COMPARATIVE STUDY OF PROXIMATE, MINERALS AND FATTY ACID (AS OLEIC) CONTENT OF COOKED AND UNCOOKED COW TRIPE CONSUMED IN GHANA

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ABSTRACT

Background: Meat and meat products such as the cow tripe are commonly eaten in Ghana, but their nutrient composition is not known and this affects evidenced based nutrition counseling and interventions.

Objectives: The study was to compared the minerals, proximate and free fatty acid (FFA) (as oleic) composition of uncooked and cooked samples of cow tripe.

Methods: Samples of cow tripewere obtained from the markets by purposive sampling which was later processed and analysed. The samples were chemically analysed to determine the nutrient content by using standard methods. Results were presented as means and standard deviations. The data from the uncooked and cooked tripe were compared using the Independent sample t-test.

Results: The moisture content was significantly higher ($p < 0.05$) in the raw cow tripe than the cooked cow tripe. Energy, ash, fat and protein content were all significantly higher ($p < 0.05$) in cooked cow tripe than raw cow tripe. The carbohydrate content of raw cow tripe is not significantly higher ($p > 0.05$) than cooked cow tripe with a 100% change after cooking. No significant difference ($p > 0.05$) was found in the FFA (as oleic) content of the raw and cooked sample. Zinc content of cow tripe reduced after cooking by 99%. Phosphorus content was significantly higher when cooked($p < 0.05$). After cooking also, there was a significant increase of copper in tripe ($p < 0.05$). Raw tripe recorded a very high iron content (app. 13.0 mg/100g), and did not decrease significantly after cooking.

Conclusion: The study gave ample information on the proximate, oleic and mineralscomposition of raw and cooked cow tripe consumed in Ghana.The findings revealed that, cow tripe have considerable nutritional value,which can make significant impact in the nutrients intakes of individuals.

Keywords:*cow tripe, minerals, proximate, Oleic*

INTRODUCTION

Generally, there is an increased demand for meat and meat products globally,and this is driven by a combination of population growth, urbanization and rising income [1]. Meat is the flesh and organ of animals that are eaten as food. The importance of meat and meat products in world food supply and nutrition cannot be overemphasized. Animal source foods (ASF) supply about one-sixth of energy supplies and one-third of protein supplies globally [2,3].

Meat and meat products are an important source of nutrients in the diet, they are especially known to supply the body with high biological value nutrients. For instance, red meat contains protein of high biological value and important minerals that are needed for good health throughout life. It is also known to contain a range of fats, including essential omega-3 polyunsaturated fats [1, 4, 5].

Animal products especially, meat, egg and milk, can make an invaluable contribution to the diets in developing countries like Ghana. Thus, apart from providing fat, the ability of meat and meat products to provide all the essential amino acids make them valuable source of proteins for human consumption. One hundred grams of lean meat for example, provides more than 25 % of the recommended daily intake (RDI) of protein [5]. Additionally, meat and meat products are an important source of several micronutrients and trace elements [6] such as niacin, vitamin B_6 and B_{12}, zinc, phosphorus and iron.

Tripe is a type of edible offal from the stomachs of various farm animals [7]. Cow tripe is another delicacy that is commonly consumed around Africa as well as in other parts of the world. Beef tripe is produced from the first stomach or rumen (blanket/flat/smooth tripe), also known as the paunch or plain tripe, and second stomach the reticulum (also known as the honeycomb or pocket tripe) of the cow [8]. The third stomach or omasum (bible/book/leaf tripe) is also processed for human consumption (being of most value for producers to be made into sausage, stew or soup) [9].

Cow tripe is used extensively in Ghana to prepare different dishes. It is used to prepare different type of soups and stews such as light soup, okro soup and tomato stew. Nigerians also eat offals in different forms. It can be added to different types of stews and soups or cooked alone as pepper soup.

Various foods differ in their protein and amino acid composition. Proteins in different foods have their own unique amino acid composition [10]. The essential amino acids present in proteins in foods are used to determine the nutritional quality of that protein [11]. High quality dietary proteins are found to contain the necessary quantities of essential amino acid to meet the needs of the human body. While low quality dietary proteins display an imbalanced ratio of essential amino acids. The essential amino acid that is most lacking in a protein is referred to as limiting amino acid [11].

A fatty acid refers to an organic acid-a chain of carbon atoms with hydrogen attached that has an acid group (COOH) at one end and a methyl group (CH_3) at the other end [12]. Fatty acids are the simplest of the lipids, they are components of the more complex lipids. Fatty acids definition has included fatty acids derived from triacylglycerols, partial glycerides, phospholipids, glycolipids, sterol esters, or free fatty acids (FFAs). However, in food analysis, the amount is expressed as grams of triacylglycerols [13].

Oleic acid is said to be the most common MUFA and it is present in substantial amounts in both animal and plant sources [14]. Typical sources include all fats and oils, especially olive oil, canola oil, high-oleic sunflower and safflower oil [14]. Reports have shown that the most abundant fatty acids in meat are oleic (C18:1), palmitic (C16:0), and stearic (C18:0) acid [15, 11]. Linoleic acid (C18:2*n*-6) is the predominant PUFA (0.5 – 7 %), followed by alpha-linolenic acid (C18:3*n*-3) [11].

Information in the food composition table for Ghana does not include the cow tripe. Thus, these information including the rest of the foods in the database needs to be updated as it was published 40 years ago [16]. This can have a negative impact on dietetic practice since proper dietary counselling requires an evidence-based information [10].

This study therefore highlights the need for the current research to analyse the nutrient composition of cow tripe which is commonly consumed food in Ghanaian homes. Hence, the aim of the study was to compare the minerals, proximate and free fatty acid (FFA) (as oleic) composition of uncooked and cooked samples of cow tripe.

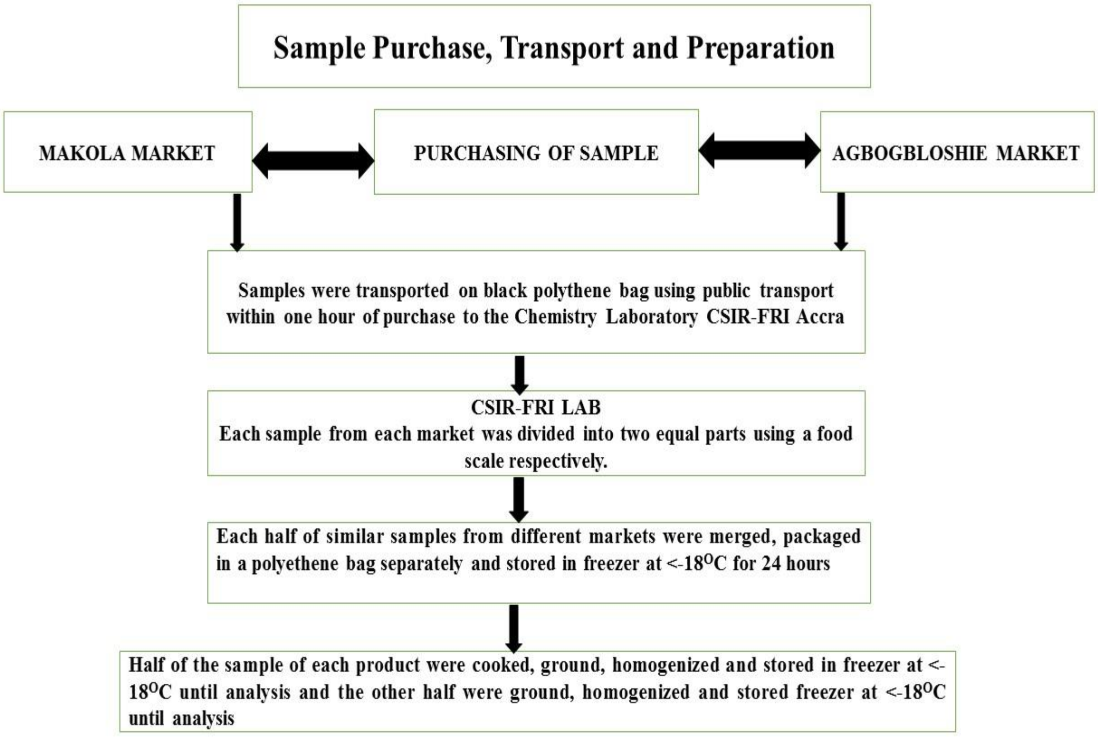
MATERIALS AND METHOD

The study employed an experimental laboratory study design. Samples were obtained from Makola and Agbogbloshie markets within the Ashiedu Keteke Sub Metro Area in Accra. The two markets were selected on the basis that large scale dealers of animal products could be found there. Furthermore, these two markets were central point of these products before distributing to other markets for sale [17].

Samples of cow tripe which were acquired from these two markets were processed and analysed at the chemical laboratory of the Council for Scientific and Industrial Research- Food Research Institute (CSIR-FRI) of Ghana.

Procedure for data collection

Samples of cow tripe were purchased from four (4) different point of sales in each of the markets (Makola and Agbogbloshie) largely by purposive sampling. Approximately, one pound (lb)/ 0.5 kg of cow tripe was purchased from four points of sale. Eight (8) samples of cow tripe were purchased for the proximate analysis and also eight samples for minerals (iron, phosphorus, zinc and copper) analysis from the markets. Thus, a total of 16 samples were purchased (8x2). The samples were carried in a polythene bag and transported to the laboratory within 30-45 minutes. The samples were kept in the freezer at less -18^0C. The figure below shows the flow chart for the process.



Sample preparation
The samples from both markets were divided into two equal parts: one to be analysed as a raw sample and the other to be cooked before analysis. The meat products were cooked by boiling separately inside an aluminium sauce pan on a Gerhadt electric burner (Gerhadt Bonn, App No, SN: 01191159). Thus, 1000 ml of water was added to cow tripe and it was allowed to boil for 40 minutes. Cooked and uncooked samples were ground and homogenized separately with an industrial food blender (Panasonic, MX-AC300, Mixer Grinder) to ensure uniform mixture of the different samples. Laboratory samples were collected from the homogenized mixture, vacuum packed and frozen at ≤ -18 ^{0} C until analysis. The homogenized samples were subjected to chemical analysis in duplicates using the standard assay. Each analysis was carried out in triplicate, however, the two most accurate were used to determine the mean. The samples are represented in the figures below.

Figure 2: Uncooked Cow tripe displayed at Makola market in Accra, Ghana

Figure 2: Uncooked Cow tripe

Figure 3: Cooked Cow tripe

Moisture content determination

The moisture content of the homogenized cow tripe was obtained by the Association of Official Analytical Chemists (AOAC) air oven method of moisture determination [18]. The method involved, the drying of the cow tripe under controlled pressure and temperature until constant weight is obtained. Moisture content is required to express the nutrient content per dry weight basis [19].

Protein content determination

The content of the protein was analysed using the automated Micro-Kjeldahl method[18].Automated Micro-Kjeldahl method involved the digestion of proteins and other organic food components in cow tripe using sulphuric acid in the presence of a catalyst such as sodium or potassium sulphate in other to release nitrogen from protein and retain it as ammonium salt. Ammonia gas is liberated upon addition of excess alkali (concentrated sodium hydroxide) and distilled into a boric acid solution to form ammonium-borate complex. Later, the ammonia obtained from the compound is titrated with standardized hydrochloric acid. Also, the amount of nitrogen in the sample is determined from the milligram equivalent of the acid used. Crude protein is further obtained by multiplying the nitrogen content with a conversion factor (6.25) which is specific to the food matrix (meat) [19].

Fat content determination

Fat composition of the cow tripe was obtained by Soxhlet Extraction method [20]. Soxhlet Extraction method ensures the cow tripe is hydrolysed by hydrochloric acid at 70-80ºC. Protein, if any, can be dissolved in the acid, crude fat is then manually extracted by diethyl and petroleum ether. The solvent is removed by evaporation and the oil residue is dried and weighed [19].

Ash content determination

Ash composition was obtained by AOAC dry as hingmethods [20]. This method involves the was directly related with the amount of phosphorus in the sample and the absorbance was measured by

separation of minerals from the food matrix by destruction of the organic matter of the sample through dry ashing[19].

Carbohydrate content determination

Carbohydrate content was determined by difference method. Thus, the summation of all the proximate values was subtracted from 100% [21].This is based on the fact that once all the other proximate parameters are obtained, the balance of the residue is regarded as carbohydrates.

Energy content determination

Energy was determined by the “Atwater factor”. The energy value of the samples was calculated by multiplying the values of fat, carbohydrate and protein with 4:9:4 the “Atwater factors” respectively [13].

Free fatty acid as oleic content determination

Free fatty acid as oleic was determined by the ISO 660 (1996-05-05) method which involves the determination of acid value of the fat [22]. The acid value is determined by directly titrating the oil/fat in an alcoholic medium against standard potassium hydroxide (KOH) or sodium hydroxide (NaOH) solution [22].

Determination of Iron, Copper and Zinc (20)

Theseensuresthe organic matter in cow tripe was destroyed by wet digestion. The trace elements in the sample were then quantitatively measured by atomic absorption spectrophotometer (AAS) at a specific wavelength [Zn (213.9), Cu (324.7) and Fe (248.3)] [23, 24].

Determination of Phosphorus (20)

Phosphorus was obtained as phosphates (PO_4) in cow tripe by spectrophotometric method. Phosphorus, as phosphate; in the test solution was made complex with molybdovanadate reagent (analar grade). The yellow colour formed

UV-VIS spectrophotometer (Cecil CE7400/7000 series).

Data Analysis

Data obtained from chemical analyses was analysed using the statistical product and service solution (SPSS) version 22. Results were summarized as means, and standard deviation. The percentage changes in the nutrient composition after cooking of the samples was calculated Using Microsoft Excel package version 2016. Data from the raw and cooked samples was compared using the independent sample t – test, and a $p<0.05$ was considered statistically significant.

RESULTS

Proximate and free fatty acid (oleic) composition of cow tripe

The table below shows the proximate and free fatty acid (FFA) (as oleic) composition of raw and cooked sample of cow tripe. The moisture content was significantly higher ($p < 0.05$) in the raw cow tripe than the cooked cow tripe. Energy, ash, fat and protein content were all significantly higher ($p < 0.05$) in cooked cow tripe than raw cow tripe. The carbohydrate content of raw cow tripe is not significantly higher ($p > 0.05$) than cooked cow tripe with a 100% change after cooking. No significant difference ($p > 0.05$) was found in the FFA (as oleic) content of the raw and cooked sample.

The proximate and free fatty acid (Oleic) composition of Cow Tripe

Parameter	Raw	Cooked	P-Value	%Changes After Cooking
Moisture g/100g	82.44±0.01^{b}	70.47±0.02^{a}	0.0001	-14.52
Energy kcal/100g	83.82±0.32^{a}	141.20±0.64^{b}	0.0001	68.46
Ash g/100g	0.37±0.01^{a}	0.42±0.01^{b}	0.0283	13.51
Fat g/100g	2.98±0.06^{a}	3.63±0.01^{b}	0.0048	21.81
Protein g/100g	13.28±0.25^{a}	27.16±0.17^{b}	0.0002	104.52
Carbohydrates g/100g	0.95±0.32^{a}	0.00±0.00^{a}	0.0524	-100.00
FFA (As Oleic) g/100g fat	2.17±0.07^{a}	2.24±0.32^{a}	0.7168	3.23

Means in the same row with different superscript (a-b) were significantly different at $p< 0.05$.

Mineral Content of Cow tripe

Raw and cooked samples of cow tripe were also analysed for its mineral composition. The zinc composition of cow tripe reduced significantly ($p < 0.05$) after cooking whiles, phosphorus composition increased significantly ($p < 0.05$) after cooking. The cooking process also resulted in a significant increase ($p < 0.05$) of copper in tripe samples. Cow tripe iron content decreased after cooking, but this change was not statistically significant ($p > 0.05$).

Mineral Composition of Cow tripe

Sample	Raw (mg/100g) Mean ± SD	Cooked (mg/100g) Mean ± SD	p-value	(Cooked-Raw) % Change
Zinc	1.01±0.01^{b}	0.01±0.00^{a}	0.00	-99.01
Phosphorus	68.58±1.24^{a}	119.29±2.32^{b}	0.00	73.96
Copper	0.25±0.01^{a}	0.65±0.78^{b}	0.02	163.27
Iron	12.58±0.06^{a}	9.98±0.79903^{a}	0.44	-20.68

Means in the same row with different superscript (a-b) were significantly different at $p < 0.05$.

DISCUSSION

Cow tripe moisture composition of the raw had a very high value of 82%. This value was found to be higher than finding from a previous study that indicated that a typical meat muscle contained about 75 g/100 g moisture [25]. Also, value was again higher than another study by Gerber [11] that reported that a typical muscle contained 62% to 75% moisture [11]. High moisture content of meat products reduce its keeping quality [15, 26]. As a result, meat often requires various preservative processes such as drying to slow deterioration. Moisture composition of animal source foods are reduced by drying and thus, makes the water unavailable for microbial growth by reducing the water activity (Aw) of the meat [26-28]. The study revealed that, tripe contained the highest level of moisture, making it most susceptible to spoilage [15]. After cooking, the sample's moisture content reduced to 70.47 g/100g. This change may be attributed to coagulation of protein and leaching out of the moisture [29]. Further, the lost after cooking is determined by various factors such as duration and method of cooking, temperature, size of sample and heat penetration [11, 13, 15, 29].

The composition of ash in both uncooked and cooked tripe was 0.37g/100 g and 0.42 g/100g respectively. As far as the food composition tables of Ghana and West Africa is concerned, data on ash content of cow tripe is not included.

The ash content of cow tripe was low compared to a study in Zurich that found that ash formed around 1% of the composition of a typical meat muscle [11]. However, these values in the present study were higher compared to a study conducted in Ghana, which found the ash content to be 0.2% [16].Differences in this values may be attributable to the fact that, the type of feed or pasture of animals can influence the level of specific minerals which in turn also affects total ash content, and that, when feed consumed is deficient in minerals, especially phosphorus and cobalt result to a reduced muscle mass [15].

The protein composition of the raw and cooked samples were 13.3 g/100 g and 27.2 g/100 g respectively. The change difference after cooking the tripe was significant, and that the increased protein composition after cooking was probably as a result of loss of moisture content in the raw sample which resulted in the concentration of the protein composition. Thus, the moisture composition in the raw tripe (app. 82 g/ 100g) reduced to approximately 70.5 g/ 100g, and this change further saw an increase in the protein content after the cooking process.

As far as the carbohydrate composition was concerned, uncooked tripe was found to have 0.72 g/100g, however, after the cooking process there was 100% loss of the carbohydrates in the sample. The finding in this present study further support previous studies that show that meat is deficient in carbohydrates [11, 16, 30].

Uncooked cow tripe had free fatty acid (FFA) composition of 2.17 g/100 g and this figure increased marginally to 2.24 g/100 g, hence percentage change after cooking was not statistically significant. The observation here goes to confirm previous studies which states that cooking animal products increases their FFA as oleic[22].The composition of zinc in uncooked cow tripe was 1.01 mg and this value was very low in comparison to the range (0.5 mg- 4.9 mg/100) in different beef and veal cuts reported in several studies [31-33]. Again, the values were further lower than that reported by the zinc content (0.055 mg to 0.190 mg/100 g). Also, values were also higher than 0.09 of beef (3.6 mg/100) in the West African food composition table [30] and also when compared to USDA [34] and FAO[30] value of 1.42 mg/100 g. These differences in the results may be attributable to the differences in animal breeds, their feeding systems, age of slaughter of the animal and geographical locations [33].

After cooking, there was a significant reduction ($p<0.05$) in zinc content of tripe, in which zinc content of the tripe reduced by 99% (0.01 mg/100g). The findings were different when compared to the West African food composition table that had higher zinc content for both cooked beef and tripe [30]. Gerber and colleagues [33] also found a significant increase in zinc content of beef cuts after cooking. The authors related the increase to longer exposure in cooking utensil for beef brisket.

It was stated by Cross and Over by [35] that, the minerals level in meat differed substantially with regards the type of meat product and also depended largely on whether the meat was cooked or raw. The degree of losses in this study might be due to the cooking process pertaining to the temperature and length of time the tripe was cooked and also the water holding capacity of tripe. The water holding capacity of raw cow tripe was high and perhaps had resulted in leaching of zinc that led to reduction in the zinc content. Aluminium cooking utensil was used to cook the samples in this study and the resultant effect saw a reduction in the zinc composition contrary to other studies in which zinc content increased when cooked for a longtime in stainless steel cooking utensils [33].

Composition of phosphorus in the uncooked tripe was 68.58 mg which increased substantially to 119.29 mg/100g after cooking. Thus, this results suggest that phosphorus may not readily leach out in tripe when cooked and that the resulting reduction of moisture level during cooking results in concentration of the phosphorus content. Furthermore, the phosphorus content of raw tripe in this study was higher than the 64mg/100g reported by both USDA [34] and FAO[30]. Thus, the explanation here may be due to the fact that, breeds and feeding systems used coupled with different ages at slaughter affects the nutrient compositions of meat [33] and this may account for the differences.

Copper content of raw tripe increased after cooking by 163%. In view of the RDA of 900 µg (0.9mg) for adult men and women [36], 100 g of cooked tripe can provide over half(>50%) of the daily copper requirement. It was demonstrated that the value (0.25 mg/ 100 g) of the raw sample was higher than the values reported by Chan *et al.*, [31] on copper content in raw lean cuts in beef and veal mg/100 g reported for beef by the West African food composition table [30]. Furthermore, the content of raw beef tripe (0.25 mg/100 g) in this study was also higher than raw beef tripe value (0.07 mg/100 g) reported by FAO[30]. As with previous observations, these discrepancies may be the result of differences in breeds and feeding systems as well as differences in ages at slaughter [33].

The study revealed that raw tripe iron composition was over 1000% more than values reported 2015 by USDA (0.59 mg). That is, the iron values are greater than the 1.8 mg/100 g value reported by Williams [5]. It was still higher than iron content of beef (2.1 mg) in the West African food composition table [30]. After cooking, tripe iron content reduced from12.5 mg/100g to 9.98 mg/100g. These observations show that, iron may have leached during cooking in the samples. However, this was different from Gerber and colleagues [33], who found that iron content increased after cooking in veal and was significantly higher in other beef cuts. Again, reports from the study differed from that of Mistry, Brittin and Stoecker [37] and Kumar, Srivastava and Srivastava [38] who also indicated that cooking meat in stainless steel utensils increased the iron content. They opined that, the iron content from meat cooked in iron cookware increased and was as available as native food iron [37]. The difference may be due to the fact that, the meat samples from this study were cooked in an aluminium pan and not stainless steel (made from iron, chromium, nickel, manganese and copper) used in the other studies.

CONCLUSION

The main aim of the study was to compare the proximate, minerals and fatty acid (as oleic) composition of cooked and raw cow tripe consumed in Ghana. Cooking had a significant effect on the nutrients composition of cow tripe. The observation related to the increases were due to reduction in moisture content of the tripe after cooking.

After cooking, FFAs increased marginally whiles proteins increased significantly in the meat sample. Furthermore, the minerals analysed were substantial that can contribute to the nutritional quality of individuals.

Recommendations

This study should be replicate in other regions in Ghana in order to come up with a comprehensive data that can be added to the food composition table for use in Ghana.

Result from the study can be used as a guide in counselling clients and educating the general public to make wise choices when they are cooking. Dietitians should advice consumers to discard the broth of tripe which has high level of fat since fats found in animal products are mostly saturated fats and cholesterol. Furthermore, consumers should be encouraged to consume these products in moderation and diversify their diet to include other sources of proteins like meat muscle, fishes, plant proteins to obtain an adequate diet. Consumers need to be discouraged from habitual consumption of these animal products as a consistent substitute to meat muscle and other rich sources of protein.

In this study, only four minerals were analysed. However, since there are several other micronutrients of public health significance, future studies must expand the scope of study. Furthermore, other studies using other experimental models especially longitudinal study designs can be done to investigate the effect of cooking temperature and duration on the trace elements that can delve into mineral content of various meat cuts for easy comparison.

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