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Influence of Sprouting on Proximate and Sensory Properties of *Gworo* (*Cola nitida*) and *Ojigbo* (C*ola acuminata*) Kola Nuts

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Abstract. Influence of sprouting on proximate and sensory properties of *gworo* (*oji-housa*) (*Cola nitida*) and *ojigbo* (*Cola acuminate*) kola nuts were explored. The two varieties of kola nuts were sprouted at ambient temperature (25 to 32^0C) for 4 weeks separately in a regularly moistened serviette wrapped with black polyethylene. Both proximate and sensory properties were conducted before and after sprouting on the mash prepared separately from them. Proximate composition showed that moisture content, ash and protein increased, while fat, crude fiber and carbohydrate decreased with sprouting in both varieties of kola nuts. Sprouted *ojigbo* kola nut had higher moisture content (56.80%), ash (2.25%), and fat (2.90%) than sprouted *gworo* with respective 50.18%, 1.90% and 1.40% for moisture, ash and fat. Also, un-sprouted *ojigbo* had higher moisture (47.00%), ash (2.03%) and fat (6.44%) as against respective 43.10%, 1.50% and 4.44% from un-sprouted *gworo* for moisture, ash and fat. Un-sprouted *gworo* had higher protein (5.95%), fiber (7.27%) and carbohydrate (37.75%) as against 5.33%, 6.80% and 32.42% from un-sprouted *ojigbo* kola nut for protein, fiber and carbohydrate. Similarly, sprouted *gworo* had higher protein (6.65%), fiber (6.60%) and carbohydrate (32.65%) than respective 6.30%, 5.30% and 26.45% from sprouted *ojigbo*. Sensory scores showed that sprouting reduced all the sensory attributes evaluated in both *gworo* and *ojigbo.* Colour was reduced from 6.60 to 5.50 and 5.85 to 5.65 respectively in un-sprouted *gworo* and sprouted *ojigbo.* Also, crispness was reduced from 6.55 to 5.95 and 6.55 to 5.45 respectively from un-sprouted *gworo* and sprouted *ojigbo* kola nuts. Bitterness was reduced from 6.05 to 5.85 and 6.40 to 5.25 respectively from un-sprouted *gworo* to sprouted *ojigbo*. Similarly, general acceptability was reduced from 6.55 to 5.35 in un-sprouted *gworo* and sprouted *ojigbo* while acceptability reduction of 6.10 to 5.40 was obtained in un-sprouted and sprouted *ojigbo* kola nuts respectively.

Introduction

Kola nut is a caffeine-rich nut belonging to *sterculiaceace* plant family which comprises of about one hundred and twenty five species of evergreen trees native to the tropical rainforests of Africa [1, 2]. Kola nut contains about a dozen round or square seeds developed in a seed-shell (testa) while the seeds are without testa [3, 4]. *Gworo* has two cotyledons while *ojigbo* has between three to six cotyledons both seeds split into their corresponding number of cotyledons [5].

Generally, kola nut contains protein, starch, phenol, niacin, and riboflavin which are good for ones health [1]. Proximate results reported [6] showed that the moisture content of *ojigbo* and *gworo* were in respective range of 9.73 to 9.81%, ash 2.72 to 2.21%, fat 3.02 to 2.20%, protein 19.14 to 15.24%, crude fiber 7.30 to 4.18% and carbohydrate 58.09 to 66.45%. *Ojigbo* has more protein, ash and fat than *gworo*. Also, [7] reported 10.64% protein for *Cola acuminata* and 2.5% fat for *gworo.* Kola nut contains considerable quantity of glucose compared to other stimulants such as cocoa and coffee, and three times greater in starch than cocoa but with relatively little fat. Substantial quantity of starch and glucose of kola nut have been reported to boost physical energy and suppresses hunger [8]. Kola nut also contains higher quantities of phenolic constituents than many fruits which play an important role in determining colour and flavour, and have an impact on metabolic processes. Seeds of both *cola accuminata* and *cola nitida* contained high quantities of

both primary and secondary amines which accounted for their higher methylating activity (49 to 174 ug/kg) than that reported for a fresh plant product [8]. Both species of kola nut induce significant increase in gastric acid secretion and advised those suffering from peptic-ulcer to avoid eating kola nut [10].

Chewing of kola nuts is a widespread habit in the sub-Saharan countries of Africa especially in Northern Nigeria and Sudan during ceremonies, as habits, hospitality, and in management of digestive upset. Kola chewing plays a similar social role as tea and coffee drinking or cigarette smoking in western countries [8]. Kola nut can also be used for refreshing the mouth because of its unique bitter taste and the twigs are used as "chewing sticks" to clean the teeth and gums. This has potential to be used as a natural fertility regulator. Kola nuts are frequently chewed before meals to assist or encourage digestion and also to assist combat possible harmful effect from impure drinking water [2]. Kola nut helps to reduce the sensations of hunger and tiredness [11].

Kola nuts are used in making beverages like milk shakes, as flavouring ingredients and as major ingredient in COCA-KOLA drinks [3] which are refreshing or stimulating substitutes for tea or coffee [8]. Kola nuts are also used in chocolate and wine making**.** Chocolates made from kola nuts do not melt easily as they are thermo resistant and suitable for the tropics. Some medicinal properties of kola nuts have been advanced [12, 1]. Moderate eating of kola nut had been recognized to avoid the ugly side effects [3].

Sprouting is the practice of germinating seed to be eaten raw or cooked. Kola nut sprouting is primarily for propagation by sprouting in a pot and transplant to plain field [13]. Today, sprouting is considered as one kind of pre-digestion that help to breakdown the high molecular complex materials into their building blocks thereby offer a variety of health and nutritional benefits. Numerous and touted health benefits of sprouting include high levels of dietary fiber, B complex vitamins and protein [14]. Sprouts also contain digestive enzymes and some of the highest known levels of certain antioxidants. Besides, germination can lead to the development of such functional foods that have a positive effect on the human organs which in turn helps to maintain good health. Compared to un-sprouted seeds, sprouted seeds are richer in phytochemicals, vitamins, minerals, enzymes and amino acids which are of most important and useful to human health [15, 16]. Sprouted kola nuts had been reported to have tremendous health and medical benefits over un-sprouted kola nuts [17]. This study aimed at exploring the effects of sprouting on the physicochemical and sensory properties of *gworo* and *ojigbo* kola nuts.

Materials and Methods

Source of raw materials: Five hundred grams (500 g) of both *Ojigbo* and *Gworo* harvested in 2017 were purchased from Urbani market in Umuahia Abia State, Nigeria.

Sprouting of kola nut: Both kola nuts varieties were wrapped separately in serviettes, moistened with water at regular intervals and allowed at ambient temperature for 4 weeks to sprout inside black polyethylene (Fig. 1). Sprouted and un-sprouted kola nuts of both varieties were crushed separately with mortar and pestle into kola nut mash and were subjected to physicochemical analyses (Fig. 1 and 2). Sensory analyses were conducted on both varieties separately with un-mashed kola nuts.

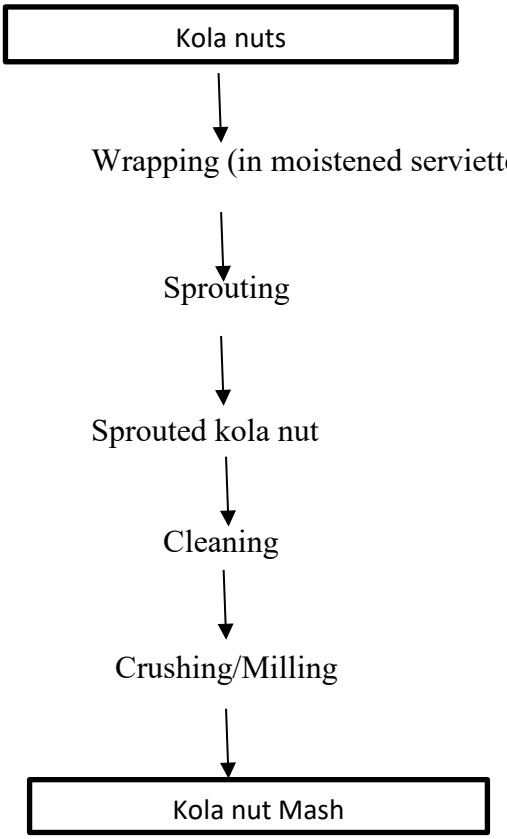

Figure 1. Flow chart for the preparation of sprouted kola nut mash

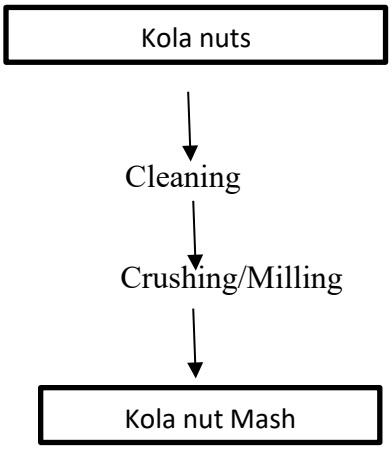

Figure 2. Flow chart for the preparation of un-sprouted kola nut mash

Proximate analysis:

Protein, fat, ash and moisture content of sprouted and un-sprouted kola nuts were determined by Kjeldahl, soxhlet, furnace incineration gravimetric and gravmetric methods respectively. And carbohydrate content was calculated by difference as the nitrogen free extract (NFE) all according to [18]. Crude fiber content was determined by Weende method described by [19].

Sensory evaluation:

Sensory evaluation was carried out on the coded samples of both sprouted and un-sprouted cola nut varieties using the method of [20]. A 25 man semi trained panelists comprising selected male and female staff and students of Michael Okpara University of Agriculture Umudike with an average age of 35yrs and 22yrs respectively were used for the sensory evaluation. The coded samples were presented to them individually at same time in same saucer along with bottle of water.

They were instructed to taste the samples one after the other, rinse their mouths after each tasting and how to score the samples. Attributes evaluated were colour, bitterness, crispiness and overall acceptability. The scoring was based on a 9-point Hedonic scale ranging from 9 (extremely like) to 1 (extremely dislike) and 5 (neither like nor dislike).

Statistical analysis:

Statistical difference between the samples were determine using one way analysis of variance (ANOVA) using SPSS Version 16.0. The experimental design used was complete randomized design (CRD).

Results and Discussion

Proximate composition:

Results of proximate composition of the sprouted and un-sprouted *gworo* and *ojigbo* kola nuts are shown in Table 1

Table 1. Proximate (%) composition of the sprouted and un-sprouted *gworo* and *ojigbo* kola nuts

Sample	MC	Ash	Crude fat	Protein	Crude fibre	CHO
UG	$43.10^{d} \pm 0.71$	$1.50^{c} \pm 0.00$	$4.44^{b} \pm 0.33$	$5.95^{c} \pm 0.00$	$7.27^{a} \pm 0.09$	$37.75^{a} \pm 0.28$
UL	$47.00^{c} \pm 0.28$	$2.03^{b} \pm 0.71$	$6.44^{a} \pm 0.33$	$5.33^{d} \pm 0.11$	$6.80^{b} \pm 0.00$	$32.42^{b} \pm 0.69$
SG	$50.18^{b} \pm 0.85$	$1.90^{b} \pm 0.14$	$1.40^{b} \pm 0.00$	$6.65^{a} \pm 0.00$	$6.60^{b} \pm 0.28$	$32.65^{c} \pm 0.99$
SL	$56.80^{a} \pm 0.57$	$2.25^{a} \pm 0.07$	$2.90^{c} \pm 0.14$	$6.30^{a} \pm 0.00$	$5.30^{c} \pm 0.14$	$26.45^{c} \pm 0.92$

Means with the same ab superscripts within the column are not significantly different (P>0.05) while those without the same ab superscripts are significantly different (P<0.05).UG=Un-sprouted Gworo kola nut, UL= Un-sprouted *ojigbo* kola nut, SG = Sprouted Gworo kola nut, SL= Sprouted *ojigbo* kola nut, MC= Moisture Content, CHO= carbohydrate.

Moisture content (MC) of both verities increased with sprouting from 43.10% in un-sprouted to 50.18% in sprouted *gworo* and from 47.00% in un-sprouted to 56.80% in sprouted *ojigbo*. The *ojigbo* had more (9.80%) increase than *gworo* (7.08%). There are significant differences (P<0.05) in MC between sprouted and un-sprouted kola nuts of both varieties. The MC of un-sprouted kola nuts of both varieties was higher than 8.29% reported by [21], and 9.73% and 9.81% reported for *ojigbo* and *gworo* respectively by [6] for un-sprouted kola nut. The results obtained were also at variance with that of [6] who reported higher MC for *gworo* (9.81%) and lower MC for *ojigbo.* Variations in moisture content of both varieties of kola nuts for sprouted and un-sprouted kola nuts may be attributed to varietal differences and differential imbibitions rates during sprouting among sprouted kola nuts. Higher moisture content of un-sprouted *ojigbo* over *gworo* kola nut may be responsible for its longer shelf life (storability) than *gworo* kola nuts [22].

Ash content of both varieties increased with sprouting from 1.50% in un-sprouted to 1.90% in sprouted *gworo* and from 2.03% in un- sprouted to 2.25% in sprouted *ojigbo.* The *gworo* had more ash increase (0.40%) than *ojigbo* (0.22%). Ash content obtained is slightly lower than that of [6] who reported 2.72% and 2.21% for *ojigbo* and *gworo* respectively. Both sprouted and un-sprouted kola nuts of both varieties were significantly different (P<0.05) in ash which could be traced to varietal differences, state of the kola nuts and spouting. It had been earlier reported that ash content, an index of mineral content may vary depending on such factors like variation in climatic condition, edaphic and disease factors of kola nuts [23].

Fat content of both kola nut varieties decreased with sprouting from 4.44% in un-sprouted to 1.40%in sprouted *gworo* and from 6.44% in un-sprouted to 2.90% in sprouted *ojigbo.* There was more fat decrease in *ojigbo* (3.54%) than *gworo* (3.04%) probably because *ojigbo* more fat than

gworo. Statistically, fat content of both sprouted and un-sprouted *gworo* were significantly similar ($p>0.05$) while that of sprouted and un-sprouted *ojigbo were* significantly ($p<0.05$) different. The trend of these results validated that of [6] who reported 3.02% and 2.20% respectively for *ojigbo* and gworo. However, the fat content values were higher than 0.92% reported by [24]**.** Lower fat content of sprouted compared to un-sprouted cola nuts for both varieties could be as a result of utilization of fat for energy by the sprouts during sprouting.

Protein content of both kola nut varieties increased with sprouting from 5.95% in un-sprouted to 6.65% in sprouted *gworo* and from 5.33% in un-sprouted to 6.30% in sprouted *ojigbo*. The *ojigbo* had more protein increase (0.97%) than *gworo* (0.70%). Sprouted *ojigbo* and *gworo* had the highest protein contents of 6.65 and 6.30 while un-sprouted *ojigbo* and *gworo* had the lowest protein contents of 5.95 and 5.33 respectively. These results were lower than 19.14% and 15.24% reported respectively for *ojigbo* and *gworo* [6], and 8.68% reported by [26] but were higher than 3.5% reported by [25]. These variations maybe traced to varieties used and sprouting. Protein contents variation were significantly ($P<0.05$) different between sprouted and un-sprouted kola nuts of both varieties. The differences could be due to physiological characteristics of the plant which offers greater resistance to nitrogen supply and genetically variability [27]. However, relatively higher protein content could complement body's need for essential nutrients for growth, energy and development. Protein had been proved to be essential for the survival of human beings and animals [28].

Crude fiber content of both varieties decreased with sprouting from 7.27% in un-sprouted to 6.60% in sprouted *gworo* and from 6.80% in un-sprouted to 5.30% in sprouted *ojigbo*. The *ojigbo* had more (1.50%) decrease than *gworo* (0.67%). Decreasing effect of sprouting on fiber content could be attributed in part to increased MC as a result of imbibitions of water during sprouting which may mean that *ojigbo* may have imbibe water more than *gworo*. The trend of the results was not in agreement with that of [6] who reported 7.30% for *ojigbo* and 4.18% for *gworo*. Fiber content of both varieties were significantly different ($P<0.05$) between sprouted and un-sprouted kola nuts which could be traced to condition of kola nut samples, cultural practices, and varieties used for analyses. Vegetables and fruit fibers have been reported to have hypocholesterolmic properties.

Carbohydrate content of both varieties decreased with sprouting from 37.75% (un-sprouted *gworo*) to 32.65% (sprouted *gworo*) and from 32.42% (un-sprouted *ojigbo*) to 26.45% (sprouted *ojigbo*). Similar trend had been reported [13] for *ojigbo* (58.05%) and *gworo* (66.45%). There were significant differences ($P<0.05$) in carbohydrate content among sprouted and un-sprouted kola nuts of both varieties which could be as a result of differences in variety or climatic condition of the kola nuts [23] during maturation. These values were lower when compared to higher content of carbohydrate (94.49%) obtained by [29] for un-sprouted kola nut. However, these variations in carbohydrate composition may imply that kola nut proximate compositions vary with season, environment and/or condition and time of evaluation.

Sensory Evaluation

Results of sensory evaluation are presented in Table 2.

Table 2. Sensory scores of sprouted and un- sprouted kola nuts

Sample	Colour	Crispiness	Bitterness	General Acceptability
UG	$6.60^{a} \pm 1.64$s	$6.55^{a} \pm 1.28$	$6.05^{a} \pm 1.79$	$6.55^{a} \pm 1.43$
UL	$5.85^{ab} \pm 1.50$	$6.55^{a} \pm 1.36$	$6.40^{a} \pm 1.79$	$6.10^{ab} \pm 1.77$
SG	$5.50^{ab} \pm 1.70$	$5.95^{ab} \pm 1.67$	$5.85^{a} \pm 1.35$	$5.35^{b} \pm 1.63$
SL	$5.65^{ab} \pm 1.63$	$5.45^{ab} \pm 2.09$	$5.25^{a} \pm 2.15$	$5.40^{b} \pm 1.88$

Means with the same ab superscripts within the column are not significantly different ($P>0.05$) while those without same ab superscripts are significantly different ($P<0.05$). UG=Un-sprouted *gworo* kola nut, UL= Un-sprouted *ojigbo* kola nut, SG= Sprouted *gworo* kola nut, SL=Sprouted *ojigbo* kola nut.

Colour rating of the kola nuts decreased with sprouting in both varieties from 6.60 in un-sprouted to 5.50 in sprouted *gworo* and from 5.85 in un-sprouted to 5.65 in sprouted *ojigbo*. The *gworo* had more (1.10) colour decrease than *ojigbo* (0.20) with sprouting. Significant difference ($P<0.05$) only existed between the un-sprouted *gworo* and the rest kola nut results. However, food colour shows surface characteristics of food products and also contributes to the appearance. Kola nut colour could be used to beef aesthetic appeal of foods during processing.

Average sensory scores on crispness decreased with sprouting in both varieties from 6.60 in un-sprouted to 5.50 in sprouted *gworo* and from 5.85 in un-sprouted to 5.65 in sprouted *ojigbo*. The *gworo* had more (0.60) decrease in crispness than *ojiigbo* (0.20) with sprouting. Mean scores of crispness for un-sprouted *gworo* and *ojigbo* kola nuts were not significantly different, but were significantly ($p<0.05$) different from sprouted *gworo* and *ojigbo* kola nuts which scored the least respectively. However, loss of crispness recorded for sprouted kola nuts of both varieties could be attributed to their higher MC recorded from them (Table 1) as a result of water imbibed during sprouting. Higher MC may have reduced kola nut hardness. Decreasing effect of sprouting on crispness of both varieties of kola nuts could also be attributed to decrease in fat content.

The average sensory scores on bitterness decreased in both varieties with sprouting from 6.05 in un-sprouted to 5.85 in sprouted *gworo* and from 6.40 in un-sprouted to 5.25 in sprouted *ojigbo*. The *ojigbo* had more decrease (1.15) than *gworo* (0.20) probably because *ojigbo* is bitterer. There is no significant ($p<0.05$) differences in bitterness between sprouted and un-sprouted samples of both varieties. Higher bitterness of *ojigbo* kola nut may be ascribed to variety while the least value recorded for sprouted kola nuts could be traced to increased moisture imbibed during sprouting. The *ojigbo* may have imbibed water more than *gworo*. Generally, decreasing effect of sprouting on bitterness for both varieties could also be attributed to hydrolysis of bettering substances of the kola nuts and dilution effects of same due to increased MC during sprouting.

Average overall acceptability scores showed that un-sprouted *gworo* was rated highest followed by un-sprouted *ojigbo* more than their sprouted counterparts. This may be traced to their relatively lower MC (Table 1), higher crispness and lower bitterness than *ojigbo* (Table 2) which kola nuts are noted for compared to their sprouted counterparts. Crispness and moderate bitterness are index of a good kola nut which were rated lower in sprouted kola nuts of both varieties. The more the MC, the lower the crispness and bitterness and vice versa. There was significant difference ($P<0.05$) in acceptability between un-sprouted *gworo* and *ojigbo* unlike in sprouted *gworo* and *ojigbo* which may be due to varietal differences or consumer preference. Generally, sprouted kola nuts were less desired than the un-sprouted ones probably due to decreased crispness and bitterness during sprouting which kola nuts were noted for. Despite lower rating of sprouted kola nuts, acceptability rating of 6 obtained indicated like slightly in the 9-point hedonic scale.

Conclusion

This study revealed the influence of sprouting on kola nuts where moisture, ash and protein increased while fat, crude fibre and carbohydrate decreased with sprouting in both *gworo* and *ojigbo.* Colour, crispness, bitterness and general acceptability ratings decreased with sprouting in both *gworo* and *ojigbo* varieties. Despite these, there was no significant difference ($P>0.5$) between sprouted *gworo* and *ojigbo* and un-sprouted *ojigbo* in terms of colour and bitterness which resulted in “like slightly” acceptability rating.

Increase in ash and protein content along side decrease in fat content due to sprouting are in line with modern changes in life style and eating habits. Besides, decrease in kola nut bitterness with sprouting will boost the eating with reduced physical side effects like nervousness, ulcer, and high blood pressure among others associated with excessive kola nut eating while utilizing the endowed health and medicinal benefits. Further more, fat, starch and glucose will boost physical energy, suppress hunger and will make *gworo* and *ojigbo* a good candidate for wine making. Sprouted kola nut extracts from both varieties can be used as food fortificant in food processing.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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