Microbiological Quality and Proximate Composition of Peanut cake (*Kulikuli*) in Nigerian Markets

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Abstract: Peanut cake (*Kulikuli*) is a groundnut-based snack that is consumed by all age range among the indigenous West African populace. It is also used as a major ingredient in poultry feed formulation. However, there is scarcity of data with regards to the microbiological quality of *Kulikuli* across Nigeria or other *Kulikuli* consuming West African states. In this study, 49 *Kulikuli* samples obtained from markets in nine districts within Nigeria were subjected to microbial and proximate analyses in order to ascertain the quality of this food material. All the samples had bacterial and fungal contamination at varying levels ranging from 4.2×10^6 to 1.0×10^7 cfu/g for bacteria, and 1.1×10^3 to 2.8×10^4 cfu/g for fungi, however, not all samples were contaminated with pathogenic Gram-negative bacteria. The contaminating enterobacteria included species of *Escherichia*, *Enterobacter*, *Salmonella*, *Shigella*, *Proteus* and *Klebsiella*. The enterobacteria gave varying haemolytic reactions. Species of *Aspergillus*, *Fusarium*, *Penicillium*, *Rhizopus* and *Trichoderma* were the fungi recovered from the samples. *Aspergillus* species were the most commonly isolated fungi and had a significantly ($P<0.05$) different relative density of 84.7% from other fungi. The data obtained for proximate composition varied from location to location. Crude protein was significantly ($P<0.05$) higher than all other parameters in the market and control samples. Crude protein and crude fat contents were significantly ($P<0.05$) higher in control samples than all market samples. Correlation analysis showed an inverse relationship between the total bacterial and fungal loads and individual proximate parameters in the *Kulikuli* samples. The data obtained in this study showed that the presence of contaminating microbes was responsible for depreciation in nutritional value in *Kulikuli*.

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1. Introduction

Peanut cake (*Kulikuli*) is a groundnut-based snack indigenous to the West African coasts. Being a snack, it is consumed by all age range but more specifically by school-age children and the middle aged. It is also used as a major ingredient in poultry feed formulation (Akano and Atanda, 1990). *Kulikuli* is usually produced from groundnut during groundnut oil extraction or otherwise, and it is simply regarded as the fried residue obtained from this process (Adebesin et al., 2001). It has been reported to be rich in protein and crude fat similar to its parent material, groundnut (Aletor and Ojelabi, 2007; Oladimeji and Kolapo, 2008).

Although peanut cake is consumed by humans across some West African states, only very few data are currently available on this food material in terms of its safety and nutritional status. Interestingly, the available data originate from Nigeria and have focused on the microbiological quality of *Kulikuli*, nutritive attributes and functional characteristics (Adebesin et al., 2001; Aletor and Ojelabi, 2007). The scarcity of data in regards to the microbiological quality of *Kulikuli* across Nigeria or other *Kulikuli* consuming West African states may be due to the fact that this product is mostly consumed by the low income populace and therefore not seen as a major food. However, Aletor and Ojelabi (2007) reported that this snack could serve as a major protein supplement since it contained high crude protein.

The enterobacteria are a large group of related bacteria that are capable of food and water contamination through faecal sources. Many of the strains and species are known to be enterotoxigenic and contribute a major quota to the many diarrheal illnesses experienced by man (Talaro and Talaro, 2002). Therefore, in the bid to enhance human health and secure food safety as well as public health enlightenment to food-borne illnesses, there is a need to evaluate the microbial load of this snack available

for human consumption in markets across Nigeria. Also, considering the fact that information obtained via questionnaire indicates that many school-age children consume this product that is known to be locally processed and under packaged, there is an urgent need to ascertain the cause of the frequent diarrheal cases reported by patients of this age group to nearby clinics after history of contact with this food. In essence, this research aims at evaluating *Kulikuli* samples obtained from various markets across Nigeria for microbial contamination and proximate changes. This will help to determine the food quality, relationship between microbial presence and count in this food and nutrient depletion, and possible associated public health risks posed by the consumption of this snack.

2. Materials and Methods

2.1 Survey and Sample collection

A survey was conducted in markets in nine districts within four agro-ecological zones of Nigeria in order to assess the microbiological quality and proximate profile of *Kulikuli* available for human consumption. The survey involved the acquisition of information (by questionnaire) from several categories of individuals that come in contact with this food product and subsequent collection of the *Kulikuli* samples for analysis. The categories of individuals included producers, traders and consumers while the agro-ecological zones (AEZ) and districts were Humid forest (HF) (Oshodi, Mile 2, Ikorodu), Derived Savannah (DS) (Abeokuta, Sagamu, Ibadan), Southern Guinea Savannah (SGS) (Minna) and Northern Guinea Savannah (NGS) (Chencheya and Kaduna Central). A total of 49 *Kulikuli* samples were collected during the survey. Forty-six of the samples were market samples while the other three were obtained from the producers at the point of production in Chencheya district. The market samples were collected from five traders in each district with the exception of Sagamu and Ibadan where *Kulikuli* from three and eight traders were sampled respectively. The producer samples were used as control samples in the proximate composition analysis.

Each sample collected from a trader or producer weighed approximately 1.5kg and was a bulk sample obtained by adding three parts each of about 500g representative sample collected from various parts of the traders' storage bags or trays. Each bulk sample was collected into a transparent *zip-lock* bag, comminuted immediately in order to reduce the particle size and stored at 4 ^{o}C prior to further analysis within 48 hours.

2.2 Bacteriological analysis of *Kulikuli* samples

Each sample was subjected to bacteriological analysis to determine the total bacterial load in consumable *Kulikuli*. The contaminating enterobacteriaceae were also determined in each sample according to the ISO Standard 7402 (1993) for Enterobacteriaceae plate count. The enterobacteria were sought for as an index of the quality of this product since it is known that some of the bacteria within this class are used as indicators of faecal contamination in food and drinks. One gram of each sample was suspended in 9ml of 2% sterile peptone water and serially diluted. Aliquots were pour-plated in triplicates on Nutrient and MacConkey agars. The nutrient agar plates were used for the Total bacterial count (TBC) in colony forming units per gram (cfu/g) while the MacConkey plates were for initial isolation of enterobacteria. Each distinct colony on MacConkey plate was picked and purified twice on MacConkey, Eosin-Methylene Blue and Salmonella-Shigella agars to ascertain morphological consistency. Plates were incubated at 37 ^{o}C for 24 hours. The purified colonies were subjected to biochemical characterization according to Cowan and Stell (1993) and Brown (2005).

A blood agar haemolytic test was conducted for all distinct colonies of contaminating enterobacteria so as to determine their virulence potential. The data obtained were reported as percentage haemolytic and non haemolytic enterobacteriaceae in each sampled location. The occurrence of each genus of Gram-negative bacteria in each sample was recorded as their relative density (*Rd*).

2.3 Mycological analysis of *Kulikuli* samples

The method of Samson et al. (1995b) was employed in the mycological analysis of each *Kulikuli* sample as a contribution to the assessment of microbial quality of the food material. Ten grams of each sample was diluted in sterile distilled water and pour-plated on Plate Count agar supplemented with 0.4g/L streptomycin sulphate and 0.2g/L chloramphenicol. The colonies on the Plate Count agar plates were counted using a digital illuminated colony counter (KA00-74A) and recorded as colony forming units per gram (cfu/g) for the Total fungal count (TFC). Each colony was transferred to freshly prepared acidified Potato Dextrose agar plates for proper identification. Plates were incubated at 31 ^{o}C for 72 hours. Fungal identification was by assessing macro- and micro-characters specific for each genus and comparing the data with descriptions and illustrations in Raper and Fennel (1965) and Samson et al. (1995a). The

distribution of contaminating fungal genera in each sample was reported as relative density (*Rd*) of each genus according to the definitions of Ezekiel et al. (2008).

2.4 Proximate analysis of *kulikuli* samples

The proximate composition of each *Kulikuli* sample was determined as an index for monitoring the product quality and deducing the possible storage duration of the food material since production till date. The parameters assessed were moisture content, crude protein, crude fat and ash content, all expressed as percentage. The samples collected from producers as described above were used as control samples. The Kjedahl, soxhlet, dry ashing and oven drying to constant weight methods of AOAC (1995) and Nielsen (2002) were followed for the analysis of crude protein, crude fat, ash and moisture contents, respectively. The pH of the samples was also determined.

2.5 Data Analysis

The One-way ANOVA test was used for comparison of means of TBC across agro-ecological zones, overall *Rd* (%) for fungal genera and means of individual nutrient profiles in the proximate analysis data. The means were separated for test of significance by the Duncan's Multiple Range Test at $P = 0.05$.

3. Results

3.1 Bacterial load in *Kulikuli* from Nigerian markets

A total of 49 *Kulikuli* samples were analyzed for total bacterial load. All the samples had bacterial contamination at varying levels. Samples from Oshodi had the highest total bacterial count (TBC) of 1.0×10^7 cfu/g while those from Sagamu had the least, 4.2×10^6 (Table 1). Generally, samples from locations within the HF had higher TBC values ($\geq8.5\times10^6$ cfu/g) resulting in a higher significant ($P<0.05$) mean TBC for HF (9.6×10^6 cfu/g) than the other AEZs excluding SGS. The mean TBC for SGS was not calculated since this AEZ had samples from only one location. The DS and NGS had the same mean TBC value of 6.3×10^6 cfu/g.

Table 1. Bacterial load and distribution of Gram-negative bacteria in *Kulikuli* sold in markets within four agro-ecological zones in Nigeria

+AEZ	Location	*TBC (cfu/g)	Relative density (*Rd*) (%) of genera of Gram-negative bacteria occurring in samples								~%Haemolytic	
			Enterobacter	*E. coli*	*Salmonella*	*Shigella*	*Proteus*	*Pseudomonas*	*Klebsiella*	*Flavobacterium*	H	nH
HF	Oshodi	1.0×10^7	---	---	25.0	75.0	---	---	---	---	100	0
	Mile 2	8.5×10^6	---	---	42.9	57.1	---	---	---	---	71.4	28.6
	Ikorodu	9.9×10^6	---	---	20.0	40.0	40.0	---	---	---	100	0
	Mean	9.6×10^{6a}										
DS	Abeokuta	5.1×10^6	28.6	14.3	7.1	28.6	---	---	21.4	---	61.5	38.5
	Sagamu	4.2×10^6	75.0	---	---	---	25.0	---	---	---	24.0	75.0
	Ibadan	7.8×10^6	---	---	12.5	12.5	12.5	62.5	---	---	50.0	50.0
	Mean	6.3×10^{6b}										
SGS	Minna	6.4×10^6	---	---	---	50.0	---	16.7	---	33.3	33.3	66.7
NGS	Chencheya	5.4×10^6	---	---	33.3	55.5	---	11.1	---	---	77.7	22.2
	Kaduna	7.1×10^6	37.5	---	12.5	12.5	---	37.5	---	---	25.0	75.0
	Mean	6.3×10^{6b}										
Overall *Rd* (%)		---	15.4	3.1	16.9	33.9	6.2	15.4	4.6	3.1	59.4	40.6

+AEZ: agroecological zones; HF: Humid Forest, DS: Derived, SGS: Southern Guinea and NGS: Northern Guinea Savannah

*TBC (cfu/g): Total bacterial count in colony forming units per gram

~% Haemolytic refers to proportion of haemolytic to non haemolytic strains of enterobacteriaceae in each location; H = Haemolytic strains, nH = non haemolytic

Mean cfu/g values in a column with different alphabets are significantly different at $P<0.05$

3.2 Incidence of Gram-negative bacteria in *Kulikuli* from Nigerian markets

A total of 63 Gram-negative bacteria belonging to 6 enterobacteria genera (*Escherichia*, *Enterobacter*, *Salmonella*, *Shigella*, *Proteus* and *Klebsiella*) and two non enterobacteria genera (*Pseudomonas* and *Flavobacterium*) were recovered from the *Kulikuli* samples (Table 1). *E. coli* and *Klebsiella* were detected only in samples collected from Abeokuta and they occurred as 14.3% and 21.4% of the total Gram-

negative bacteria in *Kulikuli* from Abeokuta, respectively. *Flavobacterium* was detected only in samples from Minna at a proportion of 33.3% of the total contaminating Gram-negative bacteria from Minna. *Shigella* was detected in relatively high proportions in samples from all locations except Sagamu where it was not detected. Similarly, *Salmonella* was present in samples from all locations except Sagamu and Minna, although at low to moderate proportions. *Proteus* was detected in samples from DS and HF while *Pseudomonas*, in samples from other AEZs excluding HF. *Enterobacter* was only recovered from samples obtained from Abeokuta, Sagamu and Kaduna central.

In terms of the overall percentage proportionate occurrence of each genus, *Shigella* had the highest *Rd* value (33.9%) while *E. coli* and *Flavobacterium* occurred the least (*Rd* =3.1%). *Salmonella* occurred as 50% of the proportion of *Shigella*. Haemolytic enterobacteria strains were detected at varying proportions in samples from all locations (Table 1). However, all enterobacteria in samples from Oshodi and Ikorodu were haemolytic while 50% of the enterobacteria in *Kulikuli* from Ibadan were haemolytic.

3.3 Fungal load in *Kulikuli* samples from Nigerian markets

All *Kulikuli* samples analyzed in this study had fungal contamination at varying levels. A total of 403 fungal isolates belonging to 5 identified genera (*Aspergillus*, *Fusarium*, *Penicillium*, *Rhizopus* and *Trichoderma*) and other unidentified genera were recovered from the analyzed samples. Samples from Ikorodu had the highest total fungal count (TFC) of 2.8×10^4 cfu/g while those from Sagamu had the least fungal load, 4.7×10^2 cfu/g (Table 2). The mean fungal load of samples from HF (1.7×10^4 cfu/g) was higher than those in other AEZs, although there was no significant (P>0.05) difference in the fungal loads across all AEZs.

Aspergillus species were recovered from samples in all locations at *Rd* >60% while *Fusarium* species were detected in samples from all locations except Mile 2. *Penicillium* species were present in samples from all locations except Mile 2, Sagamu and Minna while *Rhizopus* species occurred only in samples from Mile 2, Abeokuta, Ibadan and Kaduna central. *Trichoderma* was present in samples from Oshodi, Mile 2, Abeokuta and Kaduna central. On the overall, the incidence of *Aspergillus* species was the highest (*Rd* =84.7%) being

Table 2. Occurrence and distribution of moulds in *Kulikuli* sold in markets within four agro-ecological zones in Nigeria

			Relative density (*Rd*) (%) of fungal genera occurring in samples					
[+]AEZ	Location	[*]TFC (cfu/g)	*Aspergillus*	*Fusarium*	*Penicillium*	*Rhizopus*	*Trichoderma*	Others
HF	Oshodi	2.4×10^4	85.3	8.0	4.0	---	1.3	1.3
	Mile 2	1.1×10^3	88.2	---	---	2.9	2.9	5.8
	Ikorodu	2.8×10^4	79.2	13.0	3.9	---	---	3.9
	Mean	1.7×10^4						
DS	Abeokuta	1.5×10^3	83.8	5.4	2.7	5.4	2.7	---
	Sagamu	4.7×10^2	85.7	14.3	---	---	---	---
	Ibadan	5.2×10^3	91.6	3.8	3.1	1.5	---	---
	Mean	3.2×10^3						
SGS	Minna	2.7×10^3	95.2	4.8	---	---	---	---
NGS	Chencheya	1.3×10^3	72.7	15.2	9.1	---	---	3.0
	Kaduna	1.2×10^3	62.1	13.8	6.9	3.4	6.9	6.9
	Mean	1.2×10^3						
Overall *Rd* (%)		---	84.7^a	7.5^b	3.4^{bc}	1.3^c	1.1^c	1.9^c

[+]AEZ: agroecological zones; HF: Humid Forest, DS: Derived, SGS: Southern Guinea and NGS: Northern Guinea Savannah

[*]TFC (cfu/g): Total fungal count in colony forming units per gram

Overall *Rd* values (%) in a row with different alphabets are significantly different at P<0.05

significantly (P<0.05) higher than the proportion of all other fungal genera. *Trichoderma* occurred the least (*Rd* =1.1%) although its incidence was not significantly (P>0.05) different than the incidence of *Rhizopus* and other unidentified genera.

3.4 Proximate profile of *Kulikuli* from Nigeria

The parameters assessed in the proximate analysis of the *Kulikuli* samples varied from location to location. The mean moisture content in the market samples ranged from 6.91±1.45 to 10.41±2.53 while mean pH ranges were between 7.17±0.7 and 7.72±0.9. Crude protein was significantly (P<0.05) higher than

all other assayed parameters (crude fat, ash content and moisture contents) in all market and control samples (Fig. 1). Crude protein and crude fat contents (39.7±0.46 and 30.3±0.91 respectively) were significantly (P<0.05) higher in control samples than all market samples (Fig. 1 and 2). Samples from NGS (Chencheya and Kaduna central) and SGS (Minna) had significantly (P<0.05) higher crude protein contents than other market samples (Fig. 1 and 2). *Kulikuli* samples collected from Sagamu had the least crude protein value (26.48±0.35). Crude protein in samples from HF (28.00±2.01) and DS (28.22±2.09) were significantly (P<0.05) higher than the values obtained in samples from SGS and NGS but not significantly (P>0.05) different from control value (28.7±4.10).

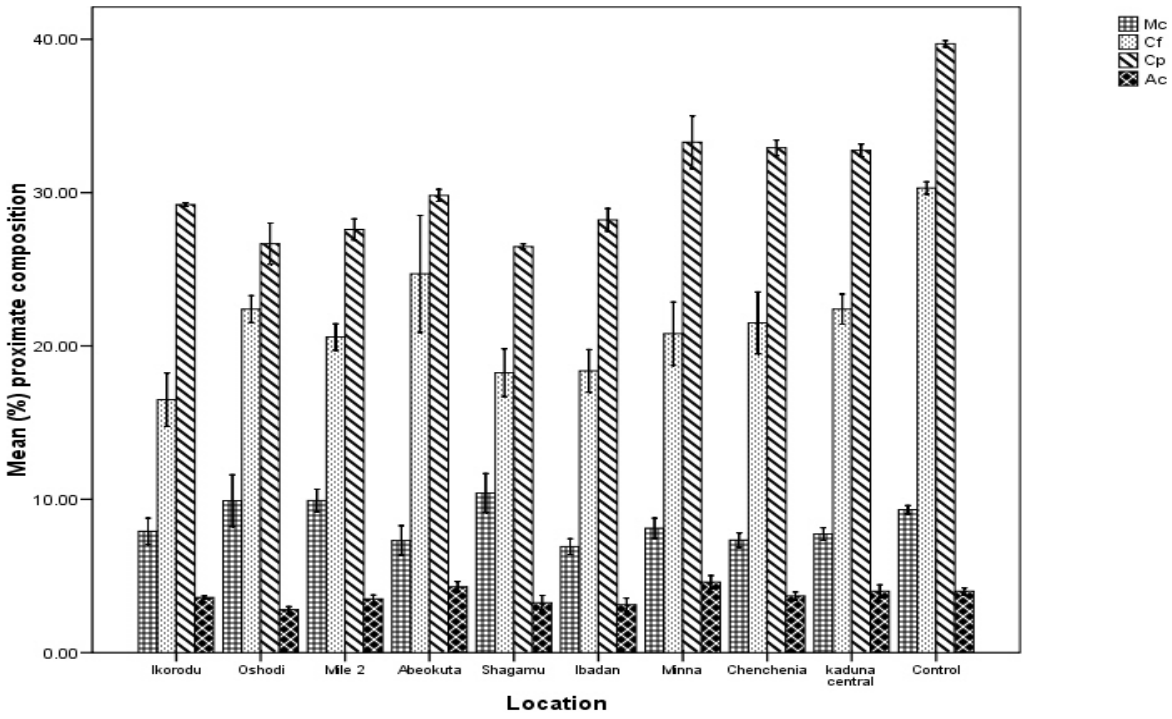

Figure 1. Proximate profile of *Kulikuli* sold in Nigerian markets
Mc: Moisture content; Cf: Crude fat; Cp: Crude protein; Ac: Ash content

Considering the crude fat analysis of samples, *Kulikuli* from Abeokuta had the highest residual crude fat (24.7±8.53) which was significantly (P<0.05) higher than crude fat in market samples from Ikorodu, Sagamu and Ibadan only (Fig. 1). From the AEZ standpoint, crude fat in *Kulikuli* samples collected from NGS (21.95±3.37) was highest but not significantly (P>0.05) different from samples in other AEZs (Fig. 2). Ash content was highest in samples from Minna (4.6±0.96) and least in those from Oshodi (2.8±0.45). No significant (P>0.05) difference was observed in the ash contents of samples across AEZs.

Correlation analysis showed an inverse relationship between the total bacteria load and individual proximate parameters in the *Kulikuli* samples. The same relationship was observed in the case of the total fungal load and individual proximate parameters in the samples. However, the relationship was higher between bacteria load and crude protein, and crude fat (r=-0.70) than the fungal load (r=-0.37). Conversely, a higher inverse relationship was observed between fungal load and ash content (r=-0.45) than bacterial load and ash content (r=-0.42).

4. Discussion

In microbial analysis of food, the number and type of microbes present in the food material under examination reflect quality of the food and extent of

risk posed to the consumers (Lund et al., 2000). In this study, the *Kuli-kuli* samples were highly contaminated with bacteria including pathogenic enterobacteria. Fungi were also recovered although in lower counts as compared to the bacterial load in the samples. Our finding in this regard is in accordance with the reports of Akano and Atanda (1990) and Adebesin et al. (2001) who evaluated the microbial load of *Kulikuli* from Bauchi, a Northern Nigerian city, and found the bacterial counts to be higher than the fungal load. They also reported *Kulikuli* to have higher microbial count than other groundnut cereal-based products. Oladimeji and Kolapo (2008) also stated that bacterial load tends to be significantly higher in food samples than fungal counts. This may be due to the fact that the generation time of bacteria is lesser than that of fungi especially moulds and also because bacteria being unicells, reproduce by binary fission unlike moulds which mostly divide after mycelia extension or spore development. The higher bacterial load in samples from Oshodi and the HF AEZ is a reflection of the number of handlers that come in contact with this food material in these locations which are highly populated as compared to other locations.

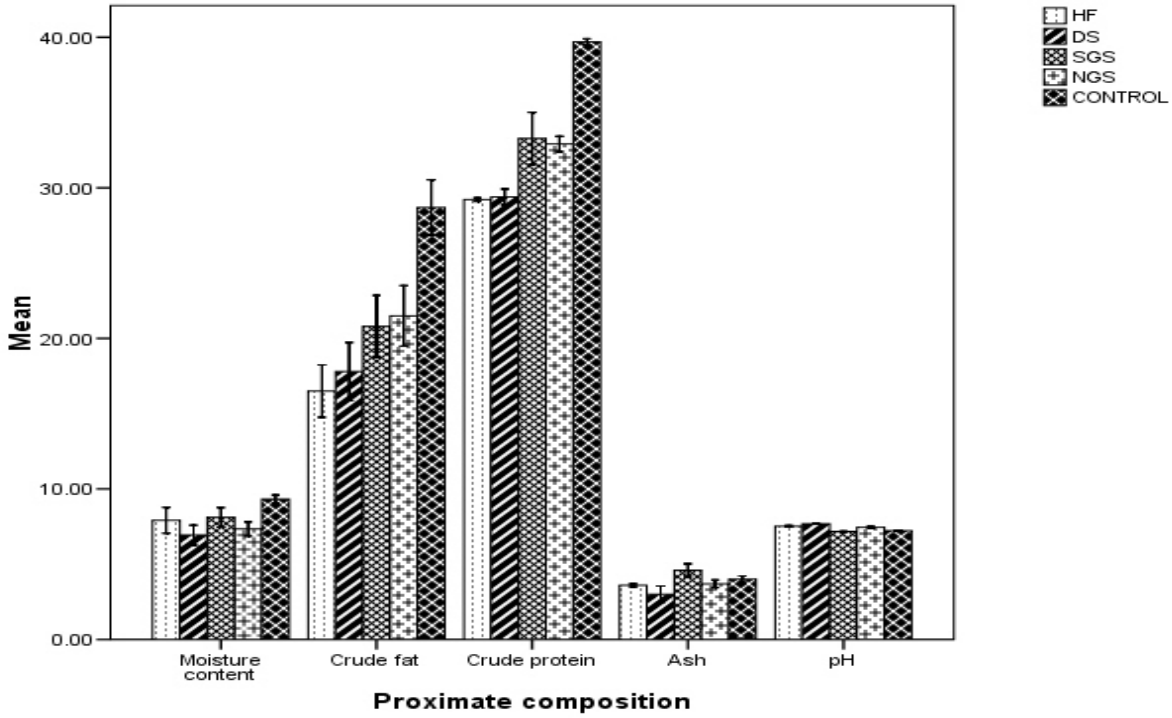

Figure 2. Comparison of proximate profile of *Kulikuli* from markets in four agro-ecological zones in Nigeria
HF: Humid Forest, DS: Derived Savannah, SGS: Southern Guinea Savannah, NGS: Northern Guinea Savannah

The occurrence of enterobacteria especially indicator bacteria such as *E. coli* and *Salmonella* in the *Kulikuli* samples obtained in markets across Nigeria is of public health importance since these culprits reflect the poor quality of this product in circulation. The indicator bacteria alongside other isolated enterobacteria such as *Shigella*, *Klebsiella* and *Proteus* have been implicated in several human infections (Collee et al., 1997; Delost 1997; Nzeako et al., 2002). *Salmonella*, *E. coli* and *Shigella* are specifically known for their potential to incite food poisoning and intoxications, some strains of which liberate enterotoxins (Lund et al., 2000; Nzeako et al., 2002; Talaro and Talaro, 2002; Adegoke, 2004; Miki et al., 2004). These bacteria are usually conveyed into food, drink or water by vectors or faecally-contaminated handlers who maintain a low level of hygiene (Lund et al., 2000; Nzeako et al., 2002). Therefore, the occurrence of these enterobacteria in *Kulikuli* samples available for human consumption in Nigeria is

alarming and poses great health hazard since their counts exceed the acceptable limits set by the International Commission on Microbiological Specification of Food (ICMSF). However, a greater risk is envisaged in Abeokuta where there was the singular isolation of *E. coli* and a high incidence of other enterobacteria than any other location. We may then infer that the producers, handlers and traders of this product in this location maintain a poor hygiene status and low sanitary standards. In addition, the occurrence of *Proteus*, *Pseudomonas* and *Klebsiella*, notable lower respiratory tract pathogens, in the *Kulikuli* samples create tension and may have resulted also from poor handling and transportation methods since it is known that this snack or roadside food is not usually well packaged and exposed to the touch of every potential buyer of this snack.

Considering the virulence of the enterobacteria in each location, it is evident that a high risk of haemorrhagic enterobacillosis is posed to the consumers of this product, majority of which are school-age children since it is well known that the haemolytic enterobacteria are usually more virulent than non-haemorrhagic strains (Finley and Falkow, 1988; Watanabe, 1988; Nowroozi and Hakemi vala, 2006). The high proportion of haemolytic enterobacteria in each location except Sagamu, Minna and Kaduna is alarming and may have contributed to the high incidence of severe gastroenteritis or other food-borne illnesses prevalent in those locations (data obtained from questionnaire analysis). The higher haemolytic incidence (%) as seen in Oshodi, Ikorodu, Chencheya and Abeokuta districts were the contributions mostly from *Shigella* and *Salmonella* species, indicating that the children who consume this snack daily may suffer or have suffered from severe shigellosis and *Salmonella* infections caused by haemolytic strains such as *Shigella dysenteriae*, *S. flexneri* and *Salmonella enterica* serovars Typhi and Paratyphi (Sharma et al., 2001; Oscarsson et al., 2002; Miki et al., 2004; Nowroozi and Hakemi vala, 2006)

The number and type of fungi recovered from the *Kulikuli* samples in this study is also of immense public health importance since some of the species are notable toxin producers while the others are mere saprophytes; inciting deterioration of the food material in their bid to adapt and survive in the microenvironment. The species of *Aspergillus, Rhizopus* and *Penicillium* isolated from our samples corroborate the findings of Adebesin et al. (2001) who reported these fungi as contaminants of *Kulikuli* alongside others which we did not recover or could not identify in this study. Gachomo et al. (2004) and Jimoh and Kolapo (2008) reported these fungi together with *Fusarium* to be the major contaminating fungi of groundnut in storage. Therefore, their occurrence in this food product may have originated from the raw groundnut used in the individual *Kulikuli* processing as well as the post-production exposure of this marketed snacks to fungal spore resident in the air. The earlier may be a minor contributor as compared to the latter (exposure of snacks in markets to air-borne fungal spores) since the fungal count was higher in markets located in the HF AEZ than other AEZs and locations. The locations within the HF are well populated than other collection sites of this snack across Nigeria.

The presence of *Aspergillus* species such as *A. flavus* and *A. niger, Fusarium* species, *Penicillium* species and *Rhizopus* in the *Kulikuli* samples pose a toxicological threat to the consumers since majority of the strains of these fungal species are toxigenic (Akano and Atanda, 1990; Jimoh and Kolapo, 2008; Makun et al., 2010). *Rhizopus* is known to liberate a metabolite rhizonin A (Wilson et al., 1984) while aflatoxins, ochratoxins, fumonisins, trichothecenes, citrinin and patulin are well produced during metabolism by the other above mentioned fungi. In 1990, Akano and Atanda reported the presence of these fungi and aflatoxins in *Kulikuli* from Ibadan, Oyo state, Nigeria after the incidence of deaths resulting from consumption of aflatoxin-contaminated foods in Nigeria.

The contaminating bacteria and fungi of the *Kulikuli* samples in this study were thus found to be involved in the utilization of the nutrients inherent in this food material. This was evident in the significant ($P< 0.05$) depreciation of the crude protein and crude fat contents of the market samples than the control samples. The high crude protein content of the control *Kulikuli* samples corroborates the reports of Aletor and Ojelabi (2007) who reported a high crude protein value of 32.4 ± 0.2 for laboratory-made *Kulikuli* and Oladimeji and Kolapo (2008) who reported a very high 39.9% crude protein content of groundnut meant for *Kulikuli* production. Although our control samples were higher in crude protein value than reports of Aletor and Ojelabi, the crude fat they reported was higher than our data. It is interesting to note that the samples from the northern regions of Nigeria (NGS and SGS) had higher protein contents than other locations. This indicates that the *Kulikuli* samples produced in the northern parts are of a higher nutritional quality and may have been from higher quality groundnut. On the other hand, it may be that the time of transportation of the snack produced in the North to the Western parts where they are sold may have contributed to the

deterioration of the samples from the South-western part (DS and HF) evidenced in the lower nutritional profiles in such samples. Since crude protein content was generally higher in all samples than all other nutrients, we may then support the fact that this snack is a very high source of protein according to Aletor and Ojelabi (2007).

The relationship between the contaminating microbes and the nutrients in the snack was inverse as seen from the high negative correlation values (> r=-0.37). When considering the data, we suggest that the bacteria contaminants may have utilized more of the proteins and fat of this food material as their sole nitrogen and carbon sources since the correlation relationship was higher for bacterial load and the nutrient profiles (r=-0.70) than the fungi (r=-0.37). Therefore the bacteria contaminant played more role in the deterioration of the *Kulikuli* samples from all markets in Nigeria than the fungi, a data supported by the significantly (P<0.05) higher bacterial load than fungal amount in all samples from all locations.

Conclusively, we have for the first time reported an extensive data on the microbial quality of peanut cake and the implication of consuming such contaminated products on human health and safety. In this study we have related the relative microbial load to the present nutritional quality of the food materials available for consumption in the markets. To this we suggest the following measures for *Kulikuli* improvement in Nigeria and other *Kuli-kuli* consuming West African countries; sourcing of high quality peanuts for *Kulikuli* production; a high level of hygiene and sanitation during production, and packaging of this snack in *zip-lock* or sealed plastic bags. Since this snack may serve as supplement to low nitrogen foods such as cereal-based snacks and foods, and tubers it is advised that *Kulikuli* be consumed within 14 days of production to avoid the consumption of nutritionally deficient food.

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