index of 25 or over and obesity as a body mass index greater than 30. (Rosenheck 2008) stated that "the 1999-2002 National Health and Nutrition Survey data estimated that "65% of US adults are either overweight or obese" which represents a 16% increase from 1988 to 1994." Johnson et al (2012) concluded that "in addition to being unhealthy junk food increases overeating which can lead to obesity." Musaiger et al (2007) recognised that "school children in Arab Gulf countries consumed more foods that were rich in cholesterol and salt and consumed fewer foods rich in micronutrients and dietary fiber." It was also noted that "these fast foods such as chocolate and carbonated beverages were the popular food choices of these children especially between meals" (Musaiger et al 2007). Therefore assessing current nutrients future nutrient intake becomes even more important"

Johnson et al (2012) observed that “consuming large amounts of junk foods and foods rich in trans-fat can shrink the brain, similar to that associated with Alzheimer disease.” The study also showed that “the brain benefitted from consumption of foods rich in vitamins B, C, D and E and although the study was done on a set of people over 65 years the impact of trans fatty acid begins to take place at the fetal stage”(Johnson et al2012).Other studies have shown that as early as the age of 30 medical history shows the groundwork for future heart attacks. Johnson et al (2012) recognised that “what children ate from puberty affects their risks of prostate and breast cancer.”He also stated that “osteoporosis and hypertension are other diseases that appear to have been caused by eating habits from childhood.”

Accessibility of Fast Foods

Fast food may be very popular because they are strategically located and allow ease of access. Its popularity may also be due to mass advertisement. Rosenheck(2008) estimatedthat, “fast foods outlets have increased from 30,000 in 1970 to more than 233,000 locations in the USA in 2004 and have been classified as the most rapidly expanding sector of the US food distribution centre”. Even developing countries have easy access to fast foods, due to mass advertisement and expansion of fast food chains. Nago et al (2009) described “the epidemic of overweight, obesity and related chronic disease as the result of the changes of dietary patterns”. He also stated that “cities such as Bamako, Accra and Dakar most individuals regardless of their demographic area, age or income bracket, consumed foods outside the home in addition to home prepared family meals” (Nago et al 2009).

It was also noted that “in Benin urban adolescents are frequently exposed to canteen foods and street foods vended within the school”Nago et al(2009). A study by Al Fedan and Robinson (2000) investigated “women who have begun to find permanent employment in industry and commerce and spend more hours outside the home, thus family meals have been sacrificed and as a result of this young people are eating many more snacks meals like sandwiches, pizzas and burgers which have no great amounts of nutrients.”Johnson et al (2012) stated that “Junk foods are high visibility products they are

easily available, highly advertised and very popular amongst children.” This may be due to the creative packaging and enticing colours and flavours, which enhances its appeal.(Rosenheck2008) stated that“money spent on food outside the home represented 25% of the total food spending in the US in 1970 and grew to 47.5% of total spending in 1999 and was projected to increase to 53%.”

Assessing Nutrient Quality of Food

In many countries there is little information about the nutrient composition of fast foods. Therefore many countries may get their nutrient composition data from a standard western source example the USDA online nutrition composition table.Nagoet al (2009) performed studies in Beninese and concede that “there is little information about the macronutrient composition of foods consumed outside the home, therefore the goal is to chemically analyse the macronutrients contribution of the foods”.Bahrain Musaiger et al (2007) stated that “counting food groups or food items cannot give a complete picture of nutrient intake in the school feeding program in hence the importance of assessing the nutrient composition of foods provided by the canteen.” Studies by Al-Fedah and Robinson (2000) in Qatar attempted to educate consumers on factual information about fast foods and evaluate the effects of replacing a traditional meal example: fish or lentils with a typical fast food meal example: pizza on a young adult male.

Johnson et al (2012) statedthat “Salt, sugar and fat are items that should be monitored” this is especially true since these nutrients appear in large quantities in fast foods.

Macronutrient and Mental Health

The brain is a major organ in the body. It is responsible for thought, reasoning, movement, speech, visual processing and perception of stimuli. “Thereforedeficiencies may alter its function, as it requires nutrients to build and maintain its structure and cognitive abilities”(Bourne 2005). He examined a study also that stated “ the cognitive performance and mood in healthy adults ages 18-65 who ate a non dairy sherbet or a turkey breast for lunch.”(Bourne 2005) The study concluded that “ women who ate the carbohydrate

meal were sleepier compared to women who ate the protein meal.”(Bourne 2005) Additionally “ The men who ate the carbohydrate meal described themselves as calmer than those who ate the protein meal and both women and men who ate carbohydrate meals for lunch performed poorly on a listening test compared those who ate protein”(Kanarek1997). The study also noted that“the effects of the meals in performance was significant to individuals 40 years and older, but also hinted that the methodology had flaws.”Mahoney (2005) stated that “when analyzing meals in its relation to cognitive behavior, the size of the meal and the amount of macronutrients affect mental performance.”He also agreed with the evidence that “even small increases in blood glucose can lead to enhancement in learning and memory across the lifespan.”There are many studies that analyze single nutrients and their effects on health and cognitive performance, but people don’t consume single nutrients, they eat varying meals consisting of protein, fat, carbohydrates and fiber. “Results vary significantly among studies on the effects of meals on cognitive behaviour. Several explanations exist for these inconsistencies in terms of macronutrients content variables such as type of cognitive task, time of meal consumption and testing are different across experiments, therefore the results will vary” (Mahoney 2005). He also stated that “ it is common knowledge that poor nutrition can have negative and even lasting effects on the human body including cognitive brain functions”(Mahoney 2005)

Nutritional Implication

Cooking is a process whereby food undergoes chemical and physical changes. Different temperatures, moisture and pH are manipulated in food, resulting in an end product that is desirable and palatable. One such cooking method is frying. It was stated that, “fried foods play a significant role in the fast food industry in America and frying has helped the acceptance of ethnic foods since it provides bolder flavours, and an added crunch to traditional meals”(Saguy and Dana2003).Ghidurus et al(2010) stated that “ frying produces many changes to the composition of food and this depends on the food the texture, size and shape of the food and the frying conditions such as temperature and duration.”It has been noted that “foods of animal origin absorb less oil than vegetables like tomatoes, onions, pineapple and peeled

egg plant, white bread was also noted to absorb a large amount of fat”(Ghidurus et al2010).In an experiment conducted it was noted that “the fat intake of peeled potatoes was 19.4% after 70 seconds, which is higher than the fat intake of fried chicken, meat, fish or prawns. Low fat changes have been determined infrying beef, pork, lamb or sausages”(Ghidurus et al2010). It was also stated that“if protein food is fried without any other ingredients the digestability of protein is not affected, however if a carbohydrate is added example flour, it reduces the protein digestability”(Ghidurus et al 2010). Further results of this study indicated s that “the frying method has no influence on the carbohydrate content of potatoes, potato products and breaded meat and fish. Deep fat frying however, increased the percentage of resistant starch, which was attributedto amylose lipid complexes, frying also decreased the amount of digestible starch in potato but increase the content of dietary fiber”(Ghidurus et al 2010).

Fast Food Similarities

Fast foods may differ in name but its nutritional quality is comparable. Many observational studies have concluded that “frequent fast food consumption leads to weight gain”. Stender et al (2007). He also made the association with “fast food consumption and the risk of insulin resistance”. It was also noted that “portion sizes of burgers, fried potatoes, pizzas and soft drinks at fast food outlets have all increased 2-5 fold over the last 50 years, the energy density of the entire menu at fast food outlets is 1100kj/100g.”(Stender et al 2007)The article concluded that “to select healthy choices at fast food restaurants meals should be labelled appropriately and correctly” (Stender et al 2007). Stender et al (2007) examined a study that “ had variations in results ofthe total fat content of the meals from McDonald with 41 to 65g and 42 to 74g from KFCf. This results was from 74 french fries and fried chicken samples bought from popular restaurants in 35 different countries during 2005-2006.” There were variations in The assumptions was made that “the variations were due to local taste preference. Results aslo showed that “the same product can vary in fat calorie content by 40% and more” Stender et al (2007). Therefore the same product can produce different variations in the amount of nutrient it provides.

Variations in Food Composition

Many factors can be attributed for the natural variations seen in food nutrient compositions. Some of these include “plant and animal husbandry, storage, production, transport and marketing” (Greenfield and Southgate 2003). In meat the “variations in lean-fat ratio affected the levels of most other nutrients”. Moisture of content of fruits and vegetables are also affected by storage, therefore causing a change in nutrient content. Greenfield and Southgate (2003) stated that “flours and grains have less variation because they hold less moisture, however the protein content can vary by 1 to 2 factors depending on what fertiliser was used and the type of variety.” Canadela et al (1997) stated that “the nutrient contents provided by foods cooked from a chef may differ from a traditional home meal due to different preparation methods, cooking methods, storage and choice of ingredients.” He also noted that carbohydrate content of legumes was significantly decreased with cooking. Insoluble fiber did not change significantly with cooking. However a significant increase of protein was noted in kidney beans and chickpeas in cooking, it was hypothesized that this happened due to the solubility of carbohydrate in soaking and cooking liquids. Process foods have many variations in ingredients, despite claims of strict adherence to quality control, they show comparable variations seen in natural foods. Human beings don't consume single nutrients, they consume composite dishes from home or restaurants and these dishes show the greatest variations. It is known that “recipe formulation and actual cooking methods are the major sources of variations” (Greenfield and Southgate 2003).

Eating a healthy balanced diet is important to one's health, rather than frequently consuming fast foods. Fast food has many health implications, as noted above and its effect can be detrimental to health. Analysing nutrient content of fast food is important because current trend shows that, that is the way people eat. It will also serve as a guide to meal planning, practicing portion control and overall healthy meal plans.

Chapter Three

Methodology:

3.1 Material

The study tested seven different on-campus meals samples typically purchased by students at the University of the West Indies St. Augustine campus

3.2 Sampling:

The sampling method used for this study was stratified random sampling. Random samples were taken from various food establishments on UWI campus where the student population patronise. The meals are all different in content and were identified as the most popular meals on campus.

3.3 Data Collection:

Questionnaires were distributed to seventy students on campus. The questionnaire was to determine the preferred food choices on campus. Students were briefed about the purpose of the questionnaire and a record of their response was taken. Food samples were collected on three different days at the different food establishments on campus around lunch time and taken to the Food Production Lab to be analyzed.

3.4 Description of samples:

- ✓ Marios mini meat (pepperoni) pizza: which consisted of four slices, condiment used was about 1 Tbsp ketchup and a cup of sprite soft drink.
- ✓ Marios mini vegetarian (garden) pizza: which consisted of four slices, topping: pineapple, corn, tomatoes and sweet pepper, condiments used was about 1 Tbsp ketchup and a cup of sprite soft drink.
- ✓ `Yvette's cheese pie: small, whole wheat baked sandwich filled with cheese in the center.

- ✓ Subway 6 inch teriyaki: which consisted of a 6 inch parmesan bread, with teriyaki chicken strips, sweet peppers, tomatoes, cucumbers and lettuce and dressed with garlic sauce and shadow beni sauce .
- ✓ KFC: spicy leg and thigh with a regular fries
- ✓ Asha's chicken roti: about a 9 inch split peas roti with potato and channa and curry chicken.
- ✓ Yvette's student lunch: brown rice, callaloo, 3 pieces of stewed chicken, fresh salad and a 330ml Trinidad Fresh orange juice

3.5 Sample Preparation:

Samples were collected from seven different food establishments on campus on Monday 25th February 2013 and from six different food establishments on Wednesday 27th February 2013 and Thursday 28th February 2013 respectively. Most of the foods provided on campus can be termed fast foods as it is similar in type but different in source and amounts. The seven popular foods, which are regularly consumed and bought, are:

1. Mario's pepperoni pizza
2. Mario's vegetarian pizza
3. Yvette's cheese pie
4. Subway chicken sandwich
5. KFC
6. Asha's roti
7. Yvette's student lunch (the only traditional meal)

The samples were purchased around lunch time and taken to the food production lab. Each sample was broken into small pieces by hand, all meat was deboned and sample was thoroughly mixed to give a homogenized mixture. It was then taken to the balance room where it was weighed using a tiered top balance scale, this type of scale was used because of the weight of sample and size of container. All prepared samples were rapidly transferred to dry clean containers with well fitting covers, properly labelled and stored in -20 degrees freezers overnight. Then it went in a freeze dryer two at a time for 24-48 hours. After freeze drying samples were then grounded into smaller pieces using a mortar and pistol, transferred into dried, clean bags, labelled properly and stored.

Chemical Analysis: (The method of analysis used was the AOAC method).

3.6Crude Fibre Analysis- Filter Bag Technique (A2000 and A20001) AOAC Approved Procedure. This method determines crude fiber which is the organic residue remaining after digesting with 0.255N H₂SO₄ and 0.313N NaOH. The compounds removed are predominantly protein, sugar, starch, fats and portions of structural carbohydrates.

a) Equipment:

1. Analytical balance
2. Oven with a temperature of $102 \pm 2^{\circ}\text{C}$
3. Electric muffle furnace with rheostat control and pyrometer that will maintain a temperature of $600 \pm 15^{\circ}\text{C}$
4. Digestion instrument capable of performing the digestion at $100 \pm 0.5^{\circ}\text{C}$ and maintaining a pressure of 10-25psi. The instrument must be capable of creating a similar flow around each sample to ensure uniformity of extraction.

5. Filter bags constructed from chemically inert and heat resistant filter media, capable of being heat sealed closed and able to retain 25 micron particles while permitting solution penetration. (F57 or F58 ANKOM Technology).
6. Heat sealer sufficient for sealing the filter bags closed to ensure complete closure.
7. Desiccant pouch that enables the removal of air from around the filter bags.
8. Marking pen solvent that is acid resistant.

b) Reagents

1. Sulphuric acid solution- $0.255 \pm 0.005N$. 1.25g H₂SO₄/100ml.
2. Sodium hydroxide solution- $0.3130 \pm 0.005N$. 125g NaOH/100ml. Concentration must be checked by titration.

c) Crude Fiber Procedure

1. A solvent resistant marker was used to label the filter bags to be used in the analysis.
2. The analytical balance was tiered, the weight and record of each empty filter bag was taken and the balance was tiered again. 0.45-.55g of prepared samples was added to the bags, and then it was sealed using a heat sealer.
3. Fat was extracted from all the samples by placing the bags into a container, covering them with petroleum ether and left to soak for about 10 minutes. After 10 minutes the solvent was poured off and the bags were allowed to air dry on a metal rack. The vessel was filled with cold water and when the temperature controller read 20°C the flush procedure was run to drain the water.
4. Next the bags were placed on suspender trays and stacked in the machine. The bag suspender weight was placed on the bag suspender to keep the bag suspender submerged. The cubetainer hose was attached to each cubetainer. Port A is used for crude fiber acid solution and port B is used for crude fiber base solution. Fiber was selected and the procedure was allowed to run, the machine heats up to digest samples, the procedure takes about 2 hours.

5. When the crude fiber extraction and rinsing processes were completed the samples were removed and placed in a beaker with enough acetone to cover the bags and left to soak for 3-5 minutes. The bags were then removed from the acetone and placed on a wire rack and left to air dry. Next it went to the oven for about 2-4 hours, when finished it was removed from oven and placed in a dessiccator container to cool.
6. The weight was then taken and it was placed into pre-weighed crucible beakers, taken to ash for about 2 hours at $600 \pm 15^\circ\text{C}$. It was then removed and left in a dessiccator container to cool and weigh. This weight was used to calculate the loss of organic matter. The crude fiber value was obtained using the standard calculations.

3.7 **Determination of oil/fat utilizing high temperature solvent extraction**

This method determines crude fat by extracting with petroleum ether. The compounds extracted are predominantly triacylglycerides. Small amounts of other lipids along with minor components having some solubility in petroleum ether are also extracted.

a) Equipments

1. Analytical balance
2. Oven capable of maintaining a temperature of $102 \pm 2^\circ\text{C}$
3. Extraction instrument capable of extracting at $90 \pm 2.0^\circ\text{C}$ (XT10, XT15, XT20, ANKOM Technology).
4. Filter bags constructed from chemically inert and heat resistant filter media, capable of being heat sealed closed and able to retain 1 micron particles while permitting solution penetration (XT4, ANKOM Technology).
5. Heat sealer sufficient for sealing the filter bags to ensure complete closure (1915 ANKOM Technology).

6. Dessicator container that enables the removal of air from around the filter bags
7. Marking pen- solvent resistant (FO8 ANKOM Technology).

b) Reagents

Petroleum ether (B.P 35-65°C)

c) Fat extraction procedure

1. Placed empty labelled filtered bag on balance and zero balance.
2. Weighed 1-2 g of sample into the bag and recorded the weight.
3. Heat sealed the filter bags to encapsulate the sample.
4. Placed samples in the drying oven for about 3 hours, when finished removed dried samples and placed in a dessicator container and left to cool.
5. Next placed samples into a bag holder and placed in the extractor. Select extraction time and preceded according to the extraction instrument instructions.
6. When the extraction process was completed the samples were placed in the oven for 15-30 minutes. Then it was placed in a dessicator container to cool and weigh, values were calculated using the standard formular.

3.8 **Determination of Nitrogen and Crude Protein**

The nitrogen compounds of the sample are converted to Ammonium Sulphate by acid digestion with concentrated boiling sulphuric Acid. The acid digest is cooled and diluted to a known volume. (250ml) 5ml aliquots of digest are made strongly alkaline with Sodium Hydroxide and the released Ammonia is

steam distilled in a Markham Still into Boric Acid. The Ammonia in the Boric Acid is titrated with standardized Hydrochloric Acid.

a) Equipment and apparatus

1. Kjeldahl digestion apparatus.
2. Kjeldahl flasks 300ml
3. Analytical balance
4. Volumetric flask 250ml
5. Markham steam distillation apparatus
6. Erlenmeyer flasks 100ml
7. Pipettes 5ml
8. Burettes

b) Reagents

1. Concentrated sulphuric acid, reagent grade
2. Concentrated Sodium Hydroxide,
3. Kjeldahl Catalyst tablets
4. Mixed indicator, 0.1% Bromocresol Green in ethanol and 0.1 Methyl red in ethanol mixed in the ratio 5 to 1
5. 0.01 HCL standardized
6. Boric Acid solution 1% with 5ml of mixed indicator

c) Nitrogen and crude protein Procedure

1. Between 1.99 to 2 grams of sample was weighed onto transparent paper, the paper and sample was folded and the sample was introduced into flask.

2. Catalyst tablets and about 25ml of concentrate H₂SO₄ was added to flask. The flask was then placed on a digestion rack, the heat turned on and temperature regulated to prevent frothing.
3. Once charred material dissolved and digest cleared it was allowed to boil for one hour, cooled and gently 100ml of distilled water was added.
4. Material was then carefully transferred to volumetric flask as to ensure no loss of material, and then distilled water was used to make up to 250ml.
5. Content was allowed to cool and make up back volume if necessary and then transferred to the Markham distillation apparatus.
6. 5ml of sample was pipette out and placed into Markham Still, approximately 5 ml of concentrate NaOH was put into funnel still and 25ml of Boric Acid solution was placed in a 100ml Erlenmeyer flask at the tip of the condenser, making sure that the tip of the condenser is just in contact with the acid.
7. Gradually the NaOH was introduced in the funnel to the distillation chamber, where steams distil aliquot until 25mls of distillate is collected in the Boric Acid at the tip of the condenser.
8. When the total contents reach 50ml the Erlenmeyer flask was removed from condenser and titrated with 0.01N HCL Acid (Vol. X). The protein content was calculated using the appropriate factors and standard calculations.

3.9 **Determination of Dry Matter (this is used in the calculation of soluble carbohydrates)**

The moisture in the sample is removed by heating the sample at 105 degree Celsius. The amount of material left after the removal of the moisture is the dry matter.

a) Equipments and apparatus

1. Porcelain crucibles or other suitable container
2. Analytical balance to 4 decimal places
3. Drying oven

4. Dessicators

b) Procedure:

1. Dry clean container (crucible) overnight at 105 degree celcius
2. Cool in dessicators
3. Weigh cooled container (crucible)
4. Weigh accurately between 1.5 to 2.0g of sample into container
5. Place container ad sample in oven at 105
6. Remove container and sample and cool in dessicators to room temperature
7. Weigh container and dried sample
8. Calculate Dry Matter content in g/kg using the calculation method.

3.10 Calculation of nitrogen free extractive (Soluble Carbohydrates)

Soluble carbohydrates is not directly determined, it is obtained by the difference between 100 and the sum of the ash, crude protein, and crude fat and crude fiber. Thus the figure for soluble carbohydrates will be affected by chemical errors in the analysis of all separate fractions. Furthermore the soluble carbohydrates do not constitute a particular substance or group of substances; it consists of all the starches and sugars, some of the hemicelluloses and a variable proportion of the lignin. It is for this reason that the term 'soluble carbohydrates' is misleading according to the AOAC International procedure.

Standard: A standard of the sample was done to determine the recovery percent

Replicate determinations: The sample was done in duplicates; this is to evaluate sample variance.

3.11 Statistical Analysis:

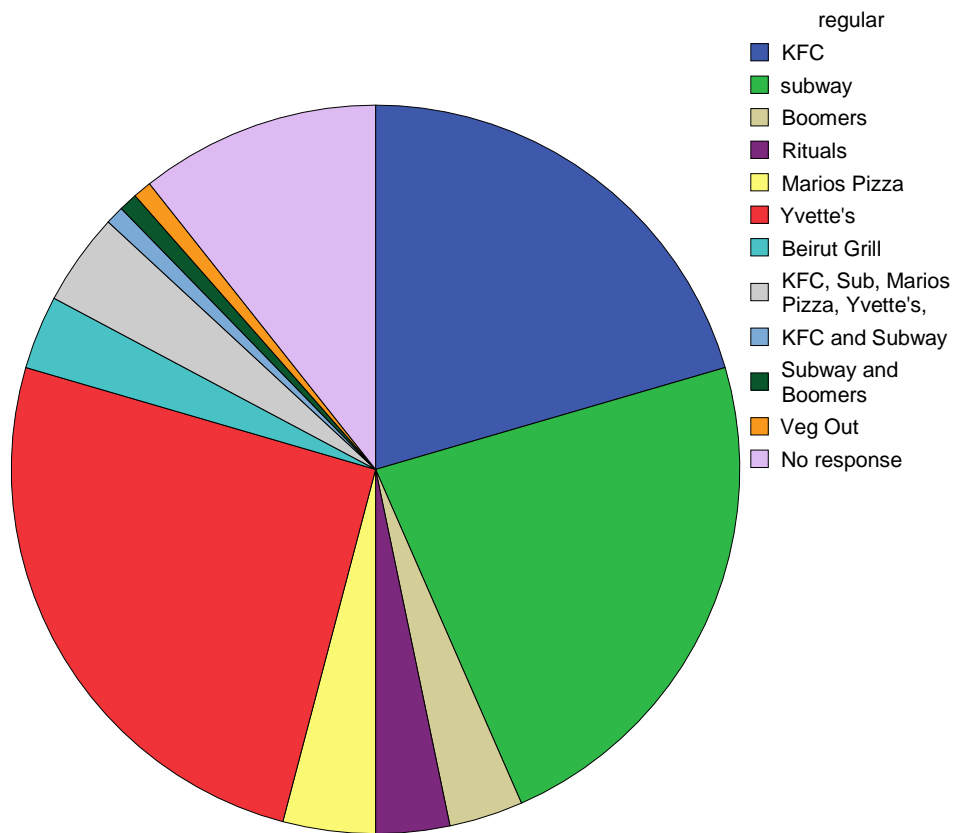
SPSS for Windows (version 12.0; SPSS Inc, Chicago, IL) software was used to analyse the collected data. A one way Anova test was done to determine whether there were any significant differences between the means of two or more independent groups. Also a Post hoc test was used to compare means of groups that have been determined to have significant differences, only significant values were recorded and the results presented in tables and in graphical forms.

Chapter Four

Results

4.1 fig 1 In terms of on-campus foods purchased by students on a regular basis, it was observed that meals from Yvette's and Subway were most popular.

Popular Food Choices



The table below shows the mean nutrient content g/100g for the three days. It takes into account the variation or standard variation in the meals. Meat pizza total fat for the three days was 18.25g/100 compared to chicken sub which was 16.29g/100g. Vegetarian pizza had a soluble carbohydrate mean nutrient content of 32.60g/100g compared to roti which had 12.32g/100g. Table 4.2 further explains the findings

4.2 consistencies of the mean nutrient content and the standard deviation for the three days

Food Type	Total Fat g/100g	Total Protein g/100g	Total Fiber g/100g	Soluble Carbohydrate g/100g
Meat Pizza	18.25	13.55	1.48	23.78.
Standard Deviation	3.55	1.40	0.25	8.02
Vegetarian Pizza	15.38	9.45	1.93	32.60
Standard Deviation	3.12	1.10	0.22	3.73
Cheese Pie	28.77	11.81	1.65	31.90
Standard Deviation	2.41	0.67	0.41	3.99
Chicken Sub	16.29	9.34	1.70	14.78
Standard Deviation	2.57	0.49	0.31	2.26
Fried Chicken	33.33	13.84	1.75	10.93
Standard Deviation	9.62	1.16	0.46	2.35
Roti	13.90	12.69	2.25	12.32
Standard Deviation	2.19	2.41	0.67	5.23
Student Lunch	13.65	11.95	2.02	18.36
Standard Deviation	0.14	0.49	0.78	2.67

The table below shows the food consistency within the meals over the three days. Meat pizza total fat content showed better consistency than the total protein content for vegetarian pizza. Vegetarian pizza showed better consistency in total fiber than student lunch. Table 4.3 further explains the finding.

4.3 food consistency throughout the three days

Day	Food Type		Total Fat g/100g	Total Protein g/100g	Total Fiber g/100g	Soluble Carbohydrate g/100g
1	Meat Pizza	1	19.63	13.43	1.50	19.35
		2	19.56	14.06	1.72	17.84
	Vegetarian Pizza	1	18.92	11.60	2.16	26.70
		2	18.13	9.20	2.19	31.58
	Cheese Pie	1	28.94	12.00	2.43	29.33
		2	28.33	11.40	1.37	32.89
	Chicken Sub	1	13.98	9.01	1.68	13.34
		2	12.57	10.29	1.95	16.19
	Fried Chicken	1	35.73	14.20	1.40	12.87
		2	34.87	13.40	1.29	14.01
	Roti	1	12.33	9.60	2.17	15.85
		2	11.78	11.70	2.08	15.44
	Student Lunch	1	13.76	12.30	1.47	16.47
		2	13.55	11.60	2.58	20.26
2	Meat Pizza	1	19.71	14.90	1.70	17.69
		2	19.99	15.00	1.01	19.67
	Vegetarian Pizza	1	11.60	9.20	1.75	37.45
		2	11.68	9.50	1.87	35.61
	Cheese Pie	1	26.79	12.00	1.47	35.73

		2	26.89	13.00	1.85	37.26
	Chicken Sub	1	16.90	8.90	1.90	18.18
		2	16.92	9.30	1.99	14.80
	Fried Chicken	1	39.44	15.00	2.09	7.75
		2	39.28	14.00	2.52	8.85
	Roti	1	13.38	14.78	2.40	6.43
Day	Food Type		Total Fat g/100g	Total Protein g/100g	Total Fiber g/100g	Soluble Carbohydrate g/100g
2			12.61	16.30	3.26	4.83
3	Meat Pizza	1	10.99	12.55	1.49	33.41
		2	11.39	11.40	1.47	34.74
	Vegetarian Pizza	1	16.15	8.55	1.62	32.83
		2	15.83	8.70	2.00	31.47
	Cheese Pie	1	33.39	11.30	1.36	27.85
		2	28.33	11.20	1.47	28.35
	Chicken Sub	1	17.77	9.35	1.17	14.57
		2	19.62	9.21	1.55	11.62
	Fried Chicken	1	37.44	12.76	1.70	11.16
		2	38.71	12.82	1.52	10.97
	Roti	1	16.63	11.83	1.16	16.51
		2	16.69	11.97	2.43	14.91

4.4 Anova one-way analysis. This table shows the significant relationship between both dependable and independent variable groups the significant p value is (<0.05). The table below will further explain the findings

Significance of the P value $<.05$

Dependent Variable	Independent Variable	Significant P value <0.05
TOTAL FAT	Between Groups, Within Groups Total	.000
TOTAL PROTEIN	Between Groups, Within Groups Total	.000
SOLUBLE CARBOHYDRATE	Between Groups, Within Groups, Total	.000

4.5 Post Hoc

This table shows the significance of P value < 0.05 between the dependent variable (nutrients) and the independent variables (food type). The negative number in the mean difference column indicates that the food type on the right side of the column has more of the nutrient than the food type on the left of the column. If there is no number in the mean difference column it means the food type on the left side of the independent column has more nutrient than the food type on the right side of the column.

Dependent variables	Independent Variables (Food Types)	Mean Difference	Significant Value or P value < 0.05
Total Fat	Meat Pizza, cheese pie	-10.52833	0.007
	Meat Pizza, Fried Chicken	-15.08833	0.000
	Vegetarian Pizza, Cheese Pie	-13.39333	0.000
	Vegetarian Pizza, Fried Chicken	-17.95333	0.000
	Cheese Pie, Meat Pizza	10.52833	0.007
	Cheese Pie, Vegetarian Pizza	13.39333	0.000
	Cheese Pie, Chicken Sub	12.48500	0.001
	Cheese Pie, Roti	14.87500	0.000
	Cheese Pie, Student Lunch	15.12333	0.006
	Chicken Sub, Cheese Pie	-12.48500	0.001
	Chicken Sub, Fried Chicken	-17.04500	0.001
	Fried Chicken, Meat Pizza	15.08833	0.000
	Fried Chicken, Vegetarian Pizza	17.95333	0.000
	Fried Chicken, Chicken Sub	17.04500	0.000
	Fried Chicken, Roti	19.43500	0.000
	Fried Chicken, Student Lunch	19.68333	0.000
	Roti, Cheese Pie	-14.87500	0.000
	Roti, Fried Chicken	-19.43500	0.000
	Student Lunch, Cheese Pie	-15.12333	0.006
	Student Lunch, Fried Chicken	-19.68333	0.000
Total Protein	Meat Pizza, Vegetarian Pizza	4.09833	0.000
	Meat Pizza, Chicken Sub	4.21333	0.000
	Vegetarian Pizza, Meat Pizza	-4.09833	0.000
	Vegetarian Pizza, Roti	-3.23833	0.004
	Cheese Pie, Chicken Sub	2.47333	0.045
	Chicken Sub, Meat Pizza	-4.21333	0.000
	Chicken Sub, Cheese Pie	-2.47333	0.045
	Chicken Sub, Fried Chicken	-4.50333	0.000
	Chicken Sub, Roti	-3.35333	0.002
Fried Chicken, Vegetarian Pizza	4.38833	0.000	

	Fried Chicken, Chicken Sub	4.50333	0.000
	Roti, Vegetarian Pizza	3.23833	0.004
	Roti, Chicken Sub	3.35333	0.002
Total Fiber			
Soluble Carbohydrate	Meat Pizza, Vegetarian Pizza	-8.82333	0.036
	Meat Pizza, Chicken Sub	9.00000	0.031
	Meat Pizza, Fried Chicken	12.84833	0.001
	Meat Pizza, Roti	11.45500	0.003
	Vegetarian Pizza, Meat Pizza	8.82333	0.036
	Vegetarian Pizza, Chicken Sub	17.82333	0.000
	Vegetarian Pizza, Fried Chicken	21.67167	0.000
	Vegetarian Pizza, Roti	20.27833	0.000
	Vegetarian Pizza, Student Lunch	14.24167	0.011
	Cheese Pie, Chicken Sub	17.11833	0.000
	Cheese Pie, Fried Chicken	20.96667	0.000
	Cheese Pie, Roti	19.57333	0.000
	Cheese Pie, Student Lunch	13.53667	0.018
	Chicken Sub, Meat Pizza	-9.00000	0.031
	Chicken Sub, Vegetarian Pizza	-17.82333	0.000
	Chicken Sub, Cheese Pie	-17.11833	0.000
	Fried Chicken, Meat Pizza	-12.84833	0.001
	Fried Chicken, Vegetarian Pizza	-21.67167	0.000
	Fried Chicken, Cheese Pie	-20.96667	0.000
	Fried Chicken, Student Lunch	-7.43000	0.460
	Roti, Meat Pizza	-11.45500	0.003
	Roti, Vegetarian Pizza	-20.27833	0.000
	Roti, Cheese Pie	-19.57333	0.000
	Student Lunch, Vegetarian Pizza	-14.24167	0.011
	Student Lunch, Cheese Pie	-13.53667	0.018
	Student Lunch, Fried Chicken		0.460

The table below shows the days and the different amounts of nutrients contained in the food samples. On day two roti contained 5.63g/100g of soluble carbohydrate compared to 15.64g/100g of soluble carbohydrate it contained on day one. Cheese pie contained 28.63g/100g of total fat on day one compared to 33.18g/100g of total fat on day three. The table below further explains the findings

4.6The table below shows the days and the different amount of nutrients contained in each samples

Day	Sample Type	Total Fat g/100g	Total Protein g/100g	Crude Fiber g/100g	Soluble Carbohydrates g/100g
1 (a)	Meat Pizza	19.59	13.4	1.49	18.59
	Vegetarian Pizza	18.52	9.1	2.17	29.14
	Cheese Pie	28.63	11.7	1.90	31.11
	Chicken Sub	13.27	9.65	1.81	21.43
	Fried Chicken	35.3	13.8	1.56	13.44
	Roti	12.05	10.65	2.12	15.64
	Student Lunch	13.65	11.65	2.02	18.36
2 (b)	Meat Pizza	19.85	14.95	1.52	18.68
	Vegetarian Pizza	11.64	8.55	1.98	36.53
	Cheese Pie	26.84	12.5	1.65	36.49
	Chicken Sub	16.46	9.1	1.94	16.49
	Fried Chicken	39.36	14.95	1.89	8.3
	Roti	12.99	15.54	2.83	5.63
3 (c)	Meat Pizza	11.9	12.25	1.47	34.06
	Vegetarian Pizza	15.99	9.35	1.81	32.15
	Cheese Pie	33.18	11.3	1.42	28.1
	Chicken Sub	18.69	9.35	1.36	13.09
	Fried Chicken	38.07	12.76	1.61	11.06
	Roti	16.66	11.83	1.79	15.71

The table below shows the various food types and its calorie content. The largest calorie content was observed in roti in day one, two and three, compared to cheese pie which had the lowest calorie content in the three days. Table 4.7 further explains the findings.

4.7 food types and their calorie content g/100g

Food Type	Calorie Content g/100g	Calorie Content of Original Sample
1A-Meat Pizza	307.26	789.04
2A-Vegetarian Pizza	323.992	965.49
3A-Cheese Pie	432.714	566.85
4A-Chicken Sub	247.374	621.40
5A-Fried Chicken	429.78	1078.74
6A-Roti	217.86	1089.08
7A-Student Lunch	246.93	1030.19
1B- Meat Pizza	316.21	868.31
2B -Vegetarian Pizza	289.04	1177.25
3B -Cheese Pie	440.836	614.07
4B -Chicken Sub	254.384	680.98
5B- Fried Chicken	447.22	1278.15
6B-Roti	207.252	11094.41
1C- Meat Pizza	288.89	662.97
2C -Vegetarian Pizza	313.53	1160.68
3C -Cheese Pie	459.06	710.16
4C -Chicken Sub	260.69	711.42
5C -Fried Chicken	459.73	1238.05
6C-Roti	263.68	1273.57

Chapter 5

Discussion

Meal Popularity

5.1 One goal of this study was to determine popular foods on the campus of the University of the West Indies and quantify the results. To determine this questionnaire was redistributed at a central location to cover all faculties of the university. Yvette's (student lunch and cheese pie), KFC and Subway were the largest groups represented in the pie chart. This indicates that these food establishments are patronised frequently by students and these foods may contribute substantially to their daily diets especially if lunch is their main meal of the day. Johnson et al (2012) in his study stated that "junk foods are well advertised and easily accessible and very popular with children." His observation was also shared by Nago et al (2009) who stated that "more people eat fast food regardless of age or socioeconomic background"

Fat Content

The highest mean value of fat was noted in fried chicken, it also had the highest standard deviation. Usually breaded fried foods absorb more oil when frying compared to foods fried without coating or batter. Also the size of the food example; a large piece of chicken or thigh would indicate the amount of oil that is absorbed, as a larger surface area tends to absorb more oil. The standard deviation was the highest because of the varying size of the meal cooked each day. Greenfield and Southgate (2003) stated that "in meat the variations in lean-fat ratio affected the levels of most other nutrients." The cheese pie had the second highest fat value of 28.7783 and the meat pizza had the third highest fat value. This was probably due to the amount and type of fat used in cooking preparation that day.

Protein Content

The student lunch had the lowest fat value because it had missing values. The highest protein value was from KFC with a value of 13.8467, it consisted of two pieces of meat a drumstick and a thigh. Meat pizza had the second highest as it contained pepperoni sausage. Cheese pie contained more protein than the

chicken sub, this may be a result of the amount of cheese used in the pie. The chicken sub was also the lowest mean protein content. The highest standard deviation in the protein nutrient was the roti. The highest mean crude fiber content was also found in the roti, this may be due to the split peas content in the flour. Split peas belong to the legumes food group and this group provides the body with a good source of dietary fiber, crude fiber is $\frac{1}{2}$ the value of dietary fiber. Canadela et al (1997) stated that insoluble fiber did not change significantly with cooking. Greenfield and Southgate (2003) stated that “flours and grains have less variation because they hold less moisture; however the lowest crude fiber value was found in chicken sub.

Table 4.3 observed the food type and its duplicate, this was done to test precision of the analysis to determine the amount of variation, and usually a small amount of variation means the test had good precision. However this is not always the case with composite meals, due to their varying nutrient contents and textures. Stender et al (2007) examined the results from a study that looked at total fat and transfat in 74 french fries and fried chicken samples bought from popular restaurants McDonalds and KFC in 35 different countries during 2005-2006. There were variations in the total fat content of the meals from McDonald was 41 to 65g and 42 to 74g from KFC. He made the assumptions that “the variations were due to local taste preference. Results also showed that “the same product can vary in fat calorie content by 40% and more” Stender et al (2007). Therefore the same product can produce different variations in the amount of nutrient it provides. Greenfield and Southgate (2003) stated that “recipe formulation and actual cooking methods are the major sources of variations.”

The multiple comparisons in table 4.4 looked at the different dependent variable (nutrient) and the independent variable (food type), the mean difference and the significant value. Total fat had a significant value with both cheese pie and fried chicken; however cheese pie and fried chicken had more total fat than meat pizza. These results may be attributed to the amounts and types of fat used in cooking. Cheese

pie had a significant relationship with all food types except fried chicken, which also had a higher total fat than the rest. Ghidurus et al(2010) stated that “frying produces many changes to foods and this may be due to factors, such as the composition of frying fat and of the food, the texture, size and shape of the food and the frying conditions such as temperature and duration.” Fried chicken had a significant value to all other food type except cheese pie they are close in total fat amount. Similar amounts of fats were probably used in their cooking method to produce this result. Overweight and obesity is becoming a worldwide problem due to the frequent consumption of high fat foods. Data taken from the 1999-2002 National Health and Nutrition Survey estimated that 65% of U.S adults are either overweight or obese, thus monitoring one’s health and eating pattern will be beneficial for the future. Roti had lower total fat content than all other food type student lunch. It had significant p value with the cheese pie (p value.000) and fried chicken (p value.000). The chicken sub showed more fat content than the student lunch, although it was topped with calorie free raw vegetables, it was dressed in garlic sauce and the subway nutrition fact file listed the garlic sauce as having 50 calories. Student lunch had a significant p value with cheese pie (.006) and fried chicken (.000). These two meals are greater in fat content compared to student lunch and this may be due to the fact that the student lunch was prepared using different cooking methods example boiling of the rice and the ingredients used, most likely had less fat content than those used to prepare the cheese pie and fried chicken.

Meat pizza had a significant value with total protein content compared to vegetarian pizza (.000) and chicken sub (.000). The meat pizza most likely had a larger protein content because it contained pieces of meat in the mixture. Fried chicken showed a greater total protein value than meat pizza since a drumstick is 11g and a thigh is 15g respectively as noted on the KFC fact file. Cheese pie had a significant relationship (.045) with chicken sub; the protein in cheese pie is more than the protein in chicken sub this may be due to the fact that the cheese pie may have had a greater amount of cheese. The results also showed that fried chicken, meat pizza, roti and student lunch contained more protein than cheese pie. Although all these meals contained food from animal sources, which makes them high biological value protein, the

cheese pie may have had less animal protein when compared to the other meals. This may also be due to the size and weight of the meals. Chicken sub showed the least amount of protein, this may be due to the types and amounts of ingredients used during preparation. Greenfield and Southgate (2003) stated that “many factors can be attributed for the natural variations seen in food nutrient compositions examples include plant and animal husbandry, storage, production, transport and marketing.” Chicken sub also had a significant p value with meat pizza, cheese pie, fried chicken and roti. Meat pizza and fried chicken had higher protein content than roti, this can be the result of the size and amounts of meat used during cooking, however it had a significant value in vegetarian pizza (.004) and chicken sub (.002) as it contained higher biological value protein compared to the protein content in vegetarian pizza and chicken sub.

Fiber content

There were no significant values for crude fiber between cheese pie and the other food types. Vegetarian pizza, chicken sub, fried chicken, roti and student lunch all had a minus number in the mean difference column, which means that those crude fiber values are all higher than cheese pie crude fiber value. Crude fiber value is 1/7 to 1/2 the amount of dietary fiber but it still has many benefits for health. “Fiber has been proven to help regulate blood sugar levels in diabetic patients; help with constipation and lower cholesterol levels” Groff et al (2005). Crude fiber have been reported to “recover 20% of the hemicelluloses, 10 to 15% of the lignin and 50 to 80% of the cellulose” Heller and Hackler(1978).

Vegetarian pizza, fried chicken, roti and student lunch had more crude fiber content than chicken sub, although chicken sub had toppings of cucumber, tomatoes, lettuce and sweet pepper. This may be due the amounts of vegetables in each food type, or preparation methods or storage. Greenfield and Southgate (2003) stated that “moisture of content of fruits and vegetables are also affected by storage, therefore causing a change in nutrient content.” Vegetarian pizza, roti and student lunch had more crude fiber

content than fried chicken; this may be a result of the type of grains used in the roti and rice was whole grain and contained more crude fiber compared to the fried chicken.

Soluble Carbohydrate

As stated in the methodology “soluble carbohydrates AOAC International procedure is obtained by the difference between 100 and the sum of the total ash, crude protein, crude fat and crude fiber. It consists of all the starches, sugars, some of the hemicelluloses and a variable proportion of the lignin.” (Crampton and Harris 1969)

Table 4.6 shows the average of the nutrients for the different days. In this table comparisons can also be made between the different days. For example on day and day two the total fat content of the meat pizzas are similar in amount compared to the meat pizza bought on day three. This variation can be due to the many factors involved in the storage, selection of ingredients, manufacturing stage and cooking stage. “Many factors can be attributed for the natural variations seen in food nutrient compositions” Greenfield and Southgate (2003). Variations can be commonly seen in analysis of composite meal rather than a single nutrient.

Table 4.7 shows the various food types and calorie content of sample. This is important information as it can serve as a guide for choosing healthier food options, especially for those who are overweight and obese. Being selective about calorie content and types and amounts of nutrients will also benefit mental health since the brain is a major organ of the body that requires glucose for energy. “Therefore deficiencies may alter its function, as it requires nutrients to build and maintain its structure and cognitive abilities” Bourne (2005).

Conclusion:

The data presented revealed that the composite meal samples vary in their macro nutrient content, even within similar meal samples. Furthermore many students on campus purchase KFC, Mario's pizza, Yvette's student lunch and cheese pie and chicken sub the latter two being the most popular. These food samples are easily accessible and KFC, Mario's pizza and the cheese pie are high in fat. The foods which had the least fat were the roti and the student lunch.

With frequent consumption of this nutrient, a person can become overweight or obese. This in turn can lead to other health related risk and chronic diseases. It can be concluded that some meals contain more nutrients and calories than others. For example KFC contained the most fat and protein, roti contained the most crude fiber content. Vegetarian pizza had the least amount of crude fiber and subway chicken had the least amount of protein. The student population can benefit from guidance in choosing their daily meals.

Recommendations:

- Analyse other popular meals on campus and quantify their results
- Provide media awareness (campus news, flyers, mini health lectures) that will educate the consumers on calorie content of food and the benefits of healthy eating for the body and mind
- Create awareness about the excess intakes of fat or protein and its implication to health
- Provide information to the student body about the meals that were analysed.

Limitations

- Missing samples (2 student lunch) due to a non selective option in service by food establishment
- Inadequate lab apparatus due to the amount of students (undergrad and post grad students) conducting analysis in the lab at the same time
- Inconsistent water flow which was needed to conduct protein distillation tests.
- Bomb calorimetry machine was out of order therefore, calories was calculated by means of a calculation formula
- Dietary fiber machine was out of order, therefore only crude fiber could be analysed.

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