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SENSORY PROPERTIES AND STABILITY OF SELECTED FREEZE-DRIED NIGERIAN SOUPS STORED AT AMBIENT CONDITION

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ABSTRACT
African traditional soups are rich in nutrients, but their preservation by reheating after use and frozen storage reduce their nutrient qualities. Freeze drying perfectly retains food nutrients and sensory properties, but literature is sparse on its application to Nigerian soups preservation. Soups (*Ila, Ewedu, Ogbono and Kuka*) were prepared using standard recipes, freeze-dried, packaged in polyvinylchloride and stored at ambient condition for 8 weeks. Moisture, free fatty acid (FFA), peroxide value (PV), pH value, titratable acidity (TTA), viscosity, microbial counts and sensory attributes of the samples were determined at 14 days interval using standard methods. The Moisture, FFA, PV, pH, TTA and viscosity of the soups ranged from 6.33% to7.57%, 0.66 % to 1.93%, 5.94 % to 8.69%, 6.87 % to 7.10 %, 0.07 to 0.31 and 0.88 to 1.98Pa.s respectively. The ambient storage period had significant influence on the sensory attributes and stability indices of the freeze-dried soups. Freeze-drying reduced soups moisture contents by 90.0-90.8% and a profound increase was not noticed during storage. Bacterial counts of freeze-dried soups ranged from 0.0 cfu/g-5.3 cfu/g. Freeze drying drastically reduced their initial microbial loads and limited their proliferation during storage. Freeze dried soups stability cannot be guaranteed after two months storage, because of continuous increase in the PV and FFA values, which affect soup tastes and overall acceptability.

Keywords: Soups, Freeze drying, Preservation, Nutrients quality, Shelf stability

1. INTRODUCTION

Food is one of the basic necessities of life (Olusanya, 2008). It can also be regarded as any substance that provides essential nutrients required for proper functioning of human body (Wahlqvist, 2011). Traditional foods are common foods that are locally consumed in a particular community, and they contribute significantly to the wellbeing of the people living in that community (Trichopoulou, 2007). Traditional soups are indigenous soups that are adherent to a particular ethnic and cultural society. The nutritional compositions of some Nigerian traditional foods have been investigated (Amadi *et. al*., 2017), and traditional soups that are indigenous to different ethnic groups within the country have been found to be rich in micronutrient naturally which eventually prevent or reduce occurrences of some micronutrient deficiencies (Kayode *et al*., 2010; Raji *et al*., 2015).

Despite their richness in nutrients, African traditional soups preservation by reheating after use and frozen storage reduce their nutrient qualities (Raji *et al*., 2015). Dehydration plays an important role in sensory and nutrient qualities retention and it is one of the most widely used methods for fruits and vegetables preservation, which reduces their moisture contents to a level at which microbial spoilage and deterioration reactions are minimized (Krokida *et al.*, 2001). Many dehydration methods have been used for fruits and vegetable preservation, but each method has its implication on the final product qualities which include degradation of the physiologically active compounds, colour and texture (Krokida *et al.*, 2001).

Freeze drying is one of the dehydration methods that is reported to be a gentle technique which retains the biological value of raw materials, their structure, flavour, aroma and colour, and its final product can be reconstituted easily by simple addition of liquid (Jayathilakan *et al*., 2012). It is a low-temperature process which minimizes chemical alteration or food degradation that occurs during dehydration of food products (Castro *et al*., 1997). Freeze drying has been rated as the best preservation method over other dehydration methods such as air or drum drying (Hsuch *et al.* 2003) and has received utmost attention by many researchers. Li *et al*. (2004) and Yun *et al*. (2006) reported that freeze drying (FD) could be used to dry sea cucumbers with good quality attribute upon rehydration. Paakkonen and Mattila (1991) discovered that low processing temperature improved the sensory quality of dried fruits. Strawberry freeze dried at 20 °C retained better quality than when oven dried at 60 °C. Better quality products can be obtained when food are dried at lower temperature to guide against structural losses, reduction in pore size and shrinkage that occur at higher temperature (Hammami and Rene, 1997).

This research work was under taken, due to sparse literature on the application of freeze drying to Nigerian soups preservation. However, selected Nigerian soups were freeze dried with the aim of establishing the influence of ambient storage on their sensory properties and storage stability.

2. MATERIALS AND METHODS

2.1. Nigerian Soups Preparation

Ewedu (*Corchorus olitorus*),*ila* (*Hibiscus esculentus)*, *ogbono* (*Irvingia gabonensis*)*, and kuka* (*Adansonia digitata*) soups were prepared following the standard recipes described by FIIRO (2006). The recipes of the aforementioned soups were presented in Table 1 and their preparation procedures were described below:

2.2. Preparation of 'Ewedu' Soup

Fresh 'ewedu' leaves were thoroughly washed with water to remove dirt. A known quantity of water was added to the leaves before blending in a blender. The blend was poured into a clean pot and a piece of potash was added to the blend. The blend containing a piece of potash was boiled for 5 min. Melonpowder was sprinkled into the boiling mixture; the mixture was gently stirred and it was left to simmer on low heat for 5 min. Ground crayfish, locust bean, and salt were added to the mixture before heat was removed.

2.3. Preparation of 'Ogbono' Soup

Pieces of fish, meat, and onions were thoroughly washed with clean water and they were placed in a clean pot containing known quantity of water. The aforementioned items were boiled in the pot until they were cooked. The boiled meat and fish were scooped out of the pot and minced using a mincer to aid drying. The minced meat, minced fish, ground pepper, ground crayfish, periwinkles, oil, and ground 'ogbono' were added to the boiling mixture. Mixture was stirred gently and allowed to boil 5 min before inclusion of chopped vegetable and seasoning. The mixture was further allowed to simmer for 5 min before heat was removed.

2.4. Preparation of 'Ila' Soups

Fish, meat and onions were thoroughly washed and placed in a clean pot contain considerable amount of water. They were boiled until softened. The boiled meat and fish were scooped out and minced to aid drying minced. Minced meat, minced fish, ground pepper, ground crayfish, and oil were added to the boiling mixture. The boiling mixture was gently stirred and allowed to simmer for 10 min. After boiling for 10 min, chopped okro fruits and seasoning were added, and left until the okro tendered and the required consistency was reached.

2.1.4. Preparation of 'Miyan kuka' Soups

Pieces of fish, meat and onions were thoroughly washed with clean water and they were placed in a clean pot contain considerable amount of water. They were boiled for 25 min. The boiled meat, stock fish and dried fish were minced using a mincer to aid drying. The minced items were placed in a clean pot. Also, curry, ground pepper, and water were added to the mixture and it was further cooked for 20 min. *Kuka* leaves powder was also added to boiling mixture and the mixture was gently stirred. The soup was allowed to steam for 15 min before heat was removed. All the soups were left to cool and then packaged in stainless steel trays prior to freeze drying.

2.2. Freeze Drying of Soups

Freshly prepared soups (350 g) were spread in the drying trays and placed in freeze drying chamber of CRC FD-10N-50 model freeze dryer for about 12-14 h. The shelf temperature was at 25 ^{o}C, while the pressure of the drying chamber was maintained at 80 Pa during drying and the cold trap temperature was maintained at -40 ^{o}C. The samples were dehydrated until final moisture contents of 6-7% w.b. were reached. The dried soups were subsequently packaged in 0.1mm poly vynil chloride bags and stored at room temperature for 8 weeks.

2.3. Reconstitution of Freeze Dried Soups

About 100 g of each freeze dried soups was reconstituted with 721.67 ml (*ewedu*), 198.63 ml (*ogbono*), 309.14 ml (*ila*) and 336.39 ml (*kuka*) of water for 30 min (optimum rehydration time) at room temperature, as already established in their reconstitution potentials reported by Raji *et al.* (2016). The reconstituted soups were heated in a water bath (80 ^{o}C) for 2 min and kept at room temperature prior to further analysis. The quantity of water needed for the reconstitution of the freeze dried soups was calculated using the method of Davies and El-Okene (2009a) for moisture content adjustment. The quantity of distilled water stated above for each soup was determined using equation 1:

$$M = W_s \left\{ \frac{M_1 - M_2}{1 - M_1} \right\} \quad (1)$$

Where: W_s = weight of sample (g), M= weight of distilled water added (g), M_1= initial moisture content (%), M_2 = final moisture content. (%).

2.4. Storage Stability and Sensory Properties of Freeze Dried Soups

Freeze dried soups packaged in 0.1 mm poly-ethene bags were stored at room temperature (28±2°C)) for 8 weeks. Samples were collected at intervals of 2 weeks during storage and analyzed for the following: degradative changes (moisture content, free fatty, peroxide value, pH, titratable acidity and viscosity), bacteria count and sensory properties (taste, colour, aroma, consistency and overall acceptability).

2.4.1. The Moisture Content, Titratable Acidity, Free Fatty Acid and pH of the Soups

The moisture content, titratable acidity, free fatty acid and pH of the soups were determined using A.O.A.C (2005) methods.

2.4.2. Viscosity determination

The method described by Akusu and Kiin-Kabari (2013) was used to determine the viscosity of both fresh and reconstituted soups samples.

2.4.3. Total bacteria count
Conventional colony count method for the enumeration of bacteria in food was adopted as described by Jasson *et al*. (2010).

2.4.4. Sensory Evaluation of Fresh and Reconstituted Freeze Dried Soups
The sensory properties of the selected freeze dried soups (100 g per sample), kept at room temperature for eight weeks and reconstituted with a predetermined quantity of water (721.67 ml for *ewedu*, 198.63 ml for *ogbono*, 309.14ml for *ila* and 336.39ml for *kuka*) at 2 weeks interval were determined by comparing them with the freshly prepared soups. The evaluation was carried out by twenty panelists that were selected from the Staff and Students of the Kwara State University, Malete, Nigeria on the basis of interest, availability and familiarity with the soups. The panellists were orientated on the soups characteristics to check for during assessment. The samples were coded with 3-figure random numbers and presented in random order to each panelist at ambient room conditions The panelists were asked to score for colour, taste, aroma, consistency and overall acceptability using a 9-point hedonic scale, where: 1 and 9 represent dislike extremely and like extremely, respectively. Data obtained were analysed using ANOVA at p=0.05.

3. RESULTS AND DISCUSSION
3.1 Storage Stability of Freeze Dried Soups
The results of storage stability studies of the freeze dried Nigerian soups were presented in Table 2. The storage period had significant influence on all the determined stability parameters at 95% confidence level.

3.1.1 Moisture Content
The moisture contents of the freeze dried soups ranged from 6.33±0.11-7.44±0.06 % (*ewedu*), 6.92± 0.12 -8.17± 0.07% (*ila*), 6.53± 0.18-7.57± 0.09% (*ogbono*) and 6.35± 0.07 -7.28 ± 0.06% (*kuka*). Significant changes in chemical composition of the soups during storage might be attributed to water absorption capacity of the biomaterials which causes re-distribution of chemicals within a food (Akinoso and Lasisi, 2013). The moisture content of food determines their suitability to microbial attack and hence spoilage (Olusanya, 2008). Dehydration of foods is one of the most common processes used to improve food stability, since it decreases considerably with the water activity of the material, reduces microbiological activity and minimises physical and chemical changes during its storage (Mayor and Sereno, 2004). The observed low moisture contents (6.33± 0.11-8.17± 0.07%) in all the soup samples during two month storage could mean that the soups might be shelf stable for more than two months. However, there was slight increase in the moisture content of all the soup samples packaged in 0.1mm polyvinyl chloride bags as the storage period increased. Slight increase in the moisture content of the samples during storage might be attributed to water adsorption of low-moisture-content food powders from storage environment (Huaning and Benheng, 2013).Similar results were obtained by Kumar and Misha (2004) and Koç *et al*.(2010), who reported that the moisture contents of mango soy fortified yoghurt powder under accelerated storage and spray-dried yoghurt powder under 25℃ and 50% RH increased slightly in 49 days and 90 days, respectively.

3.1.2 Free Fatty Acid (FFA)
The free fatty acid contents of the freeze dried soups ranged from 0.66±0.01- 0.75± 0.02% (*ewedu*),1.15±0.01-1.22±0.02% (*ila*), 1.77±0.01-1.93±0.02% (*ogbono*) and 1.15± 0.01-1.20± 0.01% (*kuka*).The values obtained show that the free fatty acid contents of the freeze dried soups decreased with increase in storage period. The maximum allowable limit of free fatty acid value in food is 3%, according to the food sanitation law in Japan (Naohiro and Wada, 2006). The FFA values observed in this study for the freeze dried soups ranged 0.66-1.93±0.02% of oleic acid which were within the acceptable limit. Slight increase in the free fatty acid values during storage of these products at ambient temperature (28±2°C) could mean that there was slow oxidation through fatty acid hydrolysis due to the presence of moisture or other water components such as H+ and OH^- ions (Rush, *et al*. 2007). On the other hand, high concentration of free fatty acids in food products are known to generate sour, astringent, pungent, and burning bitter taste (Rush, *et al*. 2007).

3.1.3 Peroxide Value
The peroxide values of the freeze dried soups ranged from 8.18±0.18 -8.33±0.08 mEq/kg (ewedu), 5.94±0.12-6.26±0.03 mEq/kg (*ila*), 8.37±0.06-8.69±0.04 mEq/kg (*ogbono*) and 6.06± 0.05 -6.26 ± 0.01 mEq/kg (*kuka*). Increase in the peroxide values of the freeze dried soups was minimal as the storage period increased. Peroxide values in all of the samples did not rise up to 20 meq/kg, which is generally considered necessary for oily food to become rancid (Hras *et al*., 2000). Slight increase in the peroxide values depicted that limited oxidation of highly unsaturated fatty acids in soups lipids occurred in the freeze dried samples during storage, by the catalytic activity of common salt, iron impurities that are probably present in the crude salt, peroxide action of moisture and auto oxidation by atmospheric oxygen (Priyadarshini *et al*., 2012). However, the peroxide value is related to the porosity of the dried samples (Rahman *et al*, 2002). This means that porosity of the freeze dried soups might also contribute to the slight changes in PV-values of the samples as the storage time increased, since oxygen diffusion is higher for freeze dried foods characterized with high porosity (Rahman *et al*, 2002).

3.1.4 pH

The pH values of the freeze dried soups ranged from 6.87±0.06 -7.00±0.00 (*ewedu*), 6.87±0.06-7.10±0.10 (*ila*), 6.87±0.06-7.10±0.00 (*ogbono*) and 6.87±0.06-6.93±0.06 (*kuka*). The pH of the reconstituted freeze dried soups stored at ambient temperature did not change obviously. This indicates that the soups qualities were well maintained during storage, which corroborates with the observations of Gopakumar (2000) on tropical fishery products.

3.1.5 Titratable Acidity

The titratable acidity values of the freeze dried soups ranged from 0.10±0.02-0.18±0.03% (*ewedu*), 0.07±0.00-0.08±0.01% (*ila*), 0.22±0.01-0.31±0.01 % (*ogbono*) and 0.08± 0.01 -0.12±
0.01% (*kuka*). During storage, slight increase was observed in titratable acidity of all the freeze dried samples. Though there were no distinct differences in titratable acidity values of the soups during the storage period of eight weeks. From the results obtained, the low temperature (-40ºC) of the freeze drier and low moisture content of the freeze dried samples reduced deteriorative activities of enzymes and microbes that enhance spoilage (Nwanekezi and Okorie, 2005).

3.1.6 Viscosity

The titratable acidity values of the freeze dried soups ranged from1.32±0.01-1.36±0.01 Pa.s (*ewedu*), 1.72±0.01-1.78±0.01 Pa.s (*ila*), 1.86±0.01-1.98±0.01 Pa.s (*ogbono*), 0.88± 0.01-0.90±0.01 Pa.s (*kuka*). The viscosity of the soup slightly reduced as the storage period increased. This could be due to the breakdown of complex molecules by enzymes and microorganisms, which might have resulted in less viscous soluble matter, including sugars and short chain dextrins as observed by Uvere *et al*.(2002).

3.2. Effect of Storage Period on the Microbiological Quality of Freeze Dried Nigerian Soups

The soups under investigation were not contaminated with fungi; this may be due to cooking temperature (100 ^{0}C) that was able to eliminate the initial fungal population. A minimal bacterial population was recorded in the samples towards the end of the storage period. The bacterial counts ranged from 0.00±0.00 -3.67±0.58(cfu/ml x10^1) in Ewedu soup samples, 0.00±0.00-4.67±0.58 (cfu/ml x10^1) in Ogbono soup samples, 0.00±0.00 -5.33±0.58 (cfu/ml x10^1) in Ila soup samples and 0.33±0.58 -5.33±0,58 cfu/ml x10^1 in Kuka soup samples (Table 3). There was a significance difference in the bacteria population at 95% confidence level. Based on the total bacterial count of the stored freeze dried soups, it could be deduced that the freeze drying method drastically reduced the initial microbial load of the soups and limited their proliferation during storage at ambient temperature. Freeze drying had been reported to be a better preservation method over other dehydration methods such as air or drum drying (Hsuch *et al*, 2003). Dried food products are considered safe with respect to microbial hazard, and reduction of the water activity of food inhibits microbial growth but does not result in a sterile product (Sagar and Suresh, 2010). The recommended microbiological limit for food is 1.0 x 10^5cfu/g (Priyadarshini *et al.,* 2012). The bacteria counts observed in this study were far below the recommended microbiological limit, indicating that the soups can be kept in good quality beyond the eight weeks of storage.

3.3. Sensory Characteristics of the Fresh and Reconstituted Freeze Dried Soups

Table 4.48 illustrates the sensory characteristics of the product stored at ambient temperature (28±2°C). The study showed a decrease in the sensory attributes and the reduction for the sensory attributes of the soups was summarized below: *Ewedu* soup samples (the taste decreased from 8.45±0.76-6.50±0.61, the colour decreased from 8.45±0.61-6.65±0.49, the aroma varied from 8.40±0.50-6.75±0.44,the consistency decreased from 8.40±0.75-6.70±0.47 and the overall acceptability varied from 8.25±0.44-6.55±0.51), for *ila* soup samples (the taste reduced from 8.40±0.68 -6.40±0.50, the colour reduced from 8.45±0.69 - 6.20±0.52, the aroma varied from 8.05±0.94-6.40±0.50,the consistency declined from 7.90±0.97- 6.30±0.47 and the overall acceptability varied from 8.20±0.83-6.25±0.55), for *ogbono* soup samples (the taste reduced from 8.35±0.81 -6.25±0.44,the colour reduced from 8.15±0.93 -6.20±0.62,the aroma varied from 8.35±0.88-6.25±0.44,the consistency declined from 8.40±0.50-6.00±0.56 and the overall acceptability varied from 8.25±0.79 -6.05±0.61) and for *kuka* soup samples (the taste reduced from 8.45±0.69 - 6.50±0.83,the colour reduced from 8.45±0.61-5.90±0.64,the aroma varied from8.40±0.68-5.70±0.73,the consistencydeclined from 7.95±0.95 -5.65±0.59 and the overall acceptability varied from8.00±0.86 -5.60±0.50). Statistical analysis of the freeze dried soups assessed for organoleptic characteristics (taste, colour, aroma, consistency and overall acceptability) showed significant differences at $p<0.05$ in the organoleptic characteristics within the column (Table 4). Freshly prepared soups were rated significantly ($P\leq0.05$) higher than the freeze-dried soups stored at ambient temperature for 2 months and reconstituted at two weeks interval. Since the sensory characteristics are important in consumer point of view (Ghadge *et al*., 2008), the freeze dried soups are expected to possess good sensory attributes on the basis of overall acceptability. The mean score values for overall acceptability of the soups fell within the like region, but reduced as the storage period increased. This indicates that the sensory quality of the soups cannot be guaranteed after two months of storage.

4. CONCLUSION

Freeze dried soups nutrient quality, stability and their sensory attributes cannot be guaranteed after two months of storage, because of continuous increase in the PV and FFA values, and concurrent reduction in sensory properties and nutrient quality of the soups. It is recommended that laminated packages should be used for the freeze dried soups in order to limit the effect of ambient storage on their quality attributes and also extend the shelf life of the products.

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Table: 1 Recipes Used for Preparation of Soups

Ogbono	***Ewedu***	***Ila***	***Kuka***
Bitter Leaf(20g)	Leaves(120g)	Okro(fruit(640g))	Meat (1000g)
Ogbono (ground (240g))	*Egusi*(ground(40g))	Pepper(14g)	Onion (75g)
Palm oil (80ml)	Water(500ml)	*Ugwu*(200g)	Dry fish (50g)
Water (2000ml)	Crayfish(40g)	Meat(1000g)	Stockfish(500g)
Maggi (8g)	Potash(1g)	Crayfish(40g)	*Kuka* (Powder (150g))
Onion (3400g)	*Iru*(5g)	Onion(300g)	Maggi (10g)
Iru (locust beans (10g))	Salt(5g)	Salt(14g)	Salt(8g)
Fish(Smoked (310g))		Palm oil(40ml)	Curry(3g)
Meat(1000g)		Water(2000ml)	Thyme(1.4g)
Crayfish(ground (40g))		Maggie cube(8g)	Crayfish(30g)
Periwinkle(deshelled (94g))		*Iru*(locust beans(10g))	Water(2000ml)
Salt(10g)			Palm Oil(100ml)
Pepper(ground (14g))			

Adapted from FIIRO (2006)

Table 2: Storage Stability of Freeze Dried Soups

Samples	Moisture Contents(%)	Free fatty acid (%)	Peroxide value(mEq/kg)	pH	Titratable acidity(%)	Viscosity (Pa.s)
Ewedu						
0 week	6.33±0.11^{d}	0.66±0.01^{d}	8.18±0.18^{a}	6.87±0.06^{b}	0.10±0.02^{b}	1.36±0.01^{a}
2 weeks	6.57±0.07^{c}	0.68±0.01^{c}	8.21±0.16^{a}	6.87±0.06^{b}	0.11±0.01^{b}	1.34±0.01^{b}
4 weeks	7.22±0.05^{b}	0.72±0.01^{b}	8.27±0.12^{a}	6.93±0.06^{ab}	0.12±0.02^{b}	1.34±0.01^{b}
6 weeks	7.34±0.04^{ab}	0.72±0.01^{b}	8.33±0.09^{a}	6.93±0.06^{ab}	0.13±0.01^{b}	1.33±0.01^{bc}
8 weeks	7.44±0.06^{a}	0.75±0.02^{a}	8.33±0.08^{a}	7.00±0.00^{a}	0.18±0.03^{a}	1.32±0.01^{c}
Ila						
0 week	6.92±0.12^{c}	1.15±0.01^{c}	5.94±0.12^{c}	6.87±0.06^{b}	0.07±0.00^{c}	1.78±0.01^{c}
2 weeks	7.27±0.58^{bc}	1.17±0.01^{c}	6.01±0.08^{bc}	6.87±0.06^{b}	0.08±0.00^{c}	1.76±0.01^{bc}
4 weeks	7.36±0.02^{bc}	1.19±0.01^{b}	6.12±0.07^{ab}	6.93±0.06^{b}	0.08±0.00^{c}	1.75±0.01^{bc}
6 weeks	7.70±0.04^{ab}	1.21±0.02^{ab}	6.15±0.05^{a}	6.93±0.01^{b}	0.08±0.00^{b}	1.73±0.01^{ab}
8 weeks	8.17±0.07^{a}	1.22±0.02^{a}	6.26±0.03^{a}	7.10±0.10^{a}	0.08±0.01^{a}	1.72±0.01^{a}
Ogbono						
0 week	6.53±0.18^{b}	1.77±0.01^{c}	8.37±0.06^{c}	6.87±0.06^{b}	0.22±0.01^{d}	1.98±0.01^{a}
2 weeks	6.60±0.17^{b}	1.80±0.02^{c}	8.43±0.05^{bc}	6.87±0.06^{b}	0.24±0.01^{cd}	1.96±0.01^{ab}
4 weeks	6.76±0.08^{b}	1.84±0.03^{b}	8.43±0.04^{bc}	6.93±0.06^{b}	0.24±0.01^{c}	1.95±0.01^{b}
6 weeks	7.33±0.11^{a}	1.86±0.01^{b}	8.51±0.06^{b}	6.90±0.00^{b}	0.26±0.01^{b}	1.90±0.01^{c}
8 weeks	7.57±0.09^{a}	1.93±0.02^{a}	8.69±0.04^{a}	7.10±0.00^{a}	0.31±0.01^{a}	1.86±0.01^{d}
Kuka						
0 week	6.35±0.07^{e}	1.15±0.01^{d}	6.06±0.05^{c}	6.87±0.06^{a}	0.08±0.01^{c}	0.88±0.01^{c}
2 weeks	6.56±0.11^{d}	1.16±0.01^{cd}	6.12±0.04^{b}	6.90±0.10^{a}	0.08±0.01^{c}	0.89±0.00^{b}
4 weeks	6.77±0.10^{c}	1.17±0.01^{c}	6.13±0.02^{b}	6.87±0.06^{a}	0.10±0.01^{b}	0.88±0.00^{b}
6 weeks	6.94±0.05^{b}	1.19±0.01^{b}	6.24±0.01^{a}	6.93±0.06^{a}	0.11±0.01^{a}	0.90±0.01^{a}
8 weeks	7.28±0.06^{a}	1.20±0.01^{a}	6.26±0.01^{a}	6.87±0.06^{a}	0.12±0.01^{a}	0.89±0.01a

Mean values having different superscripts within a column are significantly different ($p<0.05$)

Table 3: Bacterial Examination of the Freeze Dried Nigerian Soups

Weeks	*Ewedu* soup (cfu/ml)x10^{1}	*Ila* soup (cfu/ml)x10^{1}	*Ogbono* soup (cfu/ml)x10^{1}	*Kuka* soup (cfu/ml)x10^{1}
0	0.00±0.00^{d}	0.00±0.00^{c}	0.00±0.00^{d}	0.33±0.58^{d}
2	0.00±0.00^{d}	0.67±0.58^{c}	0.33±0.58^{d}	2.00±0.58^{c}
4	1.33±0.58^{c}	3.33±0.58^{b}	2.33±0.58^{c}	2.67±0.58^{c}
6	2.33±0.58^{b}	3.67±0.58^{b}	3.33±0.58^{b}	4.33±0.58^{b}
8	3.67±0.58^{a}	4.67±0.58^{a}	5.33±0.58^{a}	5.33±0.58^{a}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

Table 4: Sensory Characteristics of the Fresh and Reconstituted Freeze Dried Soups Stored at Ambient Temperature

Samples	Taste	Colour	Aroma	Consistency	Acceptability
Ewedu					
Freshly prepared	8.45±0.76^{a}	8.45±0.61^{a}	8.40±0.50^{a}	8.40±0.75^{a}	7.55±0.51^{b}
Freshly dried	7.75±0.64^{b}	7.80±0.70^{b}	7.45±0.89^{b}	7.65±0.59^{b}	8.25±0.44^{a}
Dried & stored for 2 weeks	7.50±0.61^{bc}	7.50±0.51^{b}	7.45±0.61^{b}	7.50±0.51^{bc}	7.45±0.51^{b}
Dried & stored for 4 weeks	7.10±0.64^{cd}	7.10±0.45^{c}	7.10±0.64^{bc}	7.35±0.67^{bc}	7.30±0.47^{bc}
Dried & stored for 6 weeks	7.00±0.56^{d}	6.85±0.37^{cd}	7.05±0.51^{bc}	7.15±0.37^{c}	7.10±0.45^{c}
Dried & stored for 8 weeks	6.50±0.61^{e}	6.65±0.49^{d}	6.75±0.44^{c}	6.70±0.47^{d}	6.55±0.51^{d}
Ila					
Freshly prepared	8.40±0.68^{a}	8.45±0.69^{a}	8.05±0.94^{a}	7.90±0.97^{a}	8.20±0.83^{a}
Freshly dried	7.65±0.81^{b}	7.65±0.67^{b}	7.45±0.89^{b}	7.40±0.75^{b}	7.50±0.61^{b}
Dried & stored for 2 weeks	7.05±0.61^{c}	6.85±0.59^{c}	6.95±0.61^{c}	7.00±0.56^{bc}	6.90±0.45^{c}
Dried & stored for 4 weeks	6.75±0.64^{cd}	6.80±0.41^{c}	6.80±0.41^{cd}	6.55±0.61^{d}	6.90±0.31^{c}
Dried & stored for 6 weeks	6.55±0.51^{d}	6.35±0.49^{d}	6.35±0.49^{e}	6.60±0.50^{cd}	6.25±0.44^{d}
Dried & stored for 8 weeks	6.40±0.50^{d}	6.20±0.52^{d}	6.40±0.50d^{e}	6.30±0.47^{d}	6.25±0.55^{d}
Ogbono					
Freshly prepared	8.35±0.81^{a}	8.15±0.93^{a}	8.35±0.88^{a}	8.40±0.50^{a}	8.25±0.79^{a}
Freshly dried	7.20±0.77^{b}	7.60±0.68^{b}	7.50±0.83^{b}	7.40±0.75^{b}	7.55±0.61^{b}
Dried & stored for 2 weeks	6.60±0.50^{c}	7.20±0.62^{b}	6.95±0.61^{c}	7.35±0.67^{b}	7.00±0.56^{c}
Dried & stored for 4 weeks	6.30±0.47^{cd}	6.70±0.47^{c}	6.60±0.50^{cd}	6.80±0.41^{c}	6.65±0.49^{cd}
Dried & stored for 6 weeks	6.15±0.37^{d}	6.40±0.68^{cd}	6.40±0.50^{d}	6.65±0.49^{c}	6.50±0.61^{d}
Dried & stored for 8 weeks	6.25±0.44^{cd}	6.20±0.62^{d}	6.25±0.44^{d}	6.00±0.56^{d}	6.05±0.61^{e}
Kuka					
Freshly prepared	8.45±0.69^{a}	8.45±0.61^{a}	8.40±0.68^{a}	7.95±0.95^{a}	8.00±0.86^{a}
Freshly dried	7.65±0.99^{b}	7.75±1.07^{b}	7.50±0.51^{b}	7.60±0.82^{a}	7.65±0.59^{ab}
Dried & stored for 2 weeks	6.90±1.07^{c}	6.90±0.85^{c}	6.90±0.72^{c}	6.85±0.67^{b}	7.30±0.73^{b}
Dried & stored for 4 weeks	6.80±1.01^{cd}	6.90±0.85^{c}	6.60±0.68^{c}	6.55±0.51^{bc}	6.60±0.60^{c}
Dried and stored for 6 weeks	6.30±0.66^{d}	6.55±1.00^{c}	6.00±0.80^{d}	6.25±0.64^{c}	6.20±0.70^{c}
Dried and stored for 8 weeks	5.50±0.83^{e}	5.90±0.64^{d}	5.70±0.73^{d}	5.65±0.59^{d}	5.60±0.50^{d}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

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