SENSORY PROFILING OF *OGBONO* SOUP MIX AND ITS NUTRITIONAL CHARACTERISATION

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Abstract
The study formulated ready-to-cook soup mix samples from dika kernel (Irvingia wombolu) and some dried ingredients. The samples were prepared into ogbono soup and sensory evaluation was conducted for product acceptability. The acceptable soup mix, dika kernel and the dried ingredients were subjected to proximate, microbial, and mineral analyses using standard methods. Data obtained showed that the ogbono soup prepared from the acceptable ready-to-cook soup mix was rated "very good" for flavour, colour and taste and was rated "excellent" for drawability. The soup samples were not significantly ($p > 0.05$) different from each other in appearance, colour, taste and drawability. The variations in the type and quantity of pepper used affected the attributes of the soup. The addition of ingredients to the dika kernel increased the ash (by 70%), protein (by 66%) and some mineral content (Ca, K and Na) of the ready-to-cook soup mix. The results of the microbial analysis of the ready-to-cook soup mix showed a bacteria load of 7.7×10^3 cfu/g and yeast/mould of 19.4×10^3 cfu/g. The study provided information on the nutritional composition of dika kernel (Irvingia wombolu), the soup ingredients and the ready-to-cook soup mix. The study has also provided information on the sensory characteristics of acceptable ogbono soup prepared from the ready-to-cook soup mix.

Keywords: Dika kernel, *ogbono* soup, *Irvingia wombolu*, acceptability, nutrient composition

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1. INTRODUCTION

Bush (wild) mango or dika tree is a plant that grows freely in the tropical rainforests of East, West and Central Africa and in the lower region of the Middle Belt (Nzekwe *et al.*, 2005). They are of different varieties, but the highly extensively utilised ones are *Irvingia gabonensis* (sweet flesh mesocarp) and *Irvingia wombolu* (non-edible flesh). The fruits of *I. wombolu* are usually purchased for their kernels, which is used in its fresh or dried form to add flavour and consistency to many dishes. The draw soup made from the kernel is known as "ogbono" in Ibo or "apon" in Yoruba (Ladipo *et al.*, 1996). *Ogbono* soup is a special delicacy, commonly eaten in the Southern part of Nigeria. Traditionally, leafy vegetables, dry fish, chilli peppers, crayfish, bush meat and other assorted meat are used in preparing the soup, but the final form of the soup depends on the recipe adopted, seasoning, condiments added and method of preparation (Wright, 2011).

Several recipes of *ogbono* soup from *I. gabonensis* have been reported with some added ingredients like okra, ground tomatoes, onion and bitter leaf (Oladimeji, 2007; Bamidele *et al.*, 2015). However, *I. wombolu* is known for its better drawability (Atangana *et al.*, 2001) and are preferred in preparing the soup. *Okra* is a slimy food, but some people do not consume it for personal reasons. Traditionally, tomatoes and onions are not added to the soup because tomato reduces drawability and onion give the soup a darker colour, so there is a need to produce *ogbono* soup with a better characteristic. Bitter leaf (*Vernonia amygdalin*) has astringent characteristics and may add bitter taste to the soup, but *ugwu* (*Telfaria occidentalis*) is a well-known traditional leaf rich in nutrients, and acceptable to many people. Despite all the studies on dika kernel, information on the recipe acceptability and nutritional characteristics of the soup ingredients is scanty, until this study.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Collection of materials

Dika (*Irvingia wombolu*) fruits were obtained from Agbeonu-Obey farm, near Ile-Ife, Nigeria. The variety was identified by its mesocarp and season of harvest, and was confirmed at the Herbarium, Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria. All the ingredients were purchased from a local market in Ile-Ife. The media and chemical reagents used were of analytical purity, purchased from approved distributors, and collected from the Department of Microbiology and the Department of Food Science and Technology, Obafemi Awolowo University.

2.1.2 Preparation of materials

The dika kernel was removed from the fruit, skinned, and sorted to remove unwanted materials. The kernels, dried fish, crayfish, stock fish, and pepper were sun dried to about 8 ± 2% moisture content. Samples were milled using a laboratory mill (3303, Sweden), packed separately in plastic bags and placed in a desiccator for further use and analysis.

2.2 Formulation of an acceptable ready-to-cook *ogbono* soup mix

The soup mix was formulated using the modified method of Oladimeji, 2007 (Table 1). The percentage of dika kernel and the quantity/type of pepper (*Capsicum annuum* and/or *Capsicum chinense*) were changed. The soup was prepared using the modified method of Akusu and Kiin-Kabari (2013). Fresh *ugwu* leaves were shredded, cleaned and washed. The dried and stock fish were washed and gently cooked for a softer texture. The kernel powder was added to heated palm oil (90℃) and stirred to avoid lumps. The water (25℃) was added to the mixture gradually and stirred until a smooth paste was formed. Ground crayfish, dried fish, stock fish and ground pepper were added and allowed to cook for 10 min. *Ugwu* leaves, seasoning cube and salt were added and the soup steamed for another three minutes. Finally, the soup was ready for consumption.

2.3 Sensory evaluation of the soup prepared from the formulated ready-to-cook soup mix

Panels of 17 judges (regular consumers of *ogbono* soup) were selected for the perceived characteristics and multiple comparison tests of the samples. The panellists were Nigerians and Cameroonian. Each panellist evaluated the samples on a scale of 1 (unacceptable) to 7 (excellent) for appearance, colour, taste, and drawability. The panellists also ranked the samples in their order of preference. The most preferred recipe was selected for further analysis.

2.4 Methods of analysis used to evaluate the soup ingredients and the acceptable ready-to-cook mix

Table 1: *Ogbono* soup recipe (% w/w)

Ingredient	F_1	F_2	F_3	F_4
Ground *ogbono*	12.0	12.0	11.0	11.0
Water (distilled)	75.0	75.0	75.0	75.0
Palm oil	4.0	4.0	4.0	4.0
Stock fish	1.5	1.5	1.5	1.5
Dried fish	3.0	3.0	3.0	3.0
Ugwu leaves	2.0	2.0	2.0	2.0
Shombo pepper	1.0	0.0	2.0	0.0
Scotch bonnet (scent/Cameroon) pepper	0.0	1.0	0.0	2.0
Ground crayfish	1.0	1.0	1.0	1.0
Seasoning cubes	0.2	0.2	0.2	0.2
Salt	0.3	0.3	0.3	0.3

Source: Modified Oladimeji (2007) (after a preliminary study)

Legend: F1 is the Modified Oladimeji Recipe. F2, F3, F4 are various formulations of *ogbono* soup

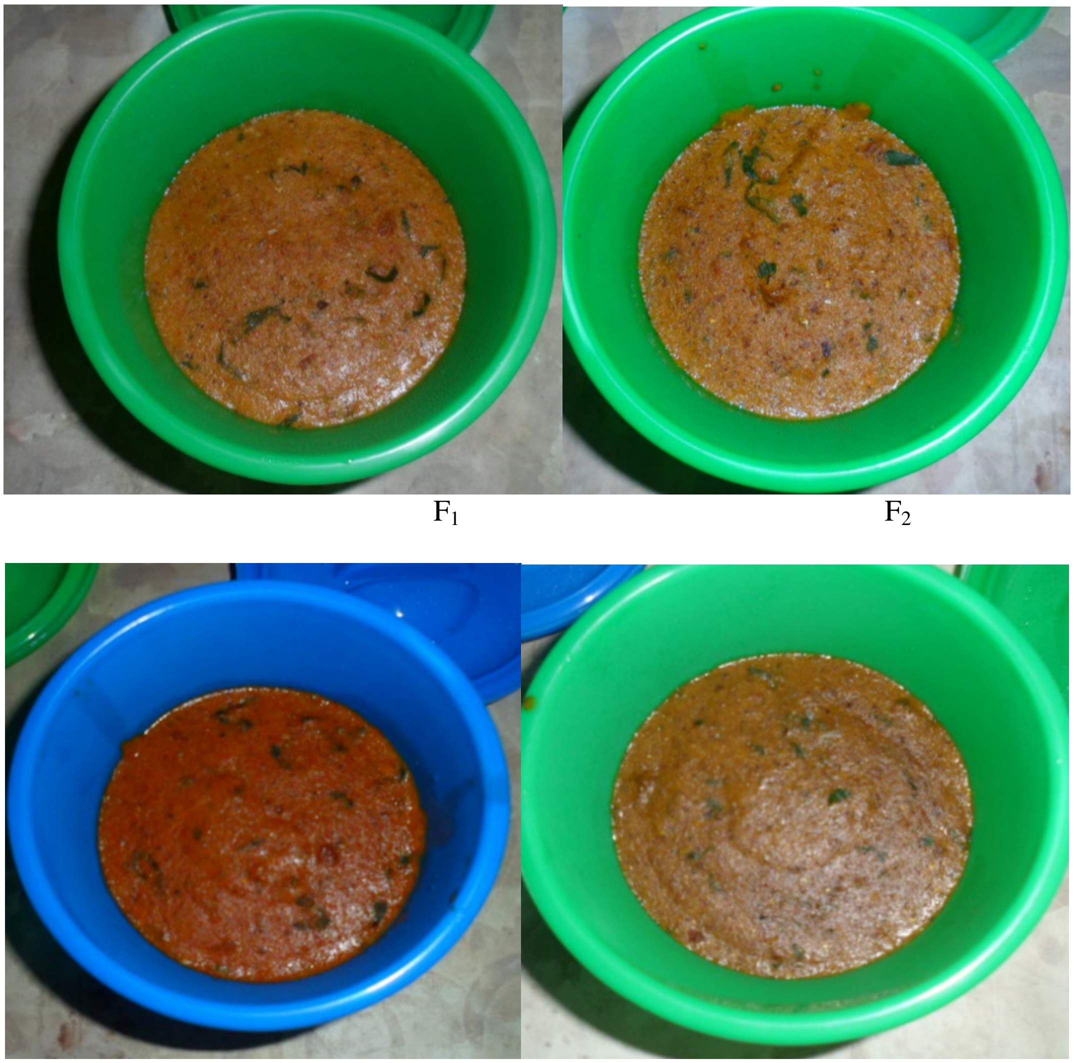
2.4.1 Proximate analysis
The moisture content of the dika kernel was determined according to ASAE (2003) and AOAC (2006). The moisture content, total ash, crude protein, crude fat, and crude fibre of other samples were analysed (AOAC, 2006) and carbohydrates were obtained by percentage difference.
2.4.2 Microbiological analysis
For each analysis, one gramme of each sample was weighed into 9 ml of already prepared Maximum Recovery Diluent, and then serially diluted up to 10^{-6}. The total viable count (TVC) and the yeast/mould count (YMC) were carried out using pour plate technique (Harrigan and McCance, 1976). After incubation in each case, the numbers of visible colonies were multiplied by the reciprocal of the dilution factor and the counts were expressed as colony forming unit per gramme ($cfug^{-1}$).
2.4.3 Mineral content analysis
The analyses for essential minerals (iron, calcium, magnesium, potassium and sodium) were determined using the method of Fashakin *et al.* (1991) with slight modification. The digested samples were analysed for iron, calcium, and magnesium using Atomic Absorption Spectrophotometer (AAS, BUCK Scientific 210) at 248 nm, 420 nm, and 285 nm absorbance wavelengths respectively, while potassium and sodium were analysed using Flame Photometer (Corning 400). All the determinations were carried out in triplicates.
2.4.3 Statistical Analysis
The experiments were carried out in three replicates. The mean values of the proximate, microbial, mineral and sensory data were subjected to analysis of variance, followed by mean separation using Duncan multiple range tests (SPSS, 2011) and Scheffe multiple comparison tests (Stata, 2013) at a significant level of 0.05.

3. RESULTS AND DISCUSSION

3.1 Sensory assessment of *ogbono* soup
The average means of the sensory parameters observed are presented in Table 2a. The values were 5.08 (appearance), 5.02 (colour), 5.02 (taste) and 5.23 (drawability). The samples were not significantly $(p > 0.05)$ different from each other in all the attributes tested. However, a larger sample size may lead to statistical significance in the colour, since the probability of the difference in colour between the groups was 0.048. Further statistical tests showed a colour difference among sample F_4 [11% dika kernel with 2% scent pepper (*C. chinense*)], F_1 [12% dika kernel with 1% s*hombo* pepper (*C. annuum*)], and F_3 (11% dika kernel with 2% *shombo* pepper), but not significantly $(p > 0.05)$ difference from F_2 (12% dika kernel and 1% scent pepper). All the formulated soup samples are shown in Fig. 1.
The dark colour of sample F_4 may be the result of the dark colour of the scent pepper (from the traditional smoking process) reflecting on the soup. Sample F_3 had the highest score in appearance (5.40), F_1 scored the highest in colour (5.53), F_1 and F_4 scored 5.07 in taste and F_3 had the highest score (5.47) in drawability. F_4 had the lowest score in appearance, colour, and drawability but tasted better than other samples. The general colour of the soup was affected by the variations in the type and quantity of the pepper used. *Shombo* pepper samples had higher scores in colour than *scent* pepper samples and an increase in the quantity of pepper decreased the scores of colour. Observations made by the panel in the preliminary test showed that the *Yoruba* tribe (81.25%) preferred the bright coloured *ogbono* soup than other Nigerian tribes (*Ibo* and *Edo*) and the Cameroonian (6.25% each) who preferred not so bright but tasty and spicy soup.

Table 2a: Mean sensory attributes of the formulated *ogbono* soups

Sample Code	Appearance	Colour	Taste	Drawability
F_1	5.33 ±0.89a	5.53 ±0.99a	5.07 ±0.96a	5.20 ±0.94a
F_2	4.93 ±1.22a	4.73 ±1.09ab	5.00 ±0.85a	5.40 ±1.06a
F_3	5.40 ±1.76a	5.47 ±1.81a	4.93 ±1.44a	5.47 ±1.19a
F_4	4.67±1.39a	4.33 ±1.35b	5.07 ±1.44a	4.87 ±1.13a



F_1 F_2

F_3 F_4

Fig. 1. ***Ogbono*** **soup samples with different recipe formulations (F_1, F_2, F_3 and F_4)**

F_1= (Other recipes constant + 12% Dika kernel + 1% *Shombo* Pepper)
F_2= (Other recipes constant + 12% Dika kernel + 1% Scent Pepper)
F_3= (Other recipes constant + 11% Dika kernel + 2% *Shombo* Pepper)
F_4= (Other recipes constant + 11% Dika kernel + 2% Scent Pepper)

Table 2b gave the percentage response to the multiple comparison tests. 57.14% of the respondents agreed that sample F_4 is too spicy/hot in taste. This is because in the recipe formulation 2% of scent pepper was used. Tradition has it that scent pepper is characterised by its hot, sweet taste, and sweet smell. All the samples were acceptable in taste by 43 – 55% respondents. About 73% respondents indicated that the colour of sample F_4 was too dark. The bright colour of *shombo* pepper may have affected the panellist response to sample F_3, where 61.11% indicated too bright and 33.33% are satisfied with the colour.

About 71% of the respondents confirmed sample F_1 to be too thick, about 82% were satisfied with the consistency of sample F_3, while about 60% were satisfied with sample F_4. This may be because of the quantity (11 and 12%) of dika kernel powder in each formulation. This could be that one gramme of dika kernel in the formulation could make a difference in the consistency of the soup. All the samples were scored adequately in drawing according to 47 – 85% of the respondents. In

addition, 26.32% of the respondents indicated that drawing was not adequate in sample F_1. About 85% of the respondents liked the drawing characteristics of sample F_4. The overall preferred sample was sample F_3 (27.44), followed by F_2 and F_4 (25.66%), and the least preferred was F_1 (21.24%).
The panellists also ranked the samples in the order of preference and the mean scores were 2.44, 2.19, 3.06 and 2.31 for samples F_1, F_2, F_3 and F_4 respectively. Responses were subjected to rank sum test and statistically, there was no significant difference $(p > 0.05)$ between the samples, but sample F_3 was ranked the highest which may be because of its bright colour and satisfactory consistency.
The formulation of the soup recipe was adjusted based on the overall comments of the panellists, and the recipes of Idowu *et al.* (2013) and Akusu and Kiin-Kabari (2013). The acceptable recipe for the ready-to-cook soup mix is presented in Table 3a. The quantity of the ground kernel required in the acceptable recipe is about half less, and the water is about 12% more than that required in the proposed formulation.

Table 2b: Panelist response on the sensory attributes of the formulated samples (%)

Attribute	Comment	F_1	F_2	F_3	F_4
Taste	Too spicy/hot	18.18	16.67	50.00	57.14
	Acceptable	54.55	50.00	42.86	42.86
	Unacceptable	27.27	33.33	7.17	-
Colour	Too bright	53.85	9.09	60.00	6.67
	Too dark	-	36.36	5.56	73.33
	Satisfactory	46.15	9.09	33.33	20.00
Consistency	Too thick	71.43	33.33	9.09	13.33
	Too thin	7.14	13.33	9.09	26.67
	Satisfactory	21.43	53.34	81.82	60.00
Drawability	Drawing not adequate	26.32	8.33	7.69	15.38
	Adequate	47.36	75.00	76.92	84.62
	Too viscous	26.32	16.67	15.39	15.38
Overall Preference	-	21.24	25.66	27.44	25.66

Means in the same column with different letters are significantly different $(p < 0.05)$ ± standard deviation
F_1= (Other recipes constant + 12% Dika kernel + 1% *Shombo* Pepper)
F_2= (Other recipes constant + 12% Dika kernel + 1% Scent Pepper)
F_3= (Other recipes constant + 11% Dika kernel + 2% *Shombo* Pepper)
F_4= (Other recipes constant + 11% Dika kernel + 2% Scent Pepper)

Table 3a: Acceptable recipe for the ready-to-cook *ogbono* soup mix

Ingredients	Quantity (%)
Ground *ogbono*	6.13
Water (distilled)	83.66
Palm oil	2.78
Stock fish	0.84
Dried fish	1.67
Fresh *ugwu* leaves	2.23
Shombo pepper	0.56
Scotch bonnet (scent/Cameroon) pepper	0.56
Ground crayfish	0.56
Seasoning cubes	0.45
Salt	0.56
Total	100

Table 3b: Mean scores for the sensory attributes of the acceptable *ogbono* soup

Attribute	Score
Flavour	5.8 ± 0.84
Colour	5.2 ±0.84
Taste	5.6 ±1.14
Drawability	5.8 ±1.64

Mean scores ± standard deviation of the sensory variables on a 7-point Hedonic scale

Table 4: Proximate composition (%) of soup ingredients and mix

Sample	Moisture	Ash	Crude protein	Crude Fat	Crude Fibre	Carbohydrate
Dika kernel	5.17 ± 0.11	2.43 ± 0.37	9.23 ± 0.01	60.19 ± 0.69	6.02 ± 0.05	16.96 ± 0.24
Stock fish	11.33 ± 0.25	8.91 ± 0.10	76.77 ± 0.60	2.63 ± 1.62	0.40 ± 0.02	0.00 ± 0.00
Dried fish	10.21 ± 0.01	30.89 ± 0.58	53.92 ± 0.77	9.57 ± 1.50	0.47 ± 0.14	0.00 ± 0.00
Crayfish	10.87 ± 0.29	12.76 ± 0.12	68.46 ± 1.36	3.16 ± 0.83	3.99 ± 0.11	0.75 ± 0.54
Scent pepper	14.40 ± 0.36	6.72 ± 0.26	10.53 ± 0.01	6.77 ± 0.11	20.88 ± 0.01	40.69 ± 0.15
Shombo pepper	7.85 ± 0.31	4.62 ± 0.15	15.51 ± 0.33	6.24 ± 0.07	37.53 ± 0.03	28.25 ± 0.18
Ready-to-cook soup mix	8.96 ± 0.84	7.99 ± 0.09	26.99 ± 0.01	34.38 ± 0.37	5.10 ± 0.06	16.58 ± 0.29

Values are means and standard deviation of three determinations (n = 3)

This recipe showed that *I. wombolu* varieties have more affinity for water and are better thickener than *I. gabonensis* in *ogbono* soup preparation. The sensory attributes of the adjusted soup made from the acceptable recipe were evaluated and the mean scores were presented in Table 3b. The flavour, colour, and taste of the sample were rated "very good" while the drawability was rated "excellent". The result confirms the acceptability of the ready-to-cook mix in the preparation of *ogbono* soup.

3.2 Proximate composition of the soup ingredients and the acceptable ready-to-cook mix

The proximate compositions are presented in Table 4. The moisture content of the dika kernel was 5.17%. This result is similar to that reported by Ogungbenle (2014) for *I. gabonensis* (5.19%). The low moisture content of the dika kernel assures a longer shelf life, as it is known that moisture content affects the quality keeping of foods. High level of moisture content in flours during storage encourages the growth of microorganisms and subsequently microbial spoilage (Oduro *et al.*, 2009). The ash content of the dika kernel was 2.43%. The value obtained was higher than those reported by Oladimeji, 2007 (1.92%) and Ogunsina *et al.,* 2012 (2.3 g/100g) for *I. gabonensis*. This means that the powder of *I. wombolu* has higher ash content than *I. gabonensis* and will, therefore, be a better source of mineral. Ash content is an indication of the mineral content of the food. Dika kernel is therefore suggested to be an important source of minerals.

The protein content of dika kernel was 9.23%. The value is lower than those reported for raw and deffated *I. gabonensis* (10.6, 14.8% respectively) by Ogungbenle, (2014). The lower value obtained in the study may be a result of varietal difference. The source of the kernel and the nitrogen level of the soil on which the kernels were grown can be influenced by soil nitrogen levels (Blumenthal *et al.*, 2008). The protein content, therefore, suggests that the kernel can be useful in food systems where protein functionality is needed. The protein content of flour generally gives an indication of the nutrient quality.

The crude fat content of the dika kernel (*I. wombolu*) was 60.19%. The value obtained is higher than 54.7% reported by Ogungbenle (2014) but close to 62.0% reported by Aremu *et al.* (2014) for *I. gabonensis*. Differences in the fat content may be varietal. Fat is important in food, it contributes greatly to the energy value of foods and could slow down the rate of carbohydrate utilisation.

Fat could be metabolised by the process of beta oxidation to provide energy for the body during starvation and more energy is provided compared to carbohydrates (Eggling, 2003).
The crude fibre value of the dika kernel was 6.02%. The value is lower than that reported by Ogungbenle (2014) for *I. gabonensis* (8.32%). However, both varieties are good sources of dietary fibre. The carbohydrate content of dika kernel was 16.96%. This value is lower than 18.7% reported by Ogunsina *et al*. (2012) for *I. gabonensis*. Differences may be as the result of the differences in other proximate compositions.
The carbohydrate content (16.96%) of the dika kernel was high, followed by crude protein (9.23%), crude fibre (6.02%), moisture (5.17%) and ash (2.43%), with crude fat having the highest content (60.19%). The protein and fat content obtained in this study are similar to those reported by Joseph (1995) for the bitter variety of *I. gabonensis* (8.7 and 66.4% respectively). All the proximate composition of dika kernel obtained in this study are comparable to those reported for *I. wombolu* (Ejiofor, 1994) and *I. gabonensis* (Abulude *et al*., 2008; Ogunsina *et al*., 2012).
The moisture, ash and crude protein content of the ready-to-cook soup mix have increased due to the ingredients added to the dika kernel. The moisture content of the mix (8.96%) was close to those mixes (6 - 8%) of *I. gabonensis* reported by Ogunbusola *et al*. (2014). The value is within the range reported by Bamidele *et al.* (2015) for *I. gabonensis* instant mix (6.20 – 12.40%). The ash content of the ready-to-cook soup mix was 7.99%. The addition of the ingredients to the dika kernel even at small quantities increased the ash content of the ready-to-cook soup mix by approximately 70%. This shows that addition of ingredients (especially dried fish) could increase the mineral content of the soup mix.
The crude protein content of the ready-to-cook soup mix was 26.99%. This value (2.69 g/kg) is higher than the recommended daily allowance of 0.8 g/kg for adults (National Academies of Science, 2005).
Stockfish, dried fish, and crayfish are rich in protein, although added in small quantities (1-2%) to the dika kernel, about 66% increase in protein content of the ready-to-cook soup mix was obtained.
The protein value of the soup mix is higher than the value (7.51%) reported for *I. gabonensis* mix by Ogunbusola *et al*. (2014); and higher than 10.40 – 24.13% reported for instant *I. gabonensis* mix (Bamidele *et al.,* 2015). Variation may be due to differences in the kernel variety and recipe formulation. The increase in the protein content of the ready-to-cook soup mix implies an improved nutritional value of the kernel powder, making the *ogbono* soup a good source of protein. Protein is important in body building and replacement of worn-out tissues. This amount of protein needed by the body may be met by consuming the soup prepared with bolus foods such as "Eba", "Fufu", and others.
The crude fat content of the ready-to-cook mix was 34.38%. This value shows that the soup mix is rich in edible fat. The value is within the range (20.13 – 34.62%) reported for instant *I. gabonensis* mix (Bamidele *et al.,* 2015). The crude fibre of the soup mix was 5.10%. This value is higher than the range (0.26 – 0.98%) reported for instant *I. gabonensis* mix (Bamidele *et al.,* 2015). The difference in the crude fibre percentage may be due to kernel varietal differences and the recipe formulation proportion of the soup mix. It may also be because of the crude fibre contents of the pepper varieties used.
Bamidele *et al. (*2015) used scent pepper (Cameroon pepper), while this study combined both the scent and *shombo* peppers. Results of the proximate composition showed that *shombo* pepper had higher crude fibre (37.53%) than the scent pepper (20.88%). The carbohydrate content of the ready-to-cook soup mix was 16.58%. The value is lower than that (27.18-35.61%) reported by Bamidele *et al.* (2015) for instant *I. gabonensis* mix.
The result revealed that the ready-to-cook soup mix (*ogbono* soup) is rich in protein, ash, crude fibre with a reduced percentage fat, and may be a good source of energy when consumed.

3.3 Microbial characteristics

The total viable count (TVC) and yeast/mould count (YMC) of the samples are presented in Table 5. The dika kernel had the lowest TVC (3.0×10^2 cfu/g), which may be attributed to the drying of the kernel to a safe moisture content level that may not be favourable to microbial growth. The microbial loads from the ingredients might have occurred during handling of the ingredients by the processors/sellers as the ingredients were sourced from open market. Wide varieties of microorganisms found in *Irvingia* kernels (Adebayo-Tayo *et al*., 2006; Ikhatua, 2010) were attributed to handling during processing. This may be responsible for the TVC (7.7×10^3 cfu/g) of the ready-to-cook soup mix.

The dika kernel sample is free of YMC. The reason may be that the properties and the pH of the ingredients were not favourable to yeast and mould growth. They are sensitive to food pH, can tolerate lower pH conditions, but some combination of microbial controls such as heat processing or drying helps to preserve foods (McGlynn, 2016). Ready-to-cook soup mix had the lowest YMC (19.4 x 103 cfu/g) and the ingredients added to the dika kernel may be responsible for this. The presence of TVC and YMC could result in spoilage of the ready-to-cook soup mix. Therefore, it is important that all ingredients should be handled hygienically to prevent contamination, hence reduce the risk of microorganisms dangerous to human health.

Moisture is an important factor in keeping quality of dika kernel and the soup mix. All ingredients should be re-dried before use and not exposed to open air for sale in the market. This finding showed the microbial hazards associated with buying unbranded condiments, spices, flour etc. If ingredients are well packed and stored, there will be less contamination. However, traditional food processing method subjects the food to rigorous heating which will destroy the microorganisms and make the food safe for consumption.

3.4 Mineral composition

The mineral composition of the samples is presented in Table 6. The dika kernel contains high amounts of calcium (865.10 mg/100g), potassium (555.11 mg/100g); magnesium (299.10 mg/100g), and sodium (95.48 mg/100g); but low levels of iron (14.89 mg/100g). All minerals identified in this study for dika kernel (*I. wombolu*) are higher than those reported for *I. gabonensis* by Ogungbenle (2014). The ready-to-cook soup mix contains a high amount of calcium (1799.90 mg/100g) followed by potassium (647.76 mg/100g). A large amount of magnesium (219.30 mg/100g) and sodium (323.11 mg/100g), but low iron content (11.21 mg/100g) was also found in the soup mix. Ingredients added to the dika kernel increased the mineral amount of the soup mix. The dika kernel and the ready-to-cook soup mix samples are rich in the selected minerals.

Iron was the mineral with the lowest value obtained in all the samples studied. Low amount of iron was also reported by Adeyeye (2013) and Ogungbenle (2014) for *I. gabonensis* kernels. The iron values obtained for dika kernel in this study agrees with the value (10 mg/100g) reported by Abulude *et al.* (2008) for *I. gabonensis* seed flour

Table 5: Microbial Counts (cfu/g) of the ingredients and soup mix

Sample	Total viable count	Yeast/Mould count
Dika kernel	3.0×10^2	NIL
Stockfish	NIL	NIL
Dried fish	3.2×10^3	24.6×10^3
Crayfish	NIL	NIL
Scent pepper	13.6×10^3	NIL
Shombo pepper	17.7×10^4	15.5×10^4
Ready-to-cook soup mix	7.7×10^3	19.4×10^3

Values are means of three determinations (n = 3).
NIL (No growth)

Table 6: Mineral composition (mg/100g) of the ingredients and soup mix

Sample	Fe	Mg	Ca	K	Na
Dika kernel	14.89 ± 0.01	299.10 ± 0.01	856.10 ± 0.01	555.11 ± 0.01	95.48 ± 0.06
Stock fish	8.01 ± 0.01	219.30 ± 0.01	1920.12 ± 0.02	939.70 ± 0.01	426.48 ± 0.03
Dried fish	67.20 ± 0.01	376.00 ± 0.04	4116.21 ± 0.01	530.40 ± 0.06	754.40 ± 0.01
Crayfish	8.30 ± 0.02	329.10 ± 0.01	1580.62 ± 0.02	698.11 ± 0.03	883.21 ± 0.01
Scent pepper	51.29 ± 0.01	154.70 ± 0.01	38.33 ± 0.03	2055.30 ± 0.05	89.30 ± 0.01
Shombo pepper	4.91 ± 0.01	157.03 ± 0.05	227.30 ± 0.02	1359.72 ± 0.02	58.40 ± 0.01
Ready-to-cook soup mix	11.21 ± 0.01	219.30 ± 0.01	1799.90 ± 0.01	647.76 ± 0.01	323.11 ± 0.01

Values are means and standard deviation of three determinations (n = 3).

This result also agrees with the result of Aremu *et al*. (2014) that iron was the least abundant mineral (3.6 mg/100g) for *I. gabonensis*. Kayode *et al*. (2010) reported iron content (11.00 mg/100g) for *ogbono* soup which is like that of the soup mix (11.21 mg/100g) obtained in this study. However, Recommended Daily Amount (RDA) of iron is 8 mg/day for adult male and 18 mg/day for female (Food and Nutrition Board, 2001). This means that *ogbono* soup will be sufficient in meeting the daily dietary iron requirement for males assuming that 100 g of the soup is eaten daily. However, the soup will contribute well with other food sources to meet the recommended daily intake (RDI) for females.
Lower Fe content obtained for the ready-to-cook soup mix compared to the dika kernel, may be due to the percentage proportion of the ingredients added. The inclusion of vegetables to the soup during preparation may increase the Fe concentration; however, the presence of anti-nutrients such as phytate (e.g. in bitter leaf) could reduce iron absorption and utilisation (Ekholm *et al*., 2003). This may explain why *ugwu* could be preferable in *ogbono* than the bitter leaf. Iron is of great concern particularly during pregnancy where supplementation appears to be essential during the second half of pregnancy (Food and Nutrition Board, 1997). Iron is also an important constituent of haemoglobin found in blood to combat anaemia.
The amount of magnesium (Mg) found in the dika kernel was 299.10mg/100g. Mg content in dika kernel in this study is higher than the values (57.4 and 48.3 – 54.5 mg/100g, respectively) reported for *I. gabonensis* by Adeyeye (2013) and Ogungbenle (2014). Mg content obtained in the ready-to-cook soup mix was 219.30 mg/100g. This value was lower than that of the dika kernel sample, this may be due to the percentages of dika kernel and the other ingredients added. Mg is necessary for teeth and bone development in children. The dika kernel could be a supplement in providing the daily requirement of Mg of 265-350 mg/day (Food and Nutrition Board, 1997).
Calcium (Ca) was the highest mineral content found in all samples except in the pepper samples. Dika kernel had 856.10 mg/100g. This value is much higher than the value (42.5 mg/100g) reported by Adeyeye (2013) for *I. gabonensis*. This may be due to varietal differences. Aremu *et al.* (2014) also confirmed calcium as the most abundant mineral in *I. gabonensis* seed (431.5 mg/100g).
The Ca content of the ready-to-cook soup mix was 1799.90 mg/100g. This value is higher than the value (87.39 – 94.69 mg/100g) reported by Bamidele *et al*. (2015) for instant *I. gabonensis* soup mix. The soup mix had high Ca content which may be due to the ingredients added. The dried fish had the highest Ca content (4116.21 mg/100g). The species and the diet of the fish may be responsible for its high calcium content. Tradition says that the fish normally feeds with crayfish. That is why it is popularly called “eja ajede” in Southwestern part of Nigeria. National Academies of Science (2001) recommends calcium intake of 500 - 800 mg/day for children (1-8 years old) and 1000 – 1300 mg/day for adults.
The result showed that consuming *ogbono* (*I. wombolu*) soup can provide the RDA of calcium for both children and adults. Calcium intake is necessary for teeth and bone

development in children. Consumption of *ogbono* soup with highly nutritious ingredients could serve as a good source of calcium to adults and children.

Potassium (K) is the second predominant mineral found in all the samples except in the pepper samples where K is the most abundant mineral. Potassium content of dika kernel was 555.11 mg/100g while that of the ready-to-cook soup mix was 647.76 mg/100g. Higher K found in the soup mix may be because of other ingredients added which were high in K. The K value obtained for soup mix was higher than that (293.77 – 374.54 mg/100g) reported for *I. gabonensis* soup mix by Bamidele *et al.* (2015). Differences may be because of the different dika kernel variety, the ingredients and the ratio of the soup mix formulation used. Potassium is an important mineral, which helps maintain electrolyte balance in humans.

The sodium (Na) content found in the dika kernel was 95.48 mg/100g. The value is higher than that reported for *I. gabonensis* (20.2 and 32.2 mg/100g); raw and defatted *I. gabonensis* (30.1 and 36.7 mg/100g respectively) reported by Adeyeye (2013) and Ogungbenle (2014). The Na content in the ready-to-cook soup mix was (323.11 mg/100g) higher than that of dika kernel. This may be due to the added ingredients like the dried fish, which was high in Na, probably because they are usually preserved with salt. Since the soup mix already contained high sodium, little salt addition is therefore required during preparation because Na affects the functional properties. The Na content of the soup mix is comparable to that of the *I. gabonensis* soup mix (226.70 - 254.80 mg/100g) reported by Bamidele *et al.* (2015). Sodium enhances flavour and acts as a preservative, but very high level could be of serious health risk. Sodium is a major positive ion in the extracellular fluid and a key factor in retaining body water.

In the body, the ratio of sodium to potassium (in the intracellular fluid) is about 2:3 (0.67) (Bender, 2006). The Na: K ratio of the dika kernel was about 0.17. The addition of ingredients increased the Na:K ratio of the soup mix to 0.49.

The values obtained in the study are low and would not promote high blood pressure, as this is essential to avoid hypertension (Caballero *et al.*, 2005).

4. CONCLUSIONS

The study formulated an acceptable ready-to-cook soup mix for the preparation of *ogbono* soup. The low moisture content of the dika kernel and the ready-to-cook soup mix assures a long shelf life. The kernel has high mineral content, and the addition of ingredients to the dika kernel increased mineral and the protein content of the soup mix by 70% and 66% respectively.

Total viable and yeast/mould counts were identified in the ready-to-cook soup mix. These microbial loads were found in the ingredients (sourced from open market) added to the dika kernel. Inclusion of the dika kernel powder in soup as thickener and eating of *ogbono* soup could be of great health benefits.

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