

Proximate and Mineral Composition of Suya Spices Sold in Port Harcourt, Nigeria

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Abstract The essence of this study was to assess the proximate and mineral composition of *suya* spices sold at different *suya* spice depot in Port-Harcourt, Rivers State, Nigeria. One hundred and fifty (150) samples of *suya* spice were collected from three *suya* spice depot located at Rumuokoro, Woji, and Trans – Amadi, all in Port-Harcourt, Rivers State, Nigeria. Standard and established methods was used for both proximate and mineral composition. The moisture content ranged from $6.41 \pm 0.02\%$ to $10.30 \pm 0.02\%$ (Trans - Amadi), $5.55 \pm 0.05\%$ to $6.18 \pm 0.02\%$, (Rumuokoro) and 6.20 ± 0.02 to 10.19 ± 0.01 (Woji). The mineral composition of *suya* spice collected from Rumuokoro, Trans-Amadi and Woji areas of Port Harcourt, Nigeria showed that all the samples have the same proportion of Lead content (<0.002). RS1 had the highest Potassium content ($74.65 \pm 0.02\text{mg/kg}$) and Calcium content ($34.28 \pm 0.02\text{mg/kg}$). RS2 had the highest Magnesium content ($17.71 \pm 0.02\text{mg/kg}$), Sodium content ($12.17 \pm 0.01\text{mg/kg}$), Zinc content ($3.03 \pm 0.01\text{mg/kg}$) and Cadmium content ($0.87 \pm 0.01\text{mg/kg}$). RS4 had highest Copper content ($1.67 \pm 0.01\text{mg/kg}$). From the samples from Trans-Amadi area, TS2 had the highest Potassium content ($70.00 \pm 0.03\text{mg/kg}$) and Cadmium content ($0.94 \pm 0.006\text{mg/kg}$). TS3 had the highest Calcium content ($30.25 \pm 0.01\text{mg/kg}$). TS2 had the highest Magnesium content ($29.25 \pm 0.01\text{mg/kg}$). TS4 had highest Sodium content ($17.58 \pm 0.01\text{mg/kg}$), Copper content ($1.75 \pm 0.01\text{mg/kg}$) and Zinc content ($2.65 \pm 0.006\text{mg/kg}$). From the samples from Woji area, WS4 had the highest Potassium content ($72.23 \pm 0.01\text{mg/kg}$), Magnesium content ($19.11 \pm 0.02\text{mg/kg}$), Sodium content ($14.53 \pm 0.01\text{mg/kg}$), Copper content ($1.28 \pm 0.01\text{mg/kg}$) and Cadmium content ($0.81 \pm 0.01\text{mg/kg}$). WS3 had the highest Calcium content (41.15 ± 0.42). Proximate and mineral contents of *suya* spice collected from three areas within Port Harcourt metropolis demonstrates slight disparity in ash, crude protein, carbohydrate, crude fat and moisture content as well as in the minerals content. The need to provide control mechanisms and establish best practice to improve the quality and safety of spices, means more studies are needed.

Keywords Suya, Spice, Mineral, Proximate composition

1. Introduction

Suya is a spiced, barbecued, smoked or roasted meat product, prepared basically from meat of animals. In developing countries like Nigeria, protein intake has been a cause of concern and *suya* has become a major source of protein in Nigeria. *Suya* spices grow mainly in mangrove and high forest areas of South-South region and South Eastern region of Nigeria, as climbers, perennial creepers, or slim shrubs and trees and are available all seasons [1].

Suya spices are Nigerian native spices usually used on roasted meat (barbecued meat) to provide it with a distinctive wanted taste and flavor. It has its origin from the Hausas in the Northern Nigeria [2]. It is the special blend of peppers and spices that is used to make Nigerian *suya* [2].

Spices could be defined as vegetable products or mixtures thereof, without any extraneous matter that is used for flavouring, seasoning and imparting aroma to foods.

The spice consists of grinded pepper (*Capsicum* sp.), *Xylopi aethiopica*, *Piper guineense* and *Monodora myristica* [2, 3]. These spices aid in giving palatable flavor and aroma to *suya*. Though *suya* has its origin in the Northern Nigeria but, its consumption go beyond the boundaries of ethnicity, particularly amongst the influential Nigerians during their recreation and relaxation period [2].

Proximate and mineral analysis of plants, edible fruits and vegetables plays an important role in evaluating their nutritional significance [4]. As numerous medicinal plant species are also consumed as food along with their medicinal benefits, evaluating their nutritional significance can help to understand the worth of these plant species [4]. Thus, the essence of this study was to assess the proximate and mineral composition of *suya* spices sold at different *suya* spice depot in Port-Harcourt, Rivers State, Nigeria.

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2. Material and Methods

2.1. Source of Sample

Samples of *suya* spice mixture were obtained from three locations, all situated in Rivers State. The mixture is composed of ginger, garlic, West African black pepper, hot pepper and groundnut. A total of one hundred and fifty (150) samples were collected with each location having 50 samples. Samples were taken to the laboratory immediately and analysed within two hours.

2.2. Chemical Analysis

All the chemicals employed in this study were of analytical grade. The proximate configuration (ash, crude protein, moisture, crude fiber and crude fat) of *suya* spices were determined as described by AOAC methods [5]. Carbohydrates were determined by the percentage difference in sum of other proximate parameters (ash, crude protein, moisture, crude fiber and crude fat from 100) as described by Dagem *et al.* [6] and Jonathan *et al.* [2]. The mineral components were determined with Atomic Absorption Spectrophotometer according to AOAC methods [5]. The concentration in mg/kg dried wt. of Lead (Pb), Cadmium (Cd), Potassium (K), Magnesium (Mg), Sodium (Na), Copper (Cu) and Zinc (Zn) in the *suya* spices were determined (after nitric acid digestion) by means of an Atomic Absorption Spectrophotometer. The concentrated and digested samples were then aspirated and their actual concentrations obtained by referring to the calibration graph and necessary calculations.

2.3. Statistical Analysis

Data obtained from the proximate analysis and mineral composition were analyzed using the single factor analysis of variance (ANOVA). Correlation between each of the parameter from each study sites were evaluated. Also correlations between same parameters from the three study site were equally compared.

3. Results

Suya spice samples collected from Rumuokoro, Woji and Trans-Amadi areas of Port Harcourt, Nigeria, were carefully analyzed for their proximate and mineral compositions. Table 1-3 show the proximate composition of *suya* spice collected from Rumuokoro, Trans-Amadi and Woji areas of Port Harcourt, Nigeria. The samples from Rumuokoro (Table 1), RS2 had the highest moisture content ($6.27 \pm 0.06\%$). RS1 had the highest ash content ($9.0 \pm 0.1\%$). RS5 had the highest crude fibre ($13.2 \pm 0.6\%$). RS4 had the highest crude protein content ($9.4 \pm 0.8\%$) while RS3 had the highest content of crude fat ($16.5 \pm 0.4\%$) and RS5 had the highest content of carbohydrate ($12.2 \pm 0.1\%$) as shown in Table 1.

The samples from Trans-Amadi area (Table 2), TS4 had the highest moisture content ($10.30 \pm 0.02\%$), ash content ($5.18 \pm 0.006\%$) and crude fibre ($7.21 \pm 0.01\%$). TS3 had the highest crude protein content ($10.60 \pm 0.2\%$) while TS2 had the highest content of crude fat ($13.70 \pm 0.4\%$) and TS2 had the highest content of carbohydrate ($40.66 \pm 0.03\%$) as shown in Table 2.

Table 1. Proximate composition of *Suya* spice collected from Rumuokoro area of Port Harcourt, Nigeria

Parameters (%)	RS1	RS2	RS3	RS4	RS5
Moisture Content	6.10 ± 0.08	6.27 ± 0.06	5.80 ± 0.16	6.18 ± 0.02	5.55 ± 0.05
Ash Content	9.0 ± 0.1	5.34 ± 0.06	4.62 ± 0.03	4.17 ± 0.02	4.87 ± 0.03
Crude fiber	8.5 ± 2.0	6.2 ± 0.4	9.3 ± 0.4	4.3 ± 0.1	13.2 ± 0.6
Crude Protein	5.9 ± 0.3	4.8 ± 0.2	8.5 ± 1.0	9.4 ± 0.8	8.6 ± 0.4
Crude Fat	11.2 ± 0.3	10.30 ± 0.3	16.5 ± 0.4	06.2 ± 0.4	7.1 ± 0.2
Carbohydrate	6.0 ± 0.1	3.4 ± 0.64	10 ± 0.8	8.0 ± 0.1	12.2 ± 0.1

All value in this table represent the mean \pm SD (n = 2).

Key: RS1 - Rumuokoro Sample 1, RS2 - Rumuokoro Sample 2, RS3 - Rumuokoro Sample 3, RS4 - Rumuokoro Sample 4, RS5 - Rumuokoro Sample 5

Table 2. Proximate composition of *Suya* spice collected from Trans-Amadi area of Port Harcourt, Nigeria

Parameters (%)	TS1	TS2	TS3	TS4	TS5
Moisture Content	8.20 ± 0.01	7.19 ± 0.02	8.11 ± 0.02	10.30 ± 0.02	6.41 ± 0.02
Ash Content	3.61 ± 0.03	5.11 ± 0.03	4.77 ± 0.02	5.18 ± 0.006	5.05 ± 0.006
Crude Fibre	6.46 ± 0.03	6.10 ± 0.02	6.22 ± 0.02	7.21 ± 0.01	5.41 ± 0.02
Crude Protein	8.60 ± 0.2	6.10 ± 0.7	10.60 ± 0.2	7.09 ± 0.2	8.20 ± 0.3
Crude Fat	12.40 ± 0.2	13.70 ± 0.4	2.20 ± 0.3	3.80 ± 0.3	11.40 ± 0.2
Carbohydrate	10.30 ± 0.1	40.66 ± 0.03	34.23 ± 0.005	28.19 ± 0.006	30.42 ± 0.02

Key: TS1: Trans-Amadi Sample 1, TS2: Trans-Amadi Sample 2, TS3: Trans-Amadi Sample 3, TS4: Trans-Amadi Sample 4, TS5: Trans-Amadi Sample 5

From the samples from Woji area (Table 3), WS2 had the highest moisture content ($10.19 \pm 0.01\%$). WS3 had the highest ash content ($6.61 \pm 0.02\%$) and crude fibre ($7.14 \pm 0.01\%$). WS1 had the highest crude protein content ($13.80 \pm 0.6\%$) while WS4 had the highest content of crude fat ($17.10 \pm 0.4\%$) and WS5 had the highest content of carbohydrate ($16.00 \pm 0.5\%$) as shown in Table 3.

Table 4-6 show the mineral composition of suya spice collected from Rumuokoro, Trans-Amadi and Woji areas of

Port Harcourt, Nigeria. The samples from Rumuokoro area (Table 4), RS1 had the highest Potassium content ($74.65 \pm 0.02\text{mg/kg}$) and Calcium content ($34.28 \pm 0.02\text{mg/kg}$). RS2 had the highest Magnesium content ($17.71 \pm 0.02\text{mg/kg}$), Sodium content ($12.17 \pm 0.01\text{mg/kg}$), Zinc content ($3.03 \pm 0.01\text{mg/kg}$) and Cadmium content ($0.87 \pm 0.01\text{mg/kg}$). RS4 had highest Copper content ($1.67 \pm 0.01\text{mg/kg}$). All the samples have the same proportion of Lead content (<0.002) as shown in Table 4.

Table 3. Proximate composition of *Suya* spice collected from Woji area of Port Harcourt, Nigeria

Parameters (%)	WS1	WS2	WS3	WS4	WS5
Moisture Content	6.28 ± 0.03	10.19 ± 0.01	7.41 ± 0.02	6.20 ± 0.02	9.42 ± 0.02
Ash Content	4.60 ± 0.02	5.11 ± 0.03	6.61 ± 0.02	4.29 ± 0.006	6.01 ± 0.006
Crude Fibre	5.71 ± 0.02	6.11 ± 0.02	7.14 ± 0.01	6.21 ± 0.01	5.22 ± 0.02
Crude Protein	13.80 ± 0.6	6.20 ± 0.01	13.20 ± 0.3	05.30 ± 0.6	8.10 ± 0.7
Crude Fat	11.20 ± 0.3	12.20 ± 0.4	10.20 ± 0.3	17.10 ± 0.4	$09.00 \pm 0.0.3$
Carbohydrate	14.04 ± 0.7	3.40 ± 0.3	9.80 ± 0.3	3.80 ± 0.04	16.00 ± 0.5

Key: WS1: Woji Sample 1, WS2: Woji Sample 2, WS3: Woji Sample 3, WS4: Woji Sample 4, WS5: Woji Sample 5

Table 4. Mineral Content of *Suya* spice collected from Rumuokoro area of Port Harcourt, Nigeria

Minerals (mg/kg)	RS1	RS2	RS3	RS4	RS5
Potassium (K)	74.65 ± 0.02	65.08 ± 0.05	70.22 ± 0.02	62.33 ± 0.02	72.43 ± 0.03
Calcium (Ca)	34.28 ± 0.02	27.31 ± 0.05	31.15 ± 0.02	24.35 ± 0.02	32.61 ± 0.04
Magnesium (Mg)	14.76 ± 0.04	17.71 ± 0.02	11.03 ± 0.05	14.22 ± 0.04	12.12 ± 0.02
Sodium (Na)	10.52 ± 0.03	12.17 ± 0.01	9.12 ± 0.02	11.47 ± 0.02	9.27 ± 0.05
Copper (Cu)	1.52 ± 0.05	1.46 ± 0.04	1.24 ± 0.02	1.67 ± 0.01	1.46 ± 0.03
Zinc (Zn)	2.97 ± 0.02	3.03 ± 0.01	2.69 ± 0.01	2.89 ± 0.01	2.60 ± 0.16
Lead (Pb)	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.68 ± 0.01	0.87 ± 0.01	0.41 ± 0.06	0.64 ± 0.06	0.35 ± 0.06

Table 5. Mineral content of *Suya* spice collected from Trans-Amadi area of Port Harcourt, Nigeria

Minerals mg/kg	TS1	TS2	TS3	TS4	TS5
Potassium (K)	34.37 ± 0.006	70.00 ± 0.03	23.38 ± 0.02	17.26 ± 0.02	10.35 ± 0.02
Calcium (Ca)	9.37 ± 0.006	28.34 ± 0.01	30.25 ± 0.01	26.45 ± 0.01	21.20 ± 0.006
Magnesium (Mg)	4.68 ± 0.006	19.61 ± 0.02	29.25 ± 0.01	18.45 ± 0.108	6.23 ± 0.03
Sodium (Na)	09.30 ± 0.02	10.17 ± 0.01	12.22 ± 0.02	17.58 ± 0.01	13.17 ± 0.006
Copper (Cu)	1.82 ± 0.02	1.57 ± 0.02	1.42 ± 0.01	1.75 ± 0.01	0.35 ± 0.006
Zinc (Zn)	1.98 ± 0.006	2.02 ± 0.006	2.59 ± 0.02	2.65 ± 0.006	1.71 ± 0.01
Lead (Pb)	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.77 ± 0.01	0.94 ± 0.006	0.63 ± 0.02	0.55 ± 0.04	0.07 ± 0.02

Table 6. Mineral content of *Suya* spice collected from Woji area of Port Harcourt, Nigeria

Mineral Content (mg/kg)	WS1	WS2	WS3	WS4	WS5
Potassium (K)	64.15 ± 0.02	71.22 ± 0.02	69.07 ± 0.03	72.23 ± 0.01	58.43 ± 0.03
Calcium (Ca)	32.09 ± 0.01	21.47 ± 0.04	41.15 ± 0.42	24.35 ± 0.09	31.02 ± 0.03
Magnesium (Mg)	14.08 ± 0.02	12.23 ± 0.01	17.14 ± 0.01	19.11 ± 0.02	10.02 ± 0.02
Sodium (Na)	11.32 ± 0.02	10.27 ± 0.01	12.11 ± 0.02	14.53 ± 0.01	11.28 ± 0.02
Copper (Cu)	1.02 ± 0.02	1.61 ± 0.01	1.51 ± 0.02	1.28 ± 0.01	1.36 ± 0.02
Zinc (Zn)	2.53 ± 0.02	2.61 ± 0.02	2.10 ± 0.02	2.89 ± 0.01	2.91 ± 0.02
Lead (Pb)	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.53 ± 0.02	0.66 ± 0.02	0.75 ± 0.01	0.81 ± 0.01	0.44 ± 0.02

From the samples from Trans-Amadi area (Table 4), TS2 had the highest Potassium content ($70.00 \pm 0.03\text{mg/kg}$) and Cadmium content ($0.94 \pm 0.006\text{mg/kg}$). TS3 had the highest Calcium content ($30.25 \pm 0.01\text{mg/kg}$). TS2 had the highest Magnesium content ($29.25 \pm 0.01\text{mg/kg}$). TS4 had highest Sodium content ($17.58 \pm 0.01\text{mg/kg}$), Copper content ($1.75 \pm 0.01\text{mg/kg}$) and Zinc content ($2.65 \pm 0.006\text{mg/kg}$). All the samples have the same proportion of Lead content (<0.002) as shown in Table 5.

The samples from Woji area (Table 6), WS4 had the highest Potassium content ($72.23 \pm 0.01\text{mg/kg}$), Magnesium content ($19.11 \pm 0.02\text{mg/kg}$), Sodium content ($14.53 \pm 0.01\text{mg/kg}$), and Cadmium content ($0.81 \pm 0.01\text{mg/kg}$). WS2 had the highest Copper content ($1.61 \pm 0.01\text{mg/kg}$). WS3 had the highest Calcium content (41.15 ± 0.42). All the samples have the same proportion of Lead content (<0.002) as shown in Table 6.

4. Discussion

Suya is extensively used in Nigeria cooking, babecue etc, either in the prepared meal or ready to eat meal. *Suya* spice is very good seasoning due flavor and aroma it add to the meal, from the study it is good especially in minerals. It was equally observed from this study that some organisms have multiple resistance to antibiotics, this is of public health importance. The wholesomeness and safety of the consumer must therefore be given high priority.

Proximate arrangement of *suya* spice collected from three areas within Port Harcourt metropolis shows disparity in ash, crude protein, carbohydrate, crude fat and moisture content. The moisture contents of the *suya* spice samples from the three study areas, Rumuokoro, Trans – Amadi and Woji had moisture content ranging from $5.55 \pm 0.05\%$ to $6.18 \pm 0.02\%$, $6.41 \pm 0.02\%$ to $10.30 \pm 0.02\%$ and 6.20 ± 0.02 to 10.19 ± 0.01 respectively. Rumuokoro recorded the lowest of $5.55 \pm 0.05\%$ to $6.18 \pm 0.02\%$, while Trans-Amadi recorded the highest moisture content of $6.41 \pm 0.02\%$ to $10.30 \pm 0.02\%$. Moisture contents reported in this study is lower than the 35.00-39.09% reported by Ogbonna *et al.* [7] and lower than 40.17 and 57.17% obtained by Edema *et al.* [8]. It is also lower than 23.29% reported in some markets by Fakolade and Omojola [9]. The low moisture compositions of *suya* spices indicate that it is sufficiently dried to minimize microbial growth. Egbunike and Okubanjo [10] reported that intermediate moisture meats are low in moisture and are shelf-stable under tropical climates without refrigeration. Moisture composition gives meaningfully to the presence of microbes in foods [11]. Consequently, the possible reasons for high level of microbiological growth. The low moisture content makes it possible to be stored for a long period without deterioration in organoleptic quality microbial spoilage because of water activity this is in line with the work of Armand *et al.* [12].

Suya spices collected from Rumuokoro area equally recorded the lowest Crude protein of $4.8 \pm 0.2\%$ to $9.4 \pm 0.8\%$ while Trans- Amadi has 6.1 ± 0.7 to 10.6 ± 0.2 . This

correlates with the work of Shumaila and Mahpara [13]. This is also lower than the 35.10% crude protein reported by Ogbonna *et al.* [7] in *suya* spice samples from Kano road market and the 28.30% reported by Ogbonna *et al.* [7] from Baga road samples. The low protein content found in the *suya* spice is in disagreement with Egbunike and Okubanjo [10] who reported that intermediate moisture meats are low in moisture composition, which makes them to be less bulky. The protein content found in the *suya* spice in this study is far lower than the reported range of 69.8% to 72.1% by Soniran and Okubanjo [14].

In this study, the fat content was observed to be lowest at Trans - Amadi (2.20 ± 0.3 to 13.70 ± 0.4) while Woji recorded the highest of 9.0 ± 0.3 to 17.1 ± 0.1 , this collaborated with the work of Armand *et al.* [12] and Nwinuka *et al.* [15]. Fat content recorded in this study is lower than the 28.26% reported by Ogbonna *et al.* [7] and higher 2.86% ash content reported by Ogbonna *et al.* [7]. The % protein content of the samples disagreed with 31.8% reported by Abdulahi *et al.* [16]. Also the values obtained in this study for fat and ash level disagreed with that obtained in some of the markets by Abdulahi *et al.* [16] and Ogbonna *et al.* [7]. Fat content in our study were observed to fall with the range of 10.9 -29.6% reported by Venia *et al.* [17]. Increase in fat contents may be due to the effect of nutrient concentration due to moisture loss [9].

The low ash levels obtained from the *suya* spice samples disagrees with the findings of most authors [18, 19] and may not be due to the condiments used during the boiling of the meat for the *suya* production as claimed. Torres *et al.* [18] also reported that ash content at the end of storage differs significantly to that at the onset. Previous authors (18, 19) observed that heat application increases the ash contents of meat.

The mineral composition of *suya* spice collected from Rumuokoro, Trans-Amadi and Woji areas of Port Harcourt, Nigeria showed that all the samples have the same proportion of Lead content (<0.002). RS1 had the highest Potassium content ($74.65 \pm 0.02\text{mg/kg}$) and Calcium content ($34.28 \pm 0.02\text{mg/kg}$). RS2 had the highest Magnesium content ($17.71 \pm 0.02\text{mg/kg}$), Sodium content ($12.17 \pm 0.01\text{mg/kg}$), Zinc content ($3.03 \pm 0.01\text{mg/kg}$) and Cadmium content ($0.87 \pm 0.01\text{mg/kg}$). RS4 had highest Copper content ($1.67 \pm 0.01\text{mg/kg}$).

The *suya* spices collected from Trans-Amadi area showed that TS2 had the highest Potassium content ($70.00 \pm 0.03\text{mg/kg}$) and Cadmium content ($0.94 \pm 0.006\text{mg/kg}$). TS3 had the highest Calcium content ($30.25 \pm 0.01\text{mg/kg}$). TS2 had the highest Magnesium content ($29.25 \pm 0.01\text{mg/kg}$). TS4 had highest Sodium content ($17.58 \pm 0.01\text{mg/kg}$), Copper content ($1.75 \pm 0.01\text{mg/kg}$) and Zinc content ($2.65 \pm 0.006\text{mg/kg}$). The *suya* spices collected from Woji area showed WS4 had the highest Potassium content ($72.23 \pm 0.01\text{mg/kg}$), Magnesium content ($19.11 \pm 0.02\text{mg/kg}$), Sodium content ($14.53 \pm 0.01\text{mg/kg}$), and Cadmium content ($0.81 \pm 0.01\text{mg/kg}$). WS2 had the highest Copper content ($1.61 \pm 0.01\text{mg/kg}$). WS3 had the highest Calcium content

(41.15 ± 0.42).

The changes in proximate and mineral contents of suya could occur as a result of the condition of the meat employed in suya production or the handling technology. Animal status also controls its proximate contents. A diseased animal or animal which suffered severe malnutrition would not produce meat having the same nutrient as animals in good shape.

The statistical analysis result using ANOVA of single factor, showed that there was no significant difference in the proximate parameters of the sample at each study area, and there was equally no significant difference on the same parameters from the three study areas, as all the *p* – value were found to be greater than 0.005. This can be attributed to the producers as of about 95% of them are from the same ethnic group (Hausa of Northern Nigeria), and as such will have some similarity on the choice and little difference in the quantity of the various ingredient added.

5. Conclusions

Proximate and mineral contents of suya spice collected from three areas within Port Harcourt metropolis shows slight disparity in their proximate and minerals contents. The need to provide control mechanisms and establish best practice to improve the quality and safety of spices, means more studies are needed.

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