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Review Article

Review of the Energy and Proximate Content of Selected Staple Foods Consumed by Diabetic Patients in Enugu State, Nigeria

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Abstract

The knowledge of the energy and proximate composition (carbohydrate, fats, protein, ash, moisture and fibre) of foods, is vital for every nutrition professional. This knowledge enables the professional, to provide evidence-based nutrition intervention to hospitalized patients and the community. The nutrient content of mixed dishes consumed in Enugu State have been of concern to nutritionists and dietitians due to the variations in the recipes used by different households. This study, reviewed the available food composition tables for use in Nigeria and West Africa. A systematic review of studies conducted in Enugu State and Nigeria as well as other related literature, were carried out to document the energy and proximate composition of selected foods consumed in Enugu State. The respective foods reviewed included: *Igbangwu-oka*, *achicha* (cocoyam and pigeon pea-based meal), *ayaraya-oka* (maize and pigeon pea-based meal), *ayaraya-ji*, *okpa*, jollof rice, boiled white rice and *abacha*. The energy and proximate composition of the following fruits were also reviewed: apple, pineapple, watermelon pawpaw and banana. The findings showed variations in the energy and proximate composition of these foods in the various study reports including the food composition tables. The range for energy and proximate composition of each food component reviewed have been reported in this study. The results of this review, will serve as a handy reference tool for nutrition professionals, researchers and the general public.

Key words: Energy contents, staple foods, fruits, mixed dishes, blood glucose

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INTRODUCTION

Staple foods are consumed in most households in Eastern Nigeria, for a minimum of three times in a week¹. In Enugu State, many of the staple foods are mixed dishes. The respective dishes are combination of two or more food groups which are cooked together and given a name which in most cases, are a local name. The quantity of ingredients used in the preparation of staple foods differ from one community to another. Some studies have tried to conduct focused group discussions to standardize the recipes used in the preparation of staple foods in Enugu State^{1,2}. However, due to the complexity of the society, it will be difficult for every household to adopt the standardized recipes. Also, these studies are not available to all especially many persons who do not have interest in reading articles. The publicity of a research article requires reviewing the content and where researchers do not have access to the original article, they may have access to the reviews that cited the original article. Although, food composition tables are available now for use in Nigeria but it does not capture the different recipes as well as all foods consumed by Nigerians or diabetic patients in Enugu State^{3,4}.

Staple diets in Enugu consist of a wide variety of foods such as cassava-based foods (such as fufu, cassava-based salad (*abacha*) and garri). Yam is consumed in different forms, such as yam pepper soup, yam pottage, yam with beans, ground yam with pigeon pea (*ayaraya-ji*), roasted yam with sauce/palm oil and fried yam. Potatoes, especially sweet potatoes is also a common staple food which could be eaten in different forms as a single dish or with other foods as a mixed dish. Maize is also consumed in different forms including cornmeal eaten with different types of soups, maize could be roasted and eaten with coconut/local Igbo pear (*ube*), it could also be eaten with pigeon pea (*ayaraya-oka*) or in combination with other legumes. Plantain, cocoyam, some underutilized legumes and grains, are basic staple food consumed in Enugu State. These staple foods could be prepared with different/similar recipes in different households. Leafy vegetables, fruits, meat and fish are eaten with soup or sauce or stew as the case may be. Most foods are consumed as a composite dish and not as a single food⁵. The food composition tables mostly captures single foods instead of composite foods^{3,4} and this hampers on the comprehension of the nutrient content of composite/mixed dishes.

Diabetes is on the increase in Enugu State and in Nigeria in general^{6,7}. When individuals become sick and are diagnosed with ailments such as diabetes mellitus, hypertension, renal diseases, liver disease and others, they are restricted from eating some types of common foods either by themselves,

relatives, friends and even a healthcare provider. Some of the restrictions or dietary modifications will have to be evidenced based especially when they were counselled by nutrition professionals⁸. Unfortunately, many of these restrictions within most communities in Enugu State and other parts of Nigeria are not evidence-based. This has been a problem for professional clinical dietitians/nutritionists in Enugu State because, individuals who are not nutrition professionals but perform as nutrition professionals with limited knowledge disseminate nutrition fads and fallacies within community settings. It has been observed, that many diabetic clients before their first consult with a dietitian, had received dietary advice from several persons including non-nutrition health professionals. Most of the times, they would have been misguided and lived with the fallacy for a long time with consequent health implications. Such non-evidence based practice include, drinking herbs, leaf extracts and "alcoholic stout beer" believing erroneously, that the bitter taste of these drinks will dilute the "sweetness" in their blood glucose.

Skipping meals and avoidance of rich sources of carbohydrates is a common practice among diabetics. Studies have shown that breakfast is the most frequently skipped meal by both healthy and unhealthy persons⁹⁻¹³. Patients with diabetes often skip their breakfast on the days of their clinic appointment when their fasting blood glucose will be checked, they tend to eat foods sold by food vendors within the hospital environment or on their way after the health check-up. The working class also eat outside their homes to ensure they arrive early to work in the morning. The meal they eat mostly outside their homes, is lunch while some, insist on eating meals prepared at home. One of the challenges of eating outside the home is that it could be addictive and habitual. Where an individual feels like eating once he/she is within the environment where he/she usually eats. However, the food consumption pattern of individuals differ from one person to the other. Some individuals are highly disciplined and insist on eating particular types of food or eat only meals prepared at their homes. Such a regimented eating pattern, could affect the blood glucose control of diabetic patients especially when they are outside their homes with resultant hypoglycaemia⁸. Some other factors that could equally affect their food consumption pattern are, the availability of food, resources to buy food, food preferences, cultural belief, food taboos, traditional foods and eating pattern, family influence and religion^{14,15}.

Few studies, have determined the proximate and energy content of staple foods consumed in Enugu State^{1,2,16}. Reporting the different values by different authors in one article provides a holistic view on the nutrient values of these

foods. Most food composition tables for use in Nigeria focus on single foods including the fruits reviewed in this study. This review was on both single end mixed staple foods consumed in Enugu State. The foods reviewed included: *Igbangwu-oka* (Maize meal added fermented African oil bean), *achicha* (cocoyam and pigeon pea-based meal), *ayaraya-oka* (maize and pigeon pea based-meal), *ayaraya-ji* (Yam and pigeon pea based-meal), *okpa* (steamed bambara groundnut paste pudding) jollof rice, boiled white rice and *abacha* (cassava-based salad). The energy and proximate content of the following fruits were also reviewed: apple, pineapple, watermelon, pawpaw and banana.

Proximate content of selected staple foods in Enugu State:

The proximate composition of food which is made up of moisture, fat, carbohydrate, fibre, crude protein and ash is an important aspect determined in food analysis¹⁷. Fat, protein and carbohydrates are used to determine the energy content of the food. The Atwater factor for carbohydrates is 4 kcal in one gram, protein is 4 kcal in one gram and fat is 9 kcal in one gram. The summation of the energy in carbohydrates, fats and protein is the total energy (calories) in the food analysed^{3,14,17}. Fat, carbohydrates and protein are categorized as the energy giving food nutrients¹⁴. They are also categorized as the macronutrients including water¹⁴. Macronutrients are those nutrients need in the body in large quantity¹⁵. Another proximate component of importance is the ash composition which represents the total minerals present in foods¹⁷. However, these minerals are not differentiated but the ash content provides the clue to the mineral content of the food being analysed¹⁷. Moisture is of importance in the proximate content of foods¹⁷. The moisture content of foods determines to a large extent the shelf life of that food¹⁷⁻¹⁹. Foods with lower moisture have lower water activity and longer storage capacity but the higher the moisture in foods, the higher the risk of spoilage through microbial activities due to higher water activity¹⁷⁻¹⁹. In addition, when the moisture content of food is high, the concentration of other nutrients in the food are lower but there is higher concentration of other nutrients when the moisture content is low^{17,18}.

Staples are foods that are consumed routinely in a household or by individuals. Research report in Enugu State defined staples as foods that are consumed in the household for at least 3 times in a week¹. In every locality, there are foods that constitute the staple for that locality. In Enugu State, rice dishes, foods prepared with legumes such as beans constitute the staple. Many households combine legumes with tuber or cereal or plantain. Examples of identified common foods consumed in Enugu State include: *Igbangwu-oka* (Maize meal

added fermented African oil bean), (local name in igbo is "ugba" or "ukpaka"), *achicha* (cocoyam and pigeon pea based meal), *ayaraya-oka* (maize and pigeon pea based meal), *ayaraya-ji* (Yam and pigeon pea based meal), *okpa* (steamed bambara groundnut paste pudding), jollof rice and beans, jollof rice, white rice with tomato stew, cassava based fufu or gari eaten with different types of soups (bitter leaf soup, ora soup, vegetable soup), yam cooked in different methods and many others¹. There are many other foods consumed in Enugu State which are single foods but many of the single foods are fruits and vegetables. Common fruits available in Enugu State include pawpaw, oranges, mango, cashew fruits, apple, watermelon, banana, amongst others. Many persons consume vegetables with soups and high carbohydrate vegetables available include cucumber, carrot, eggplant/garden egg, beetroot and others. In other parts of Nigeria, many other foods are consumed^{1,20}.

Moisture content of selected staple foods consumed in Enugu State:

Moisture content of staple foods consumed in Enugu State tend to be high because these foods are not usually consumed as dry foods. However, some foods like confectioneries could have low moisture but other foods which were considered in this study had high moisture content. The fruits analyzed included three species of banana, two species of apple, pineapple, watermelon and papaw. The common foods were three species of rice prepared as jollof rice, boiled white rice with tomato stew and fried rice respectively. *Igbangwu-oka* (Maize meal added fermented African oil bean), (local name in igbo is "ugba" or "ukpaka"), *achicha* (cocoyam and pigeon pea based meal), *ayaraya-oka* (maize and pigeon pea based meal), *ayaraya-ji* (Yam and pigeon pea based meal), *okpa* (steamed bambara groundnut paste pudding) and *abacha* (local cassava salad) were also studied. The moisture content reported for the *achicha*, *ayaraya-ji*, *ayaraya-oka*, *Igbangwu-oka*, jollof rice, white rice without stew and *okpa* in rural communities in Enugu State were 62.7, 63.1, 70.4, 73.1, 70.2, 66.2 and 57.0% respectively¹. The moisture content reported for *abacha* varied because the recipe was varied especially, the vegetable and protein sources ranged from 53.8-65.6%².

The variability in the nutrient content of foods especially in mixed dishes is mainly attributed to the recipes of the meal^{1,2}. All these foods reported, have moisture content exceeding 50% which indicates that they will be highly perishable due to the activities of microorganisms if they are not stored properly¹⁷⁻¹⁹. However, these foods are usually eaten as soon as they are cooked in most homes except for some households that cook food in bulk and store in their

freezer. Water added to food during preparation determines the higher moisture content seen in foods as eaten. The reports have shown that foods as eaten by individuals have higher moisture content unlike the dried forms used for analysis. Unfortunately, foods are not dried before consumption^{1,2}.

Another category of food considered in this study was fruits. Results showed that red (red delicious) and green (golden delicious) apples contained 82.68 and 83.72% moisture respectively²¹. Another study reported that the apple with and without skin contained 83.9 and 84.5% moisture content respectively²². Pineapple is known to be high in moisture, 86.3% moisture was reported in a study on the nutrient content of edible fruits in oil producing communities of River State, Nigeria²³. Another study reported 87.3% moisture in pineapple pulp (edible portion)²⁴. Watermelon is one of the fruits that is widely consumed in Nigeria and it is generally known to contain high moisture. Moisture content ranged from 93.4-94.6% for different species of watermelon^{25,26}. Pawpaw is another fruit that is rich in moisture. According to a previous study pawpaw contained 88.75%²⁷ of moisture. The moisture content in different banana species ranged from 60.06-75.25%^{28,29}. The moisture content of fruits could vary depending on the season, variety and level of exposure of the fruits before the moisture determination. The region where the fruit is harvested or sold, the freshness of the fruit as well as the degree of ripeness of the fruit could affect the moisture content significantly^{1,18,21-23,25,27-30}.

Protein content of selected staple foods consumed in Enugu State:

Protein in food is an important nutrient needed by the body to repair worn-out tissues, make hormones, enzymes and synthesize the cells of the immune system. Protein is utilized by the body as a source of energy. One gram of protein supplies 4 kilocalories¹⁷. Protein in foods is one of the basic components determined during food analysis. The protein content of staple foods could be sourced from plant or animal products including fish and meat used in preparing the meals. The protein content of *achicha*, *ayaraya-ji*, *ayaraya-oka*, *lgbangwu-oka*, jollof rice, white rice without stew and *okpa* in rural communities of Enugu State as reported in literature are 7.9, 3.1, 3.6, 4.5, 2.0, 2.6 and 15.1% respectively¹. The protein content reported for *abacha* when the recipe was varied especially the vegetables content and protein sources ranged from 2.21-10.45%².

Fruits are not known to be rich sources of protein, however, there are few reports on the protein content of various fruits used in this study. The protein content of ripened

banana of different varieties ranged from 1.1-3.75%^{28,29}. Protein content of ripe pawpaw pulp of different species ranged from 0.47-1.17%^{27,30-32}. The protein in apple varieties ranged from 0.19-0.44%^{21,22}. Protein content of pineapple pulp ranged from 0.35-3.7%^{3,4,16,23,24,33,34}. Although most of the values in literatures were within the range of 0.35-0.55%^{3,4,16,23,24,34}, only one study reported higher value of protein (3.7%) in pineapple³³. Watermelon is not a good source of protein in our daily meal but studies have found small proportion of protein in watermelon ranging from 0.34-0.60%^{25,26}.

Ash content of selected staple foods consumed in Enugu State:

Ash content of food reflect the total mineral content in the food¹⁷. Ash is one of the proximate components determined during food analysis¹⁷. Minerals are micronutrients required in the body in small quantity for vital functioning of the cells of the body. Iron is required for hemoglobin synthesis, iodine is required for proper cognitive development, calcium is required for strong bones, potassium and sodium are required to maintain the osmolality of body fluid and the control of blood pressure, phosphate is utilized in the Krebs cycle for phosphorylation of energy molecules, enzyme and hormone synthesis in the body require various minerals, some nutrients require minerals for the body to absorb it properly such as in nutrient-nutrient interaction^{8,14,15,35-37}. Therefore, the ash content of foods which reflect the sum of all the minerals in that particular food provides information on the nutrient density of the food.

The ash content of staples could be influenced by the ingredients used in preparing the meals and the food groups the foods were drawn from. Meat, fish and poultry food group, Milk and milk products food group, legumes and nuts food group and fruits and vegetable food group are known to be rich sources of minerals^{15,35}. Thus, foods prepared that contain substantial amount of foods sourced from the aforementioned food groups will probably supply higher ash content. However, there could be variability of the ash content in foods as a result of the soil where the food is cultivated, method of cooking, moisture content of the food and the recipe of the foods. Some single foods might contain high ash content such as milk, egg, meat, fish and nuts but when they are combined as mixed dishes, more minerals will be derived from them¹⁸. Consuming local staple as mixed dishes from different food groups increases dietary diversity and nutrient density of foods.

The ash content documented for different local staples: *achicha*, *ayaraya-ji*, *ayaraya-oka*, *lgbangwu-oka*, jollof rice, white rice without stew and *okpa* consumed in rural

communities of Enugu State are 2.3, 4.0, 5.2, 3.0, 3.2, 0.3 and 4.0% respectively¹. The ash content reported for *abacha* ranged from 0.87-1.44%². Fruits are considered to contain appreciable amount of minerals making up the ash content of foods. The ash content of ripened banana of different varieties ranged from 0.82-4.5%^{4,16,28}. Ash content of ripe pawpaw pulp of different species ranged from 0.37-3.9%^{4,23,27}. The ash content of apple varieties ranged from 0.14-4.6%^{4,21}. Pineapple pulp contained ash ranging from 0.22-3.16%^{4,23,33}. However, most of the values in literatures were within the range of 0.22-0.76%^{4,23}, only one study reported higher value (3.16%) of ash in pineapple³³. The ash content reported for watermelon ranged from 0.31-0.59%^{4,25,26}.

Carbohydrate and fibre content of selected staple foods consumed in Enugu State:

Carbohydrates is the primary source of energy for humans. It contains 4 kcal in one gram^{14,15,38,39}. Fibre is a type of carbohydrate which is digested through the activities of microorganisms in the large intestine and make the nutrients available to humans^{14,15,38,39}. This is because the body does not have the enzyme for its digestion. Most plant based foods are rich sources of carbohydrates such as the local staples consumed in Enugu State. The most abundant nutrient in fruits is water and carbohydrates. The carbohydrate composition reported for *achicha*, *ayaraya-ji*, *ayaraya-oka*, *Igbangwu-oka*, jollof rice, white rice without stew and *okpa* in rural communities in Enugu State were 22.4, 23.7, 4.8, 7.1, 16.6, 30.1 and 16.7% respectively¹. The carbohydrate content reported for *abacha* ranged from 17.42-28.34%². It is important to note that the above two studies^{1,2} standardized the recipes used in their study after conducting a focused group discussion in rural communities of Enugu State. In this study, food samples were based on foods sold by food vendors or restaurants in Enugu State. The crude fibre reported for *achicha*, *ayaraya-ji*, *ayaraya-oka*, *Igbangwu-oka*, jollof rice, white rice without stew and *okpa* were 0.2, 0.3, 0.3, 0.2, 0.5 and 0.2% respectively¹ while crude fibre reported for *abacha* with varying quantity of vegetables in the ingredients ranged from 1.49-1.67%². Fibre is an important dietary component required by diabetic patients, it helps to regulate the release of glucose in foods, increase satiety, adds bulk to food to reduce excessive caloric intake as well as help in the removal of cholesterol from the body^{14,15,38,39}.

Results showed that the carbohydrate content of apples ranged from 9.25-15.3%^{4,21,22,40}. Previous studies have reported that Pineapple contained 6.75-13.7% of carbohydrate contents^{4,23,24,33}. The reported carbohydrate content in watermelon ranged from 4-6.5%^{4,25,26}. Studies reported wide range of carbohydrate contents in pawpaw ranging from

2.9-9.51%^{4,23,27,30,31}. The wide range in the carbohydrate is mostly due to the moisture content which was as high as 88.3 and 91.4% in pawpaw harvested at Rivers State and Benue State respectively²³. The carbohydrate content in different ripe banana species ranged from 21.8-22.84%^{3,4,29,41}. The degree of ripeness of the fruits could affect the carbohydrate content significantly^{17,22-29}.

The fibre content of banana is affected by the degree of ripeness of the banana. The more the ripeness, the higher the simple sugars and lower fibre content. A study showed that the crude fibre content of banana was higher in the unripe species than that of the ripe ones of similar species. The crude fibre content of ripe banana of different species ranged from 1.58-2.6%^{3,4,28,29}. The crude fibre in watermelon reported in previous studies ranged from 0.29-0.40%^{3,4,25,26}. Different varieties of pawpaw pulp contained 0.77-0.93% of crude fibre^{27,31}. However, other studies reported higher values of crude fibre for pawpaw fruit (2.47-2.93%²³, 6%^{4,16} and 1.9%³). The crude fibre content in apple as reported in previous studies were 0.77%²² and 2.3%⁴. The value of crude fibre in pineapple reported in various studies were 1.2^{4,16}, 1.4^{3,24}, 2.25 and 7.21%²³.

Fat content of selected staple foods consumed in Enugu State:

Fat is a very important nutrient needed by humans for various purposes including synthesis of steroid hormones, cholesterol, insulation of organs, formation of cells of the immune system especially the essential fatty acids and production of energy for the body^{14,15,35,38,39}. The fat content of staple foods consumed in Enugu State have been reported by various studies and in food composition table for use in Nigeria as well as in the West African food composition table^{3,4,16,23-34,40}.

The fat content documented for different local staples: *achicha*, *ayaraya-ji*, *ayaraya-oka*, *Igbangwu-oka*, jollof rice, white rice without stew and *okpa* consumed in rural communities of Enugu State were 4.5, 5.8, 15.4, 12.0, 7.7, 0.2 and 7.0 % respectively¹. The fat content reported for *abacha* ranged from 1.54-14.15%². Fruits are considered to contain low or negligible fat values. The fat content of ripened banana of different varieties reported in various literatures was: 0.3-0.5%^{3,4,16,29}, 1.63-2.59%²⁸. The fat content of ripe pulp of pawpaw in various studies ranged from 0.1-0.7%^{3,4,16,27,30-32}, however, higher values of fat content in pawpaw species were reported in a single study in Rivers State and Benue State respectively and the result reported fat content ranging from 1.11-1.85% respectively²³. The fat composition of apple varieties have been reported by different authors. A study reported fat content of 0.36% in apple analyzed with the

skin²². Eating apple with the skin is a common practice in Nigeria, thus it is considered as edible portion in Nigeria. A value of 0.2% of fat was reported for red delicious apple in the Nigerian food composition table⁴. Another study reported a value of 1.95% of fat in red delicious and 2.21% in golden delicious apple respectively⁴⁰. The fat content in ripe pineapple pulp was reported by various authors as 0.47%³³, 2.0-3.5²³, 0.3³ and 0.12%⁴. The fat content reported for watermelon in various literatures ranged from 0.1-0.24% in some reports^{3,4,16,25,26}.

Energy content of selected staple foods consumed in Enugu State:

Energy is defined as the ability to do work. The energy in food is measured in kilocalories (kcal) or kilojoules (kJ)^{14,17,35}. The energy present in food nutrients are fat, carbohydrates and protein supplying 9, 4 and 4 kcal per gram of the nutrient respectively^{15,38,39}. These factors are used in calculating the energy present in foods. After the determination of the proximate composition of foods, the fat, carbohydrate and energy values are known which is then used to derive the energy value per 100 g. Food composition tables are then presented per 100 g of the food samples analyzed^{3,4,16,34}. The value of energy in food samples especially in mixed dishes vary due to the recipes used in the preparation of the food. Frying food with oil makes the food to absorb oil, thus increasing the fat content of the food and invariably the energy content⁴². Some local foods in Enugu State like *ayaraya-oka*, *ayaraya-ji*, *achicha*, *abacha* and *okpa* require extra time and large quantities of oil for preparation, the quantity of oil added to these foods vary from household to household. Two studies have tried to standardize the preparation of these foods, through, a focused group discussion carried out by the researchers. However, there is still a high tendency of variation in the energy content of foods consumed in different household when compared with their standardized values^{1,2}.

The knowledge of the energy content of foods helps consumers to make informed decision on what to eat and what quantity to eat from any type of food as well as deciding to modify the recipes to suite the physiological condition. Dietary modification considers energy requirement per day as the most important factor to determine for every individual. Various factors that influence the energy requirement of people are weight, body mass index, height, age, physical activity level, stress factors, physiological condition and the purpose of dietary modification. Therefore, knowing the energy content of the food is necessary for proper dietary counselling and appropriate nutrition education.

The energy content per 100 g reported for the following selected foods: *achicha*, *ayaraya-ji*, *ayaraya-oka*, *Igbangwu-oka*, jollof rice, white rice without stew and *okpa* consumed in rural communities of Enugu State are 161.6kcal, 159.5kcal, 175.6, 154.3, 143.5, 134.0 and 190.1 kcal respectively¹. The energy content per 100 g reported for *abacha* ranged from 152-263 kcal². The variation in the energy content for *abacha* for instance is majorly due to changes in the quantity of vegetables and oil added during preparation².

The major source of energy in fruits is its carbohydrate content. Fruits are good sources of vitamin and minerals as well as water but they are not relied upon to supply fat and protein except for few of them such as avocado pear and coconut which are not considered as fruit though⁴. Some fruits considered in this review are banana, apple, watermelon, pawpaw and pineapple. The energy content reported for these fruits in different literatures vary, which is directly related to the variations reported for their carbohydrate, fat and protein content^{3,4,16,21-27,28-31,33,34,40}.

The energy content per 100 g of ripe banana of different varieties ranged from 89-103.89 kcal^{3,4,29}. The energy content per 100 g reported for pawpaw ranged from 32-53.48 kcal^{3,4,16,31}. The energy per 100 g of apple varieties reported by different researchers ranged from 59-69.54 kcal^{4,21,22}. Energy content per 100 g reported for ripe pineapple pulp by various authors ranged from 46-56 kcal^{3,4,16,24}. Authors reported energy content per 100 g in watermelon which ranged from 22-30.9 kcal^{3,4,16,26}.

CONCLUSION

The staple foods consumed by diabetic patients in Enugu State showed a high tendency of variation in the energy content and proximate composition (carbohydrate, fats, protein, ash, moisture and fibre) when compared with their standardized values. The value of energy in food samples especially in mixed dishes vary due to the recipes used in the preparation of the food. Frying food with oil makes the food to absorb oil, thus increasing the fat content of the food and invariably the energy content.

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