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Original Research Article

Proximate, Vitamins, Minerals Compositions Together with Mineral Ratios and Mineral Safety Index of Kilishi (Beef Jerky Meat)

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Abstract

Kilishi is a great spicy beef jerky from Nigeria. Dry kilishi was analysed for its content of chemical components: proximate, vitamins, minerals using standard methods. From the minerals were calculated the mineral ratios and the mineral safety index (MSI). Highest concentrations of proximate contents came from crude protein (64.4 g/100g) and crude fat was 14.2g/100g. Proportion of total energy due to protein was 1,095 kJ/100g (66.0%) or 258 kcal/100g (65.3%) whereas in carbohydrate we had values of 39.1 kJ/100g (2.36%) or 9.20 kcal/100g (2.33%). Utilization of 60% of proportion of total energy due to protein percent ranged between 39.2 – 39.6. Minerals of high concentration in the sample were (mg/100g): K, 985 (44.3%); P, 781 (35.1%); Na, 320 (14.4%); reasonable contents were observed in Fe, Zn, Ca, Mg. Among all the minerals ratios calculated, only the value for Na/Mg (3.91) was very close to reference balance ideal (4.00) and within the acceptable ideal range (2 to 6). The MSI values showed that only Zn was higher than the recommended MSI showing that Zn might be deleterious in kilishi consumption. The two most concentrated vitamins were water soluble vitamins with values of (mg/100g): vitamin C, 6.53 (38.4%); B_3, 5.98 (35.2%) and followed by two other fat soluble vitamins: vitamin A, 1.94 (11.4%) and vitamin E, 1.38 (8.10%). These results revealed that kilishi could be regarded as a protein-filled snack that still retains its nutritional value despite being dried.
Keywords: Kilishi meat, chemical composition, healthy snack.

INTRODUCTION

Kilishi (kilichi) is a spicy beef jerky that is popular in the northern part of Nigeria. It is one of the Nigerian snacks. It is often mistaken for suya because they have similar ingridients but preparation and texture are different. Jerky is lean trimmed meat that has been cut into strips and dried (dehydrated) to prevent spoilage. Usually, the drying includes the addition of salt to prevent bacterial growth before the meat has finished dehydrating process (Jerky – Wikipedia). The quality of kilishi is further improved as follows. A paste made from peanuts, called *labu,* is diluted with enough water, spices, salt, ground onions, and sometimes sweeteners such as honey, to add sweetness. A more natural way to add sweetness is by adding date palm. The dried "sheet" of meat are then immersed one after the other in the *labu* paste to coat them, before being left to dry for hours before roasting to taste [1].

Meat ranks among one of the most significant, nutritious and favoured item available to the people, it aids in fulfilling most of their body requirements. It is an important constituent of a well-balanced diet. It is a good source of proteins, low source of carbohydrates, moderate source of fat, good source of minerals and vitamins [2]. Other ingredients or treatments to improve the quality of kilishi are: use of suya spice (suya pepper); cloves of garlic; one teaspoon of cloves (kanafuru); piece of ginger; stock cube; dry cayenne pepper seeds; the meat used for kilishi should be free from fat and should be gotten from the reddish part of the beef. Each of these items give kilishi special characteristics such as aroma, etc [3].

The information above gave some insight on the preparation, food characteristics and ingredients that make up kilishi. There is paucity of information on the chemical composition of kilishi. The major concern of this work is therefore to find out if an improvement occurs when beef is treated into kilishi snack meat. To address this concern, the following were analyzed for in kilishi: proximate constituent, mineral constituent and vitamin constituent. Discussion was based on these compositions in relation to literature information as well as health implications of the consumption of kilishi as a beef product.

MATERIALS AND METHODS

Collection of Samples

Samples of packaged kilishi were obtained from NAO Supermarket in Ado – Ekiti, Ekiti State, Nigeria. The kilishi samples were prepared for sale by Golden Datol Ent., Akure, Ondo State, Nigeria. The kilishi was labelled as containing beef, onion, garlic, salt, honey, ginger, maggi, groundnut and pepper. A typical kilishi sample is shown in Figure-1.

Fig-1: Kilishi sheets assembly
Source: Wikipedia

Sample Treatment

The kilishi pack were further dried at 50^{o}C in the oven, allowed to cool, blended and packaged in plastic containers and kept in the refrigerator pending analysis.

Sample Analyses

Proximate Determination

Micro-Kjedahl method [4] was followed to determine the crude protein. The crude fat was extracted with a chloroform/methanol (2:1 v/v) mixture using Soxhlet extraction apparatus [5] method while carbohydrate was determined by difference. The calorific value in kilojoule (kJ) and kilocalorie (kcal) were calculated by multiplying the crude fat, protein and carbohydrate by Atwater factors of (kJ/kcal) 37/9, 17/4 and 17/4 respectively. All determinations were in duplicate.

Mineral Element Determination

The minerals were analyzed from the solution obtained by initially dry ashing the samples at 550^{o}C. Filtered solutions were used to determine Na, K, Ca, Mg, Zn, Fe, Mn, Cu, Pb, Co, Cd, Ni and Se by means of atomic absorption spectrophotometer (Buck Scientific Model- 200A/210, Norwalk, Connecticut 06855). Phosphorus was determined colorimetrically by Spectronic 20 (Gallenkamp, UK) using the phosphovanado molybdate method [5]. All chemicals used were of British Drug House (BDH, London, UK) analytical grade. Earlier, the detection limits for the metals in aqueous solution had been determined using the methods of Varian Techtron [6]. The optimal analytical range was 0.1-0.5 absorbance units with coefficients of variation from 0.9 % to 2.21%. From the mineral elements determined, further calculations were made.

Mineral Ratios

Ratios of Ca/Mg, Na/K, Ca/K, Na/Mg, Zn/Cu, Ca/P, Fe/Cu, Ca/Pb, Fe/Pb, Zn/Cd, Fe/Co, K/Co and [K/(Ca + Mg)] were all calculated [7-9].

Mineral Safety Index (MSI)

The mineral safety index (MSI) [7] of Na, P, Ca, Fe, Se, Zn and Cu were calculated using the formula:

Calculated MSI = MSI/RAI x Research data result

Where,

MSI = mineral safety index Table (standard)
RAI = recommended adult intake.

Simultaneous Analysis of Fat and Water Soluble Vitamins

The samples were brought out of the less than 4^oC compartment in the laboratory and placed on the bench to allow acclimatizing to the laboratory conditions.

Extraction of Water-soluble Vitamins

The sample was ground with the aid of the laboratory mortar and pestle. Accurately weighed value of 0.100g of ground sample was put into 100ml volumetric flasks and 80ml of deionized water added. After 15min of ultrasonic extraction, the water was added to the volumetric flask mark.

Extraction of Fat-soluble Vitamins

A weighed value of 0.125g of ground sample was added into 10ml volumetric flasks and 8ml of CH_3OH-CH_2Cl_2 was added to the volumetric flask mark. This prepared solution was stored in the dark; and diluted if need be. Prior to injection, the solutions were filtered through a 0.2µm filter (Millex-GN).

Optimized Chromatography Conditions

Water and fat soluble vitamins were separated simultaneously under the following optimized chromatography conditions combined with valve switching, double injection, envelope-injection and wavelength switching.

Column

Acclaim PA, 3µm, 120A, 3.0 x 150mm for fat soluble. Acclaim C18, 3µm, 120A, 3.0 x 150mm for water soluble.

Column Temperature: 25^0C

Mobile Phase

For Water-soluble Vitamin Determination

(A) 25mm phosphate buffer (dissolved ~ 3.4g KH_2PO_4 in 100ml water, and adjust pH to 3.6 with H_3PO_4).
(B) CH_3CN Mobile Phase A (7:3, v/v).

For Fat-soluble Vitamin Determination

(A) CH_3OH-CH_3CN (8:2, v/v).
(B) Methyl tert-butyl ether (MTBE)

Injection volume: 10µl (Dionex, Technical Note 89) (www.dionex.com). All determinations were on dry weight basis.

PubChem CID For Mineral Elements

Mineral elements studied in this report were: Copper/Cu (PubChem CID: 23978); Iron/Fe (PubChem CID: 23925); Zinc/Zn (PubChem CID: 23994); Magnesium/Mg (PubChem CID: 5462224); Calcium/Ca (PubChem CID: 5460341); Cobalt/Co (PubChem CID: 104730); Manganese/Mn (PubChem CID:23930); Sodium/Na (PubChem CID: 5360545); Potassium/K (PubChem CID: 5462222); Nickel/Ni (PubChem CID: 935); Phosphorous/P (PubChem CID: 5462309); Selenium/Se (PubChem CID: 6326970); Lead/Pb (PubChem CID: 5352425); Cadmium/Cd (PubChem CID: 23973).

PubChem CID For Mineral Vitamins

Retinol (PubChem CID: 445354); Cholecalciferol (PubChem CID: 5280795); Cyanocobalamin (PubChem CID: 5311498); alpha-Tocopherol (PubChem CID: 14985); 3-Hyroxy-vitamin K (phylloquinone) (PubChem CID: 5280540); Niacin (PubChem CID: 938); Riboflavin (PubChem CID: 493570); Pyridoxamine (PubChem CID: 1054); Thiamine (PubChem CID: 1130); Folic acid (PubChem CID: 6037); Pantothenic acid (PubChem CID: 6613); Ascorbic acid (PubChem CID: 54670067).

PubChem is a database of chemical molecules and their activities against biological assays. The system is maintained by the National Centre for Biotechnology Information (NCBI), a component of the National Library of Medicine, which is part of the United States National Institute of Health (NIH). Hence we can talk of PubChem Compound ID (CID) [10].

RESULTS AND DISCUSSION

In Table-1 we have the proximate composition as well as the energy contribution to the total metabolizable energy from carbohydrate, crude fat and crude protein. The ash and moisture levels were moderately concentrated whereas both crude fibre and carbohydrate contents were low. From the metabolizable energy results, carbohydrate contributed the lowest value of 39.1 kJ/100g kilishi (2.36%) or 9.20 kcal/100g kilishi (2.33%); crude fat was second with energy contribution value of 525 kJ/100g (31.7%) or 128 kcal/100g (32.4%) whereas crude protein contributed the highest energy value of 1095 kJ/100g (66.0%) or 258 kcal/100g (65.3%) giving an overall total energy of 1659 kJ/100g or 395 kcal/100g dry kilishi. Assuming 60% utilization of the proportion of total energy due to protein percent (UEDP%), we have values of 39.6 (under kJ energy) and 39.2 (under kcal energy). Removal of elements of water content in the sample gave solid content value of 88.8 g/100g whereas removal of both moisture content and ash content gave the value of 81.3g/100g as the organic matter of kilishi. To convert the crude fat to fatty acid and other lipids, the crude fat was multiplied by a value of 0.916 [11], i.e. 14.2 x 0.916 = 13.0 g/100g meaning that about 1.2 g/100g of the crude fat would be due to other forms of lipid. This fatty acid value gave metabolizable energy values of 481 kJ/100g or 117 kcal/100g kilishi.

The keeping quality of any biological sample will depend partly on its moisture content. The moisture content of the kilishi sample was 11.2 g/100g (Table-1). Low moisture will always discourage microbial growth. It is known for kilishi that after roasting, the final moisture content ranged between 10 – 12% which decreases during storage at room temperature to 7.0%. When packaged in hermetically sealed low density plastic pack of 0.038mm thickness, kilishi remains appreciably stable at room temperature for a period of about one year. Both the crude fibre (0.40 g/100g) and carbohydrate (2.30 g/100g) were of low values. Whilst the low crude fibre would have led to high digestibility of kilishi, the low carbohydrate could have led to the correspondingly high crude protein content.

The crude protein of 64.4 g/100g was high. This value was almost at par with the values of 65.4 – 68.5 g/100g as observed in *Acanthurus monroviae* and *Lutjanus goreensis* fishes [12]. A source of protein is an essential element of a healthy diet, allowing both growth and maintenance. There has been debates and published works on protein intake and health. Issues that arise from the potential for protein intakes are predicated on protein intakes to be in excess of the recommended intake [13]. These potential deleterious issues were based mostly on renal function, bone health, kidney stones, cardiovascular disease and cancer. For bone health, protein as part of a well-balanced diet may be beneficial for bone, possibly at dietary levels in excess of the recommended intake; in order to minimize the risk of kidney stones in patients who are at risk, the protein safe level of 0.83 g/kg per day is recommended but not in excessive amounts (i.e. less than 1.4 g/kg per day, preferably from vegetable sources; inverse relationships between protein intake and blood pressure have been reported [14, 15]; for cancer, it has been reported that high dietary protein results in better survival in women with breast cancer [16]. From our results, a kilishi consumption of 64.4 g/100g per day would yield greater than 58.1 kg per day for a 70kg adult by an excess of 6.3 g/100g or 9.78%.

The total ash of 7.70 g/100g was at moderate concentration level. The ash gives an estimate of the likely mineral composition of any sample. The ash content would likely lead to moderate levels of the mineral elements.

The crude fat content was also at a moderate level. The crude fat level of 14.2 g/100g was close to the values of 11.8 – 12.5 g/100g in the innards of male and female *Neopetrolisthes maculatus* [17]. The calculated total fatty acid value was 13.0 g/100g whereas the remaining lipid content composition was 1.20 g/100g. This 13.0 g/100g FA had energy equivalent value of 481 kJ/100g or 117 kcal/100g whereas energy from the total lipid was 525 kJ/100g or 128kcal/100g kilishi. The crude fat of 14.2 g/100g was an indication that the kilishi samples would be good for people wanting to avoid animal protein with high level of fat.

The metabolizable energy as contributed from protein, carbohydrate and total lipid to the total metabolizable energy can be observed also in Table 1. For energy values in kJ, the contributions were: carbohydrate [39.1 (percentage level of 2.36)] < crude fat [525 (percentage = 31.7)] < crude protein [1095 (percentage = 66.0)] with corresponding kcal values of 9.20 (2.33%) < 128 (32.4%) < 258 (65.3%). The following literature values would show that kilishi was a moderate source of fat: sheep lean meat (2.06 MJ/100g), lean pork (2.29 MJ/100g) [18]; lower than in cereals having energy range of 1.3 – 1.6 MJ/100g [19]; eight organs of guinea-fowl had metabolizable energy levels of 1.61 – 1.71 MJ/100g [20]. Protein contributed the highest energy value of 1.10 MJ/100g and 66.0% contribution was close to the energy values of 944 – 966 kJ/100g or 64.7 – 65.2% from the proteins of male and female *N. maculatus* respectively [17].

In terms of energy need, the daily energy requirement for an adult is between 2500 – 3000 kcal which depends on ones physiological state whilst it is 740 kcal in infants [21]. This translated to mean that an adult would have to consume between 634 – 760g to make up the energy range of 2,500 – 3000 kcal whilst infants would require 188g of kilishi to satisfy their energy needs. These values were lower than 733 – 880g (adults) and 220g (infants) in *A. monroviae;* 735 – 882g (adults) and 221g (infants) in *L. goreensis* [12]; in *Callinectes latimanus*, it was 915g (adults minimum) and 271 (infants) [22]; 786 – 944g (muscle) and 761 – 913 (skin) of turkey to meet adult requirements but 233g (muscle) and 325g (skin) in infants [23]. However the values of 634 – 760g were highly comparable to the values of 649 – 733 (adult man) and 188g was also highly comparable to 192g (infants) [20]. The utilizable energy due to protein (UEDP%) was high at 39.2–39.6

(assuming 60% of protein energy utilization). This is much higher than the recommended safe level of 8% for adult man that requires 55g protein per day with 60% utilization. Comparable literature values to these UEDP% were 56.4 (turkey muscle), 40.0 (turkey skin) [23]; 38.8 – 39.1 in male and female *N. maculatus* innards [17]. The UEDP% of 39.2–39.6 would be far more than enough to prevent energy malnutrition in children and adults that depend solely on kilishi as the main protein source. The sample could also be used to fortify or supplement protein deficient cereal products. The recommended PEF% from food sources is 30% of the total energy requirement [24] or the value of 35% [25] for total fat intake. The present PEF% value of 31.7–32.4 fell within the two recommended levels as shown above. It meant the consumption of kilishi would be very useful to people wishing to adopt the guidelines for a healthy diet.

As changes occur in dietary, nutritional status and age of an animal, appreciable shifts occur in the tissue compartments, water and protein levels [26]. For the efficient utilization and conservation of food within the human body, water is indispensable [27], it is because the water content of the body changes with the type of diet [28]. This important connection of water with other food substances is the fact that the biochemical basis for the relationship arises from the fact that the water deficit created by protein metabolism is about seven times that for equivalent calories of carbohydrates or fat. Therefore, in young children an increase in calories from carbohydrate causes hydration; whereas an increase in calories from proteins causes dehydration [29]. The increased output of ketones and acids that accompanies a shift to high-fat diets is associated with increased water loss that can be offset by increase in carbohydrate intake. Protein quality as well influences the degree of tissue hydration. Albanese [30] had estimated grammes of water needed for complete metabolism of 100 calories of some food substances. Food materials (protein, starch and fat) all have preformed water of 0.00 in each case; water gained by oxidation: 10.3 (protein), 13.9 (starch) and 11.9 (fat); lost in dissipating heat: 60.0 for each of the food material; water lost in excreting end products (1 calorie of protein requires 3.0ml of water for the excretion of the urea and sulphate formed from it, 1g of ash requires 65ml of water for its excretion): 300 (protein), both 0.00 in starch and fat; deficit: 350 (protein), 46 (starch) and 48 (fat). From Table 1, 258 kcal/100g energy from the kilishi protein would require 774 ml of water for complete metabolism. Hence, water deficit = 350/100 x 258 = 903ml; hence 903 – 774 = 129ml. (This is because 100 calories have water deficit of 350 ml.) This means that a lot of water (just below one litre: 903ml < 1000ml by 129ml) would always be needed for consumption in taking the diet containing kilishi.

Table-1: Proximate composition of kilishi (beef jerky meat) and energy contribution from carbohydrate, crude protein and crude fat

Proximate	Energy contribution		
Parameter	**Value (g/100g)**	**kJ/100g (% value)**	**kcal/100g (% value)**
Total ash	7.50	-	-
Moisture	11.2	-	-
Crude fibre	0.40	-	-
Carbohydrate	2.30	39.1 (2.36)	9.20 (2.33)
Crude protein	64.4	1,095 (66.0)	258 (65.3)
Crude fat	14.2	525 (31.7)	128 (32.4)
Total energy	-	1,659	395
UEDP (%)	-	39.6	39.2

UEDP = utilization of 60% of proportion of total energy due to protein percent; - = not applicable.

In Table-2, we have the mineral values and their ratios. Minerals of major significant values were (mg/100g): Fe, Zn, Ca, Mg, K, P and Na. Total minerals observed in the kilishi was 2225mg/100g. For major minerals observed in the sample, their percentage (%) values were Fe (3.88 e-1), Zn (8.23 e-1), Ca (1.33), Mg (3.67), K (44.3), P (35.1) and Na (14.4). Minerals in traces in the sample were: Cu, Mn, Pb, Se, Cd, Ni and Co whose percentage values ranged from 8.99 e-6 to 8.23 e-1. Mineral ratios of nutritional significance were Ca/P, Na/K, Ca/K, Zn/Cu, Na/Mg, Fe/Cu and [K/(Ca + Mg)]. All these significant ratios have their values in the results being less or greater than the ideal as well as not falling within the acceptable ideal range. Toxic mineral ratios in kilishi were: Fe/Pb, Ca/Pb, Zn/Cd whereas other ratios were Fe/Co and K/Co.

The various mineral contents, their percentage values and their ratios (where appropriate) were depicted in Table 2. Minerals of high content values were: mg/100g (percentage value): Mg, 81.6 (3.67), K, 985 (44.3), P, 781 (35.1) and Na, 320 (14.4) whereas moderate levels were Zn, 18.3 (8.23 e-1), Fe, 8.62 (3.88 e-1) and Ca, 29.6 (1.33). Others, such as Cu, Mn, Pb, Se, Cd, Ni and Co were in traces with percentage value range of 8.99 e-6 to 1.44 e-2. These minerals: Fe, Cu, Mn, Se, Ni and Co should be sourced from other animal protein sources when kilishi serves as the main source of animal protein. The presence of Pb, 0.0009 mg/100g (4.05 e-5%) and Cd, 0.0002 mg/100g (8.99 e-6%) showed that both minerals were at ultra-trace levels and their presence in kilishi could be an evidence of onset of pollution. Calcium is an important mineral in human nutrition being important for bone density. Calcium salts provide rigidity to the skeleton and calcium ion play many roles in most metabolic processes [31]. Nearly 99.0% of the calcium in the human body is found in the bones [32]. The recommended daily intake of calcium is about 400 – 500mg/day for adults. Compared with other minerals, calcium absorbance to the body is relatively inefficient; in general, only about 25.0% - 30.0% of dietary calcium is effectively absorbed [31]. When the amount of Ca is adequate in the diet, Fe is utilized to better advantage; this is said to be an instance of sparing action [33]. Both Fe and Ca were low in the kilishi.

Phosphorous plays an important role in the bones as well as in the cellular membranes as a component of the phospholipids building the membrane lipid bilayer. In addition, it is also a component of many intracellular compounds as nucleic acids, nucleoproteins and organic phosphates such as creatine phosphate and adenosine triphosphate. The total content of phosphorous in the human body is about 700g of which 80.0% are found in the bones, 10.9% in viscera and 9.00% in the skeleton muscle tissue [34, 32]. Deficiency of phosphorous in the body leads to muscle disorder, metabolic acidosis, encephalopathy and alteration in bone mineralization as well as in cardiac, respiratory, neurological and metabolic disorders [32]. In many publications, P is suggested to be better sources from the following: between 204 and 230 mg/100g in fish, mollusks, crustaceans, when compared to 176mg/100g in terrestrial meat [35]. Phosphorous in kilishi was much higher than the literature values.

Table-2: Mineral composition and mineral ratios of kilishi (beef jerky meat)

Mineral		**Mineral ratio**				
Parameter	**Value (mg/100g)**	**Percentage value**	**Mineral ratio**	**(Reference balance ideal)**	**Acceptable ideal range**	**Calculated mineral ratio**
Fe	8.62	3.88e-1	Ca/Mg	7.00	3 to 11	3.62e-1
Cu	0.32	1.44e-2	Ca/K	4.20	2.2 to 6.2	3.00e-2
Mn	0.0009	4.05e-5	Zn/Cu	8.00	4 to 12	58.0
Pb	0.0009	4.05e-5	Ca/P	2.60	1.5 to 3.6	3.78e-2
Zn	18.3	8.23e-1	Fe/Cu	0.90	0.2 to 1.6	27.3
Ca	29.6	1.33	Ca/Pb	84.0	126 to 168	31,456
Mg	81.6	3.67	Fe/Pb	4.40	6.60 to 8.80	27.3
K	985	44.3	Zn/Cd	500	750 to 1000	101,564
Se	0.0594	2.67e-3	Fe/Co	440	–[a]	4,660
Cd	0.0002	8.99e-6	Na/Mg	4.00	2 to 6	3.91
Ni	0.0009	4.05e-5	K/Co	2000	–[a]	532,642
P	781	35.1	K/(Ca + Mg)	2.2	–[a]	17.7
Co	0.0019	8.54e-5	Na/K	2.40	1.4 to 3.4	3.24e-1
Na	320	14.4	–[b]	–[b]	–[b]	–[b]
Total	2,225	100	–[b]	–[b]	–[b]	–[b]

–[a] = not available; –[b] = not applicable.

Potassium is primarily an intracellular cation, most part being bound to protein and with sodium influences osmotic pressure and contributes to the normal pH equilibrium [36]. Dietary lack of potassium is seldom found as both plants and animal tissues are rich sources of the mineral. In kilishi, K value was 985 mg/100g making a percentage of 44.3 of the total mineral analysed for. This showed that K was dominant quantitatively over other minerals like phosphorous, sodium and magnesium. Sodium regulates water content of the body, aids in transport of CO_2 and maintains osmotic pressure of body fluids. Magnesium repairs and improves the growth of human body, maintains blood pressure, prevents tooth decay and helps to keep bones healthy. Zinc is a part of many enzymes, required for the body immune system, having role in cell division, growth and wound healing. Selenium prevents cancer, poisonous effect of heavy metals and helps the body after vaccination [2]. Iron is one of the key minerals present in meat, it plays a vital role in human health and its deficiency causes several hinderances in the normal functioning of human body, particularly disturbs child growth and development [37]. Iron is available in a number of food stuffs and occurs in two forms like heme and non-heme iron. The former one comes from the hemoglobin and myoglobin, so it is present in animal foods only and has a high degree of bioavailability that could easily be absorbed in the intestinal lumen [38].

The mineral ratios are often more important than the individual mineral levels themselves and this had been illustrated by the following statements by Vitale et al., as quoted by Watts [8]: "Determining nutritional interrelationships is much more important than knowing minerals levels alone. From a global standpoint, although dietary deficiency is at the more serious end of the spectrum, the opposite end, dietary excess and aberrations contribute to the burden of disease". "Mild and subclinical deficiencies of nutrients outnumber overt syndromes ten to one". In the present report under discussion, calculated significant ratio values were Ca/P, Na/K, Ca/K, Ca/Mg, Zn/Cu and Fe/Cu. These mentioned mineral ratios revealed not only the important balance between these elements, but they also provide information regarding the many possible factors that may be represented by a disruption of their relationships, such as disease states, physiological and developmental factors, the effects of diet, drugs, would also predispose a person with parasympathetic dominance to certain health conditions if severe or chronic [8].

The Na/Mg had the following information – ideally there should be 4:1 ratio of sodium relative to magnesium with a range of 2 to 6 being acceptable. The sample result gave a ratio of 3.91:1 which was within the acceptable range of 2 to 6. All these following significant ratios have their values in the results being less than the ideal and also not falling within acceptable ideal range: Ca/Mg (3.62 e-1 to 1), Ca/K (3.00 e-2 : 1), Ca/P (3.78 e-2 : 1) and Na/K (3.24 e-1 : 1). Toxic mineral ratios in this result were Fe/Pb, Ca/Pb and Zn/Cd whilst additional ratios were Fe/Co and K/Co. It should be noted that Zn/Cu and [K/(Ca + Mg)] are good in nutritional discussion. Mineral ratios analyses have been very important in analysis of hair as a biochemical marker. The ratios mostly reported here were for the purpose of gathering analytical data.

The mineral safety index (MSI) values of kilishi were shown in Table 3. For easy verification of the calculation, the following information were provided: recommended adult intake (RAI), standard or table value (TV) of MSI and our calculated kilishi MSI values depicted as CV. The difference (D) between TV – CV values were shown to be high and positive for Fe, Ca, P, Mg, Cu, Se and Na with their percentage differences that ranged from 15.1 – 975, i.e. standard values were higher in those values than we calculated for kilishi within the range of 15.1 – 975%. Whereas the least difference occurred in Se (15.1%), Ca depicted the highest difference with a value of 975%. Zinc was the odd mineral out as the TV – CV = -7.22 and TV – CV/TV (%) was -21.9. This meant the MSI Zn (standard) was lower than the calculated MSI for zinc. Since standards were not available for K, Mn, Co, and Pb, their kilishi MSI were not calculated for.

In Table-3, the mineral safety index (MSI) of some minerals were depicted whose standard comparisons were available from literature. The table value (TV) MSI values were in column 3 of Table 3. The explanation of the MSI calculation could be followed thus: taking Ca as an example: the recommended adult intake (RAI, column 2 Table 3) of Ca is 1200mg, its minimum toxic dose (MTD) is 12000mg or 10 times the recommended daily average (RDA) which is equivalent to MSI of Ca. This reasoning goes for the other minerals whose MSI were determined. Only zinc had its MSI in kilishi greater than the standard value (40.2 > 33.0) thereby giving negative difference whilst others gave positive differences. The negative difference in Zn MSI was -7.22 and percentage difference of 21.9 [TV – CV/TV%)]. This meant that Zn might be overloading the consumer to the tune of 21.9%. When the $MSI_{Calculated} < MSI_{Table}$, it means such mineral would not constitute mineral overload or become toxic to the sample consumers. Furhermore, the MSI value for Cu showed that Cu might not impair the metabolism of Fe, Zn and Mn.

Table-3: Mineral safety index (MSI) of Fe, Ca, P, Mg, Zn, Se and Na of kilishi (beef jerky meat)

Mineral	RAI (mg)	TV of MSI	Kilishi (beef jerky meat)		
			Calculated (CV) MSI	TV – CV (D)	TV – CV/TV (%)
Fe	15	6.70	3.85	2.85	42.5
Ca	1200	10.0	0.2467	9.75	975
P	1200	10.0	0.6512	9.35	93.5
Mg	400	15.0	3.06	11.9	79.6
Zn	15	33.0	40.2	- 7.22	-21.9
Cu	3	33.0	3.47	29.5	95.5
Se	0.07	14.0	11.9	2.12	15.1
Na	500	4.80	3.07	1.73	36.1

CV = calculated MSI; TV = Table MSI; D = difference; RAI = recommended adult intake. No MSI standard for K, Mn, Co, and Pb.

The vitamins analyzed for in kilishi were shown in Table-4. Vitamins of significance in the sample were: retinol (A), α- tocopherol (E), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxamine (B_6) and ascorbic acid (C). With a total vitamin content of 17.0 mg/100g, highest concentrated vitamin was vitamin C (38.4%), this was followed by niacin (35.2%), third mostly concentrated was retinol (11.4%) and fourth concentrated being α- tocopherol (8.10%). The following vitamins were in traces: cholecalciferol (6.23e-4%), phylloquinone (2.00 e-1%), thiamine (2.14 e-1%), folic acid (6.29 e-2%) and cyanocobalamin (7.38e-3%).

Vitamins are a group of organic substances that function in a variety of dimensions in human body. They are generally classified into two groups on the basis of their solubility in water and fat, i.e., water soluble vitamins and fat soluble vitamins. In this report, the water soluble vitamins determined were the B-complex vitamins (thiamine, riboflavin, niacin, pantothenic acid, pyridoxamine, folic acid, cyanocobalamin) and vitamin C. Fat soluble vitamins in this report were vitamin A, D, K and E. The vitamin composition as determined in the sample can be seen in Table 4. Vitamins of significance in the samples were: in the water soluble vitamins – vitamin C was highest in both water soluble and fat soluble vitamins with a concentration of 6.53 mg/100g (38.4%) and the second water soluble vitamin of significance was niacin with a value of 5.98mg/100g (35.2%); the two significant fat soluble vitamins were vitamin A, 1.94mg/100g (11.4%) and vitamin E, 1.38mg/100g (8.10%). Vitamins greater than 0.10mg/100g which were water soluble were vitamins B_2, 2.94e-1mg/100g (1.73%), B_5, 3.85e-1mg/100g (2.65%) and B_6, 4.07e-1 (2.39%). These vitamins were in trace levels: vitamins D and K (all fat soluble). In literature, vitamins of the following meat sources were reported (beef, bacon, mutton, veal and pork) [39, 40]. Vitamins A and D were in traces in the meat sources mentioned earlier; B_1 ranged from 0.06 – 1.2mg/100g; B_2 ranged from 0.16 – 0.26mg/100g (all lower than in kilishi); B_5 ranged from 0.4 – 0.6mg/100g (values close to that in kilishi); B_9 ranged from nil – 9 µg (lower than in kilishi = 10.7µg); B_6 ranged from 0.2 – 0.4mg/100g (lower than kilishi); B_{12} ranged from nil - 2µg (closer to kilishi = 1.25µg) and vitamin C from nil – nil (much lower than in kilishi = 6.53mg/100g).

Table-4: The vitamin composition (mg/100g) of kilishi (beef jerky meat)

Vitamin	Common name	CID	Content	% content
A: Fat soluble				
A	Retinol	445354	1.94	11.4
D	Cholecalciferol	5280795	1.06e-4	6.23e-4
E	α-Tocopherol	14985	1.38	8.10
K	Phylloquinone	5280540	3.40e-2	2.00e-1
B: Water soluble				
B_1	Thiamine	1130	3.64e-2	2.14e-1
B_2	Riboflavin	493570	2.94e-1	1.73
B_3	Niacin	938	5.98	35.2
B_5	Pantothenic acid	6613	3.85e-1	2.65
B_6	Pyridoxamine	1054	4.07e-1	2.39
B_9	Folic acid	6037	1.07e-2	6.29e-2
B_{12}	Cyanocobalamin	5311498	1.25e-3	7.38e-3
C	Ascorbic acid	54670067	6.53	38.4
Grand totals	–	–	17.0	100

– = not applicable; CID = compound ID

Vitamin A is necessary for the maintenance of healthy tissues for maintaining the normal vision and eyesight. Vitamin E comes under the group of tocopherols or tocotrienols. The RDA for male (19 – 70years) is 15.0 mg per day; this is much higher than the kilishi result [41]. It's deficiency is said to be very rare; sterility in males and abortions in females, mild hemolytic anemia in newborn infants. Tissue defence mechanism against free radical damage generally involve vitamin C, vitamin E and B-carotene as the major vitamin anti-oxidants in extracellular fluids [42]. Other fat soluble vitamins in kilishi were in traces: vitamin D (1.06e-4mg/100g, 6.23e-4%) and vitamin K (3.40e-2mg/100g, 2.00e-1%).

Vitamin B_1 (3.64e-2mg/100g, 2.14e-1%) works along with other B-complex vitamins to carry out numerous chemical reactions required for the growth and maintenance of the human body. It is involved in the metabolic processes necessary for energy production to perform various body functions. Deficiency of thiamine could cause loss of appetite, fatigue, constipation, irritability and depression [2]. Vitamin B_2 (2.94e-1 mg/100g, 1.73%) is essential to release energy from the major food constituents like proteins, fats and carbohydrates. It helps in retaining good eye sight and healthy skin as well as aiding the absorption and utilization of iron. It is also required in the conversion process from tryptophan to niacin [2]. Vitamin B_2 deficient person has the accumulation of fat in the liver which resembles changes observed in the liver of chronic alcoholics. In humans with liver cirrhosis, decreased concentration of vitamin B_2 is found mostly in necrotic regions [43]. The value of vitamin B_2 in kilishi was low and would require supplementation with riboflavin-rich foods. Niacin (vitamin B_3) was high in kilishi (5.98 mg/100g, 35.2%). The term niacin has been used generally to encompass the active forms of this vitamin, nicotinic acid and nicotinamide; although estimates of niacin requirements take into account preformed niacin as well as that got as niacin equivalent in the body from tryptophan metabolism. Hence it was estimated that when 60mg of Trp is consumed by an adult, enough of Trp is oxidized to produce 1.0mg of niacin [44]. In 1980, RDA of niacin was 6.6 niacin equivalent (NE) per 1000 kcal and intake not less than basic NE had been recommended when the calorie intake is less than 2000 kcal; one NE is equivalent to 1.0 mg niacin (or 60mg Trp) [45]. The Trp level in kilishi (unpublished) was 1.02 g/100g (1020 mg/100g). This meant that kilishi would be good source of vitamin B_3 either directly or indirectly. The observed value of 5.98 mg/100g in vitamin B_3 almost doubled the values of 3.01 mg/100g (male crab) and 3.18 mg/100g (female crab) of *N. maculatus* [17]. Niacin deficiency causes the disease called pellagra which is characterized by the rough or raw skin. Other problems include memory loss, vomiting and diarrhea [2]. Vitamin B_6 value was 4.07 e-1 mg/100g (2.39%). Vitamin B_6 is a generic name used for pyridoxine, pyridoxal and pyridoxamine, the co-enzyme forms of which are pyrodixal phosphate and pyridoxamine phosphate [45]. Vitamin B_6 is needed in the synthesis of DNA bases; it is a co-enzyme in the biosynthesis of thymedine, synthesis of neurotransmitters and important in the synthesis of heme iron, i.e., a component of hemoglobin. Also, it also helps in the synthesis of niacin from tryptophan. A dietary vitamin B_6 deficiency or an increase in the thymedine requirement at a critical time during cell division could result in initial cell mutations that develop into tumor [46]. The RDAs were based on a ratio of 0.02mg of vitamin B_6 per gramme of protein consumed. From this estimate, the vitamin B_6 required to satisfy the protein composition (assuming as being main protein source) from the kilishi would be 0.02 x 64.4 = 1.29mg. The kilishi (4.07 e-1) value generally fell below the RDA standards. Vitamin B_5 had value of 3.85 e-1 mg/100g (2.65%). People require vitamin B_5 to synthesize and metabolize fats, proteins and co-enzyme A. Some functions of vitamin B_5 include: converting food into glucose; synthesis of cholesterol; forming sex and stress-related hormones and forming red blood cells. The value of 3.85e-1 mg/100g was higher than values of 0.18 – 0.81 mg/100g observed in 10 fish species of Lakshadweep Sea [47]. Recommended daily intake ranged from 1.7mg per day to 7mg per day depending on the age status [48]; the present value was far from meeting this standard. Deficiency may lead to tiredness, depression, hypoglacaemia and increased sensitivity to insulin. Vitamin B_9 was 1.07e-2mg/100g (6.29e-2%). Vitamin B_9 (folate, folic acid, folacin) has a recommended adult daily intake in the U.S of 400µg from foods or direct supplements. Present kilishi report had a value of 1.07 e-2 mg/100g (10.7µg/100g). Folic acid is essential for the body to make DNA, RNA, metabolise amino acids that are required for cell division. Not consuming enough folate can lead to folate deficiency that may result into a type of anaemia in which low numbers of large red blood cells occur. The value of 10.7 µg/100g was close to the report of Lall and Parazo [49] who reported that the average folic acid content of fish and shellfish was 0.5 - 10µg/100g in flesh. Vitamin B_{12} (cyanocobalamin) is found only in foods of animal origin; vegans (vegetarians who consume no animal products) are at risk for developing Cbl deficiency owing to suboptimal intake as vitamin B_{12} (Cbl) is essential for the synthesis of nucleic acids, erythrocytes and in the maintenance of myelin, deficiency may result in a variety of symptoms [50]. The daily human requirement is 1 µg. Value in kilishi was 1.25 e-3mg/100g (7.83e-3%) (1.25 µg/100g) which slightly overshoot the standard by 0.25e-3mg/100g. Vitamin C is active in the body either as ascorbic acid or as dehydro ascorbic acid. It plays important roles in many biochemical reactions including mixed-function oxidation involving incorporation of oxygen into the substrate [51]. The RDA of vitamin C for adults (60mg/day) maintains a body pool of 1.5g and 10mg/day is sufficient to prevent or cure scurvy [44]. The vitamin C kilishi value was low to the adult daily requirement to prevent or cure scurvy. Hence, supplements or fortification may be needed when kilishi serves as the main source of vitamin C.

CONCLUSION

Kilishi is a snack with low fat because fat is removed during preparation and the fat that remained mostly dripped off during drying. Kilishi is packed full of protein; protein consumption boosts the body metabolism. One of the ingredients used in the preparation of kilishi is garlic, garlic is very good for the heart since the antioxidant properties of allicin (found in garlic) help lower cholesterol levels. Garlic in kilishi helps regulate blood pressure and blood sugar. Carbohydrates in kilishi was very low. Kilishi demonstrated to be sources of essential minerals and vitamins. The kilishi (as a meat product) is superior to beef probably due to its materials of production.

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