Effect of Reheating on the Nutritional, Phytochemical, Microbial and Sensory Properties of *Gbanunu*- a Traditional Soup in Nigeria

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Introduction

- Nigeria is a multi-socio cultural society with different traditional soups which are indigenous to different ethnic group and culture (Hart *et al*., 2005).

- The majority of traditional soups in Nigeria are prepared with indigenous leafy vegetables that are rich in food nutrients with health-promoting effects from the dietary antioxidants in the vegetables which is also beneficial for immune functioning in preventing diseases (Asaolu, 2012; Sumazian, 2010)

- One of the African Indigenous Green Leafy Vegetables (AIGLV) available in the Yoruba ethnic group of South West, Nigeria is "Marugbo" scientifically known as *Cleridendrum volubile* (Adeboye *et al*., 2019).

Introduction (Contd)

- ‘Marugbo’ is an inexpensive source of proteins, carbohydrates, dietary fibres, minerals, and vitamins (Ogunwa, 2015).

- Soups made with ‘Marugbo’ leaf has been reported to supply a huge amount of iron, zinc, phenolic compounds, and other phytochemicals that are important in building body healthy functions with medicinal values (Neeta *et al*., 2007; Adefegha *et al*., 2011).

- The leaf of *C. volubile* (‘Marugbo’) is the major leafy vegetable employed in the preparation of *gbanunu* though, blended with other vegetables (such as; ‘Moringa’, ‘Ewe ege’, 'Ewe Owu', 'Ewe Alukoofo' 'Efirin', etc), spices and some other ingredients.

- *Gbanunu* is a popular soup delicacy consumed among ‘Ikale’, ‘llaje’, and ‘Apoi’ ethnic groups in the southern senatorial district of Ondo State; western Nigeria especially, the postpartum mothers (Adefegha *et al*., 2011).

Statements of Problem

•As important (with health benefits) as *gbanunu* soup is, like other traditional soups, it has a short shelf life of just about 24 h after preparation.

•*Gbanunu* soup is consumed majorly by rural dwellers and if the soup must be kept longer than a day, the only means of preservation to prevent spoilage is by reheating (Doyle *et al*., 1996), without the knowledge of its effect on the quality attributes of the soup.

Justification for the research

The knowledge about the effect of reheating on the quality attributes of *gbanunu* soup is necessary in maintaining the number of reheating times that will not impact negatively on the quality of the soup at the point of consumption.

Aim and Objectives

The major aim of this study is to investigated on the effect of reheating on the quality attributes of *gbanunu* soup

The specific objectives are to:

- determine proximate and mineral composition of the fresh and reheated *gbanunu* soup,
- quantitatively assess the phenolic compounds and anti-nutritional factors of the fresh and reheated *gbanunu* soup,
- establish the microbial quality of the fresh and reheated *gbanunu* soup, and
- evaluate the sensory characteristics of the reheated *gbanunu* soup in comparison with the freshly prepared soup.

Materials and Methods

Materials

- Varieties of vegetable leaves, spices, and other ingredients used for the preparation of *gbanunu* soup were purchased from Okitipupa market in Ondo State, Nigeria.

- Reagents and agars used for the analyses were of analytical grade and were prepared according to the manufacturer's specifications.

Preparation of *gbanunu* soup

The traditional method was adopted in the preparation of the soup. Each of the ingredients was sorted, picked, washed to remove dirt, and weighed. The ingredients were ground together, mix with water in a stainless pot, and put on the fire (gas burner); after 5 minutes of boiling (at about 80^{o}C), palm oil, salt, and seasoning (Maggi cubes) were added, then allowed to cook further for 30 minutes. The soup was analysed after cooling on the first day (fresh soup) and after reheated in each of the two other days. The recipe for the preparation is depicted in Table 1.

Table 1: Recipe employed for *Gbanunu* soup preparation

Ingredient	Quantity (g)
Leafy vegetables	
Marugbo leaves (*Clerodendrum volubile*)	200
Moringa leaves (*Moringa oleifera*)	13.1
Cassava leaves (*Manihot esculentum*)	36.2
Seluju/Lapalapa leaves (*Jatropha gossypifolia*)	12.6
Cotton leaves (*Gossypium herbaceum*)	24.1
Lemon grass (*Cymbopogen citrate*)	1.8
Adin din pupa leaves (*Boerhavia diffusa*)	35. 9
Ailu leaves/Ewe lle (*Euphoria hirta*)	40.5
Spices	
Lefi pupa/ Tumeric (*Curcuma longa*)	39.5
Bell pepper (*Capsicum annuum L.*)	48.8
Posa (*Monodora myristical*)	10.1
Scent leaves (*Ocimum gratissimum*)	31.5
Ogiri (*Citrullus vulgaris*)	15.5
Garlic (*Allium sativum*)	1.6
Ginger (*Zingiber officinale*)	1.6
Others	
Salt	29
Bouillon seasoning cube	8.0
Palm oil (*Eleais guinesses*)	50
Water	1600

Microbial analyses

The total viable bacterial (TVC), coliforms, staphylococcal, salmonella, shigella, and fungal (mould and yeast) loads were enumerated (CUF/g) from the soup samples using standard methods.

Table 2: Proximate analysis (AOAC, 2005)

Proximate parameter	Unit
Moisture	%
Crude protein	%
Ash	%
Fat	%
Crude fibre	%
Carbohydrate	%

Carbohydrate content was determined by difference of (100-(moisture+protein+ash+fat+crude fibre)).

Mineral and vitamin analyses

Calcium (Ca), iron (Fe), zinc (Zn), sodium (Na), and potassium (k) content (mg/100g) of each sample were estimated using the method of AOAC (2000).

Iodimetry method was used to determine the vitamin C concentration (mg/100 g) according to AOAC (2010).

Pro-vitamin A (β- carotene) was determined using the method adopted from International vitamin A Consultative Group (IVACG, 1992).

Phytochemical and anti-oxidant analyses

Spectrophotometric and Folin-Ciocalteu assay method as described by Singleton et al. (1999) was used for the determination of total phenol.

Phytate and Oxalate content (mg/100g) were determined by the methods of Wheeler and Ferrel (1971); Day and Underwood (1986), respectively.

The DPPH scavenging activity (%) of the soup extracts for the antioxidant properties was determined by the method of Leong and Shui (2002).

Sensory evaluation

The sensory evaluation was done to assess the acceptability of the fresh and reheated soup while hot. The same set of ten semi-trained panelists selected based on their likeness and familiarity with the soup and were used to assess the sensory quality. The 5-points Hedonic scale, where 5=Like very much; 3=Neither like nor dislike; and 1=Dislike very much as described by Aworh *et al*. (2002) were adopted in the analysis.

Statistical analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) and mean separation was done by Duncan multiple range test using Statistical Package for Social Sciences (SPSS, Version 20). Significance was observed at $p<0.05$.

RESULTS

Table 3: Proximate Composition of *Gbanunu soup*

Samples	Proximate parameters (%)					
Days	Moisture	Fat	Ash	Fibre	Protein	CHO
1- Fresh	75.18±0.00 ^{a}	4.07±0.00^{a}	2.47a±0.01^{c}	0.15±0.00^{c}	9.75±0.01^{c}	8.38±0.00^{a}
2-1st reheated	74.36±0.0 ^{b}	4.06±0.00^{a}	2.49±0.01^{b}	0.17±0.01 ^{b}	10.58±0.01^{b}	8.34±0.00^{a}
3-2nd reheated	74.09±0.01^{c}	4.06±0.01 ^{a}	2.67±0.01^{a}	0.19±0.00^{a}	10.69±0.01^{a}	8.31±0.00^{a}

Values with different superscripts along the same column are significantly different ($P < 0.05$)

CHO = Carbohydrates

Table 4: Mineral composition of *gbanunu* soup samples

Samples/	Minerals composition (mg/100g)				
Days	Calcium	Potassium	Sodium	Zinc	Iron
1- Fresh soup	1.54±0.01 [a]	1.22±0.11 [a]	1.52±0.00 [a]	0.11±0.12 [a]	0.12±0.09 [a]
2- 1st reheated soup	1.46±0.02 [b]	1.07±0.01 [b]	1.12±0.01 [b]	0.03±0.02 [b]	0.08±0.06 [b]
3- 2nd reheated soup	1.22±0.00 [c]	0.58±0.06 [c]	0.52±0.10 [c]	0.04±0.05 [c]	0.05±0.05 [c]

Values represent the mean ± SD of three determinations. Values with different superscripts in the same column are significantly different ($p<0.05$)

Table 5: Vitamins and phytochemical content of soup samples (mg/100 g)

Samples	Antioxidants			Anti-nutrients	
	βcarotene (Vit. A)	Vitamin C	Total phenol	Phytate	Oxalate
Day 1	15.37±0.06^{a}	2.97±0.81^{a}	1.55±0.01^{a}	20.00±5.00^{a}	3.6±0.10^{a}
Day 2	10.32±0.08^{b}	2.81±0.01^{b}	1.25±0.01^{b}	16.96±1.01^{b}	1.76±0.58^{c}
Day 3	8.77±0.02^{c}	2.03±0.01^{c}	0.94±0.00^{c}	12.82±0.46^{c}	2.07±0.01^{b}

Values represent the mean ± SD of three determinations. Values with different superscripts in the same column are significantly different ($p<0.05$)

Day 1 = Fresh soup; Day 2 = First reheated soup; Day 3 = Second reheated soup

Table 6: Sensory analysis of *Gbanunu* soup samples

Samples	General appearance	Consistency	Aroma	Taste	Overall acceptability
Day 1	4.77± 0.06 [a]	5.03± 0.06 [a]	4.64± 0.52 [a]	4.67± 0.06 [a]	4.8 ± 0.18 [a]
Day 2	4.43 ±0.06 [b]	4.27± 0.06 [b]	3.87± 0.06 [b]	4.10± 0.10 [b]	4.17 ± 0.07 [b]
Day 3	4.13 ±0.06 [c]	3.67± 0.06 [c]	3.63± 0.06 [c]	3.13± 0.06 [c]	3.64± 0.06 [c]

Values represent the mean ± SD of three determinations. Values with different superscripts in the same column are significantly different ($p<0.05$)

Day 1 = Fresh soup; Day 2 = First reheated soup; Day 3 = Second reheated soup

Table 7: Microbial load (CFU/g) of the soup samples

Samples	TVBC	Escherichia coli	Staphylococcal count	Shigella	Samollena	Total fungal count (mould /yeast)
Day 1	2.3 $x10^1$	0.2 $x10^1$	1.1x 10^1	ND	ND	3.4 $x10^1$
Day 2	3.5 x 10^1	ND	9.0 x 10^1	ND	ND	3.7 $x10^1$
Day 3	4.6 x 10^1	ND	1.0 x 10^1	ND	ND	4.4 x 10^1
Standard	5.0$x10^5$					$\leq 10^6$

Values represent means of three determinations. The standard values (ICMSF, 1986)

TVBC = Total Viable Bacteria Count; ND = Not detected

Conclusions

❖The macronutrient contents of the soup increased with increase in the days of reheating.

❖Notwithstanding, the study has indicated that reheating of *Gbanunu* soup caused appreciable loss of micronutrients and phytonutrients.

❖Consequently, the DPPH value for free radical scavenging activities was highest with the fresh soup at 400.00 µg/mL of the soup extracts.

❖ The mean scores for all the sensory attributes were found at the 'like' region but decreases as the number of reheating increased; hence, reheating generally decreases the overall quality of *gbanunu* soup.

❖Nevertheless, the microbial loads were very low; *E. coli*, Salmollena and Shigella were ordinarily not detected indicating safety for consumption and the preservative effect of the reheating process.

Recommendations

- It is advisable that consumable quantity of *gbanunu* soup within 1-2 days should be prepared at a time to relatively retain the micronutrients and freshness at point of consumption.

- Otherwise, alternative means of preservation such as the use of food additives or refrigeration may be necessary.

- Also, the leafy vegetables that contain high level of anti-nutrient contents should be identified and sparingly used in the preparation to minimise the possible chelating effect on the mineral constituents of the soup.

Contribution to knowledge

This work has been able to:

• establish a scientific and baseline documentation on the effect of reheating on the quality attributes of *gbanunu* soup;

•provide information on the nutritional, antioxidants and sensory properties of reheated *gbanunu* in comparison with the freshly prepared soup;

These contributions will help to maintain a good level of reheating process that will not impair the nutritive and the acclaimed health benefit of *gbanunu* soup.

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