

Microbiological and Sensory Assessment of Stored 'Zogale'-A Snack Food Produced from Peanut (*Arachis hypogaea*) Cake and Boiled *Moringa oleifera* Leaves

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Abstract: The effect of boiling time on the microbiological and sensory quality of "Zogale" was determined. *Moringa* leaves were boiled for 5, 10, 15 and 20 min after which the various portions were blended with coarsely grounded peanut cake (kulikuli), in a ratio of 75 *Moringa* leaves: 25 kulikuli, giving zogale samples A, B, C and D respectively, (in line with the composition of the market sample E, which served as control). The samples were stored on the shelf (30- 34°C) and in the refrigerator (8-12°C) for 12 h., after which the microbiological and sensory properties were determined. While there was significant decrease ($p < 0.05$) in microbial load for processed samples sample E gave higher microbial load (3.2×10^5) CFU/g. There was a significant ($p < 0.05$) increase in microorganisms with ambient storage giving higher values for TVC and molds in all the samples. Sample E recorded the highest TVC values of 3.2×10^5 , 3.1×10^4 and 3.4×10^5 CFU/g and mold count of 1.8×10^2 , 2.1×10^2 and 2.6×10^2 CFU/g for fresh, refrigerated and ambient storage respectively. *Enterobacteriaceae* and *Staphylococcus* species were the predominant bacteria in the zogale products. There was a reduction in the mean sensory scores of all the attributes with storage. The fresh sample enjoyed the highest acceptability with a mean score of 4.25, followed by the refrigerated and ambient stored samples in that order, with scores of 4.15 and 3.96, respectively.

Keywords: Ambient temperature, *Arachis hypogaea*, *Moringa oleifera*, refrigeration, storage, total viable counts

INTRODUCTION

The consumption of fresh fruits and vegetables has increased because of heightened awareness of their benefits (Annon, 2007). Changes in consumption trends have led to a demand for a wider range of food products, which has culminated in an increase in the popularity of salads and other ready-to-eat fruit vegetable preparations (Abadias *et al.*, 2007).

'Zogale' is a delicious local salad-like snack food which is prepared by mixing boiled *Moringa oleifera* leaves with coarsely milled peanut cake ('Kulikuli') and some spices. It is very easy to produce and is commonly consumed by all age groups including the young, pregnant women, lactating mothers and the elderly, in the northern regions of Nigeria. It has been used by rural dwellers for centuries (Kawo *et al.*, 2009).

The drumstick tree (*Moringa oleifera*) referred to as the "miracle plant" and known as "Zogale" in Hausa, "Okwe Oyibo" in Ibo, "Ewe Ile" in Yoruba and "Jeghel-Agede" in Tiv, is common throughout the West African region. Although it has been known for long for its medicinal uses, it is of recent that, the nutritional value of the different parts of the plant are coming to

light. Almost all parts of the plant have nutritional and therapeutic value (Olusola, 2006). The raw leaves are outstanding as a source of vitamin A, B group and C (Gernah and Sengev, 2011) and are among the best plant sources of minerals (Fuglie, 2000). They are excellent sources of protein (especially when dried), but poor in carbohydrates and fats, thus making them one of the best plant foods available in nature (Olusola, 2006). They can be cooked and eaten as a vegetable like spinach (Price, 2000).

Peanut is very important in the vegetarian diet. It has as much or more protein than meat and contains no uric acid or cholesterol (Pamplona-Rogers, 2006). Peanuts are therefore a fundamental food for vegetarians. In fact, they do not cause obesity but rather aid weight loss when they are used to replace other high caloric foods in the diet (Onyeike and Oguike, 2003). And since peanuts do not contain pro-vitamin A nor vitamin C, vegetables such as *Moringa oleifera* leaves can compensate for these vitamin deficiencies.

Usually, zogale produced in the morning as a breakfast dish is not consumed completely and has to stay sometimes until late evening before it is consumed. With the highly nutritious nature of the food, it could be

a good medium for microbial growth leading to spoilage of the food, leading to microbial contamination and development of off-flavors.

The aim of this study was therefore, to assess the effect of different storage conditions on the microbiological and sensory quality of zogale.

MATERIALS AND METHODS

Procurement of raw materials: About 1.5 kg fresh tender leaves of *Moringa oleifera* were sourced from the Federal Housing Estate, North Bank, Makurdi, while about 2.0 kg of peanut (*Arachis hypogaea*) (2010 harvest), table salt, dry chili pepper, dry ginger, fresh tomatoes, fresh onions and already prepared 'zogale' product were purchased from North Bank market, Makurdi.

Material preparation:

Boiling of *Moringa* leaves: About 1.0 kg of *Moringa* leaves was washed twice in a 5.0% salt (Sodium chloride) solution made with clean tap water in order to remove grubs and other impurities. The washed leaves were then left in a colander for about 5 min to drain after which they were immersed in 2.0 L of boiling water and allowed to cook for 5, 10, 15 and 20 min. The boiled leaves were drained in colander and allowed to cool before being blended to obtain samples A, B, C and D, respectively.

Production of peanut cake ("Kulikuli"): About 0.5 kg of shelled peanuts seeds (2010 harvest) were thoroughly sorted out and cleaned of stones, bad seeds and other foreign objects. They were roasted in an aluminum saucepan and milled into a paste after which about 250 mL of boiling water was added and the dough kneaded alternately and further expressed to release oil. The De-Oiled Cake (DOC) was then cut into small pieces of about 50 g and fried in the oil already expressed until they turned a golden brown color. They were then removed and allowed to cool, giving a product locally known as "Kulikuli".

Preparation of 'Zogale' samples: Boiled *Moringa* leaves and ground kulikuli were blended to give 'zogale' samples (A, B, C and D) as earlier indicated. Peanut cake (kulikuli), dried pepper and ginger were coarsely ground in a mortar and pestle, while tomatoes and onions were sliced into thin slices. All the spices and additives were added in the same quantities to all the samples to give the desired taste. The already prepared zogale purchased from the market was used as control sample (E).

Storage studies: Zogale samples, as obtained above, were stored on the shelf ($32\pm 2^\circ\text{C}$) and in the

refrigerator ($10\pm 2^\circ\text{C}$) for 12 h. After which their microbiological and sensory properties were determined.

Analysis:

Microbiological analysis: Twenty five grams of zogale sample were immersed in 225 mL peptone saline solution (PS: 1.0 g peptone and 8.5 g sodium chloride/L) and homogenized for 2 min in a blender. Serial dilutions of the suspension were made in PS and analyzed for Total Viable Count (TVC), yeasts, moulds and *Enterobacteriaceae* using the method described by Frazier and Westhoff (2010). Evaluation of each sample was carried out by pour plate method. The dilutions were plated and incubated in triplicate at 37°C for 24 h for bacteria and at 30°C for 48 h for yeast and moulds. Nutrient agar was used for the bacterial and potato agar was used for yeast and mould count.

Sensory evaluation: Sensory evaluation of the zogale samples was carried out using the method of Iwe (2002). The panelists consisted of 20 persons from the University of Agriculture, Makurdi and Lafia. A 5-point hedonic scale (5-like extremely, 1 dislike extremely) was used to rate the sensory attributes of color, taste, mouth feel, aroma and overall acceptability of the products. Each attribute was evaluated separately. At each session each panelist judged 5 samples which were presented randomly, with fresh tap water used for mouth rinsing in between evaluations (Ihekoronye and Ngoddy, 1985).

Statistical analysis: All determinations were carried out in triplicates. Values were subjected to Analysis of Variance (ANOVA) using GENESTAT 2005 edition. Least significant differences between means were determined as outlined by Ihekoronye and Ngoddy (1985).

RESULTS AND DISCUSSION

Microbiological composition: Results of microbiological composition of Zogale samples are presented in Table 1 and 2. There was a significant ($p < 0.05$) decrease in the Total Viable Counts (TVC) of the fresh processed samples (A-D) with increase in boiling time and no mold growth, while control sample (E), which was boiled for a longer time, still had the highest TVC values of 3.2×10^5 CFU/g and showed a mould growth of 1.8×10^2 CFU/g. The very low levels of viable micro-organisms in the fresh zogale samples were expected, with the few survivors being most probably heat resistant bacteria (Ariahu *et al.*, 1999b). Beuchat (1996) reported that raw vegetables harbour pathogens like *Listeria* and *Escherichia*. Heaton and Jones (2008) also commented that consumption of

Table 1: Total viable counts and mould composition of the zogale samples (CFU/g)

Parameter		A	B	C	D	E
Fresh	TVC	3.8×10^4 _b	8.4×10^3 _c	6.8×10^3 _d	5.6×10^3 _e	3.2×10^5 _a
	Moulds	<30 _b	<30 _b	<30 _b	<30 _b	1.8×10^2 _a
Ambient storage	TVC	6.4×10^4 _b	1.2×10^4 _c	9.1×10^3 _d	8.4×10^3 _e	3.4×10^5 _a
	Moulds	11.2×10^2 _b	11.1×10^2 _c	8.0×10^2 _d	6.0×10^2 _e	12.6×10^2 _a
Refrigerated storage	TVC	9.9×10^3 _b	9.1×10^3 _c	7.9×10^3 _d	6.7×10^3 _e	3.1×10^4 _a
	Moulds	9.0×10^2 _b	7.0×10^2 _c	6.0×10^2 _d	4.0×10^2 _e	12.1×10^2 _a

Values are means of triplicate determinations; Means with the same subscripts within the same row are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

Table 2: Bacterial composition of the zogale samples (CFU/g)

Parameter		A	B	C	D	E
Fresh	<i>Enterobacteriaceae</i>	<30 _b	<30 _b	<30 _b	<30 _b	2.0×10^2 _a
	<i>Staphylococcus</i>	<30 _b	<30 _b	<30 _b	<30 _b	1.8×10^2 _a
Ambient	<i>Enterobacteriaceae</i>	5.0×10^2 _b	5.2×10^2 _c	4.3×10^2 _d	3.6×10^2 _e	8.4×10^2 _a
	<i>Staphylococcus</i>	2.0×10^2 _b	1.6×10^2 _c	1.2×10^2 _d	1.0×10^2 _e	4.6×10^2 _a
Ref. storage	<i>Enterobacteriaceae</i>	<30 _b	<30 _b	<30 _b	<30 _b	3.1×10^2 _a
	<i>Staphylococcus</i>	<30 _b	<30 _b	<30 _b	<30 _b	2.1×10^2 _a

Values are means of triplicate determinations; Means with the same subscripts within the same row are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

Table 3: Mean sensory scores for color of the stored zogale samples

Parameter	A	B	C	D	E
Fresh	4.90 ^a	4.50 ^a	4.40 ^a	3.75 ^a	2.63 ^a
Ambient storage	4.60 ^b	4.32 ^b	4.10 ^b	3.60 ^b	2.54 ^b
Refrigerated storage	4.75 ^a	4.45 ^a	4.30 ^a	3.70 ^a	2.60 ^a
LSD	0.20	0.15	0.25	0.10	0.05

Means with the same superscript within the column are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

Table 4: Mean sensory scores for taste of the stored zogale samples

Parameter	A	B	C	D	E
Fresh	4.15 ^a	4.00 ^a	3.82 ^a	3.70 ^a	2.88 ^a
Ambient storage	3.86 ^b	3.40 ^b	3.16 ^c	2.72 ^c	2.20 ^c
Refrigerated storage	4.05 ^a	3.96 ^a	3.72 ^b	3.45 ^b	2.64 ^d
LSD	0.15	0.20	0.10	0.25	0.24

Means with the same superscript within the column are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

fruits and vegetables is commonly viewed as a potential risk factor for infection with enteric pathogens. This could also be due to introduction into the food products by the handlers during blending of the leaves with the 'kulikuli'. The higher population of viable organisms in the market sample (E) could therefore, be an indication of poor hygiene during preparation since it is supposed to have been.

There was a significant ($p < 0.05$) increase in the microbiological counts of zogale samples stored at ambient temperature with ambient storage giving higher values for TVC and molds in all the samples. Here too, the control sample (E) recorded the highest TVC values of 3.2×10^5 , 3.1×10^5 and 3.4×10^5 CFU/g and mold count of 1.8×10^2 , 2.1×10^2 and 2.6×10^2 CFU/g for fresh, refrigerated and ambient storage, respectively. A similar trend was observed for bacteria as shown in Table 2. This could be due to recontamination from the atmosphere, which was also aided by the favorable

Table 5: Mean sensory scores for aroma of the stored zogale samples

Parameter	A	B	C	D	E
Fresh	4.25 ^a	4.15 ^a	4.10 ^a	3.82 ^a	2.78 ^a
Ambient storage	3.94 ^b	3.86 ^b	3.80 ^b	3.60 ^b	2.21 ^c
Refrigerated storage	4.15 ^a	4.00 ^a	3.94 ^a	3.76 ^a	2.46 ^b
LSD	0.20	0.26	0.18	0.15	0.25

Means with the same superscript within the column are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

Table 6: Mean sensory scores for general acceptability of the stored zogale samples

Parameter	A	B	C	D	E
Fresh	4.25 ^a	4.20 ^a	4.15 ^a	4.00 ^a	3.67 ^a
Ambient storage	3.96 ^b	3.84 ^b	3.78 ^b	3.48 ^b	2.72 ^b
Refrigerated storage	4.15 ^a	4.08 ^a	4.00 ^a	3.86 ^a	3.49 ^a
LSD	0.20	0.25	0.30	0.26	0.32

Means with the same superscript within the column are not significantly different ($p > 0.05$); A: Zogale (with leaves boiled for 5 min); B: Zogale (with leaves boiled for 10 min); C: Zogale (with leaves boiled for 15 min); D: Zogale (with leaves boiled for 20 min); E: Zogale purchased at north bank market (control); LSD: Least significant difference

temperature. There was however, less growth with increased boiling time. This could be due to destruction by heat and reducing pH accompanying the boiling. ICMSF (1996) reported that the optimum pH for growth of *Enterobacteriaceae* is in the range of 6.0-8.0.

This implies that Zogale should be consumed fresh as soon as it is prepared. However, if it must be stored, it should be in the refrigerator, since it will gradually deteriorate. However, the total viable counts of the zogale products were within the acceptable limits of 10^7 CFU/g as given by ICMSF (1978). The *Enterobacteriaceae* and *Staphylococcus* counts of the food products were also within ICMSF (1978) specifications of 4.0×10^2 CFU/g and 10^3 CFU/g, respectively except for the market sample (E). Ragaert *et al.* (2007) also reported that microbial counts that produce changes in the sensory quality attributes, resulting in rejection of vegetable products are in the

range of 708.0 logs CFU/g. They also averred that exceeding this microbiological limit does not always result in the occurrence of visual defects since both microbiological and physiological activity play a role in the spoilage of vegetable products.

Sensory evaluation: Table 3 to 6 presents the mean sensory scores of all the measured attributes of the Zogale samples. There was general decrease in the scores for the different attributes with increase in boiling time. While there was no significant ($p>0.05$) difference between the scores for most of the attributes for fresh samples and those stored in the refrigerator, there was significant ($p<0.05$) difference between these samples and the sample stored on the shelf under ambient conditions, with the later having the lowest scores. This is an indication that ambient storage for a long period will adversely affect the organoleptic quality of the zogale. The fresh sample scored highest in all the sensory attributes during the storage period

Though all the samples were acceptable at the end of the storage period, the fresh sample had the highest general acceptability score of 4.25, followed by the sample stored in the refrigerator (4.15) with the sample stored under ambient conditions recording the least acceptability score of 3.96.

CONCLUSION

Zogale, being a very nutritious unpackaged food, should be consumed as quickly as possible after preparation, so as to avoid microbial contamination which could cause food poisoning and deterioration in sensory properties. For the usual period of about 12 h, within which the product is consumed, the quality is still acceptable even at ambient storage. However, if a longer period of storage becomes necessary, it should be done in the refrigerator.

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