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NUTRITIONAL COMPOSITION AND SENSORY ATTRIBUTES OF 'KUNNU-AYA' FORTIFIED WITH *VIGNA-RACEMOSA* FLOUR

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CONFLICTS OF INTEREST

There are no conflicts of interest for any of the authors.

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ABSTRACT

Background:

Kunnu drinks are locally produced beverages, which of recent have become popular among the various non-alcoholic drinks in Nigeria. 'Kunnu-aya' is produced from tigernut, an underutilized crop that is rich in fibre and fat. Since 'kunnu-aya' is produced from tigernuts, which are generally low in protein and lack other nutrients, the beverage cannot fulfill the nutrient intake of consumers. In order to increase the nutritional quality of 'kunnu-aya', it was fortified with *Vigna racemosa,* an underutilized legume that is abundant in nutrients.

Methods:

Vigna-racemosa fortified 'kunnu-aya' was produced by supplementing tigernut kunnu ('kunnu-aya') with *Vigna -racemosa* at various substitution levels (0 – 25%). The fortified beverages were analyzed for proximate composition, mineral contents and sensory properties.

Results:

The results obtained from proximate analysis showed an increase of 28-102%, 6-21% and 2-11%, respectively, in protein, ash and carbohydrate content of the fortified kunnu. However, a decrease in the moisture (0.3-27%), fat (6-22%) and crude fibre (12-5%) contents were observed with increasing substitution levels. The mineral contents of the fortified kunnu increased significantly. Results of the sensory analysis indicated that the fortified 'kunnu-aya' were more acceptable than the unfortified 'kunnu-aya'. The fortified kunnu was also more nutritious.

Conclusion:

Vigna-racemosa fortified 'kunnu-aya' is rich in protein and other nutrients. Its consumption could help in reducing the problem of protein-calorie malnutrition especially among children, in developing countries.

Keywords:

beverage, fortification, proximate composition, mineral content, sensory attributes

INTRODUCTION

Kunnu beverages are commercially available drinks that are commonly consumed in the Northern part of Nigeria [1]. It is a favorite beverage of both low income earners and high class people of the North, but recently, it is also taken as thirst quencher and refreshment in other geopolitical region of Nigeria [2]. Kunnu is a cheap beverage, because the ingredients used for the preparation are cheap and readily available in local markets and stores. Kunnu are principally produced from cereals such as millet, sorghum, maize and sometimes from tigernut [3, 4, 5]. It is usually flavored with spices such as ginger, black pepper and tamarind for taste and aroma, and also to serve as purgative and cure for flatulent conditions [6]. The composition of kunnu generally include 85-87% moisture, 9.0-12.05 carbohydrate, 1.6-1.8% protein, 0.1% fat, 0.6% ash [7].

'Kunnu-zaki' is a non-alcoholic beverage produced from millet or sorghum grains [8]. It can also be produced from guinea corn or blends of cereals [9]. 'Kunnu-zaki' contains low protein (0.1%), fat (0.6%) and carbohydrate (9-12%) but high (85-87%) moisture content [10]. To make up for the poor nutritional qualities of kunnu prepared from cereals, tigernut was found to be a good substitute for cereal grains. The nut which is cultivated throughout the world is also found in the Northern part of Nigeria and other West Africa Countries like Guinea, Cote d'ivore, Cameroon, Senegal. The nuts are valued for their starch content, dietary fibre and carbohydrate [11]. Kunnu produced from tigernut is called 'kunnu-aya'.

'Kunnu-aya' is also a commercially available beverage in Northern Nigeria. Although kunnu-aya is slightly more nutritious than 'kunnu-zaki', the beverage is also low in protein and other nutrients but high in fat and crude fibre, due to high fibre and fat content of tigernut seeds [12, 13]. It is therefore necessary to fortify the beverage with legumes which are rich source of cheap protein and other micronutrients. Legume seeds contain an average of twice as much protein as cereals and nutritive value of high dietary protein sources [14, 15]. In this study, 'kunnu-aya' was fortified with *Vigna recemosa*, an underutilized legume rich in protein (29.3%) containing sulphur amino acids (2.05-3.63 g per 16 g N) and other nutrients [16]. The proximate, mineral content and sensory attributes of the fortified 'kunnu-aya' was evaluated.

MATERIALS AND METHODS:

Materials

Tigernut (*Cyperus esculentus*), spices; whole clove, red pepper (*Capsicum anuum*), ginger (*Zingiber officinale*) and sugar were purchased at a local market in Ogbomoso, Oyo state, SouthWest, Nigeria. *Vigna-racemosa* was purchased in a local market in Ilesha, Osun state, SouthWest, Nigeria.

Production of Vigna-racemosa flour

Vigna-racemosa seeds were sorted, roasted, dry milled and packaged in an air tight container prior to use.

Production of Vigna-racemosa fortified 'Kunnu-aya'

'Kunnu-aya' was produced following a modified method of Belewu and Abodunrin [12]. Tigernut (1 kg) was washed, cleaned and steeped in portable water for 72 hr, wet milled (1:3 w/v) with spices (20 g) and filtered using muslin cloth. The slurry was left to ferment for 24 hr and divided into equal halves after fermentation. One half of the slurry was mixed with *Vigna-racemosa* flour at various proportions (100:0; 95:5; 90:10; 85:15; 80:20; 75:25) and boiled for 15 min (on a gas cooker set at medium flame) and allowed to cool to 40^{o}C. The *Vigna-racemosa* fortified cooled portion of the kunnu was mixed with the other uncooked half portion. Water (100 ml) and sugar (200 g) were added to the fortified 'kunnu-aya' to obtain desired thickness and sweetness. The flow diagram for the production of *Vigna-racemosa* fortified 'Kunnu-aya' is presented in Figure 1.

Proximate composition

Crude protein and crude fat of the fortified 'kunnu-aya' samples and the unfortified kunnu (10ml) were determined using standard macro-kjeldhal and soxhlet procedures, respectively [17, 18]. Total ash was obtained by igniting 10ml sample at 60 deg C using muffle furnace [18]. Crude fibre was determined according to the procedure of AOAC [19]. Moisture content was determined by weighing and drying to constant weight and carbohydrate content was estimated by difference.

Mineral composition

The potassium content of the samples was carried out using flame photometry, while phosphorus was determined by the phosphovanado-molybdate (yellow) method [8]. The other elemental contents (Calcium (Ca), Magnesium (Mg) and Iron (Fe)) were determined after wet digestion of ash sample, with an Atomic Absorption Spectrophotometer (AAS, Hitachi Z6100, Tokyo, Japan). All the determinations were carried out in triplicates.

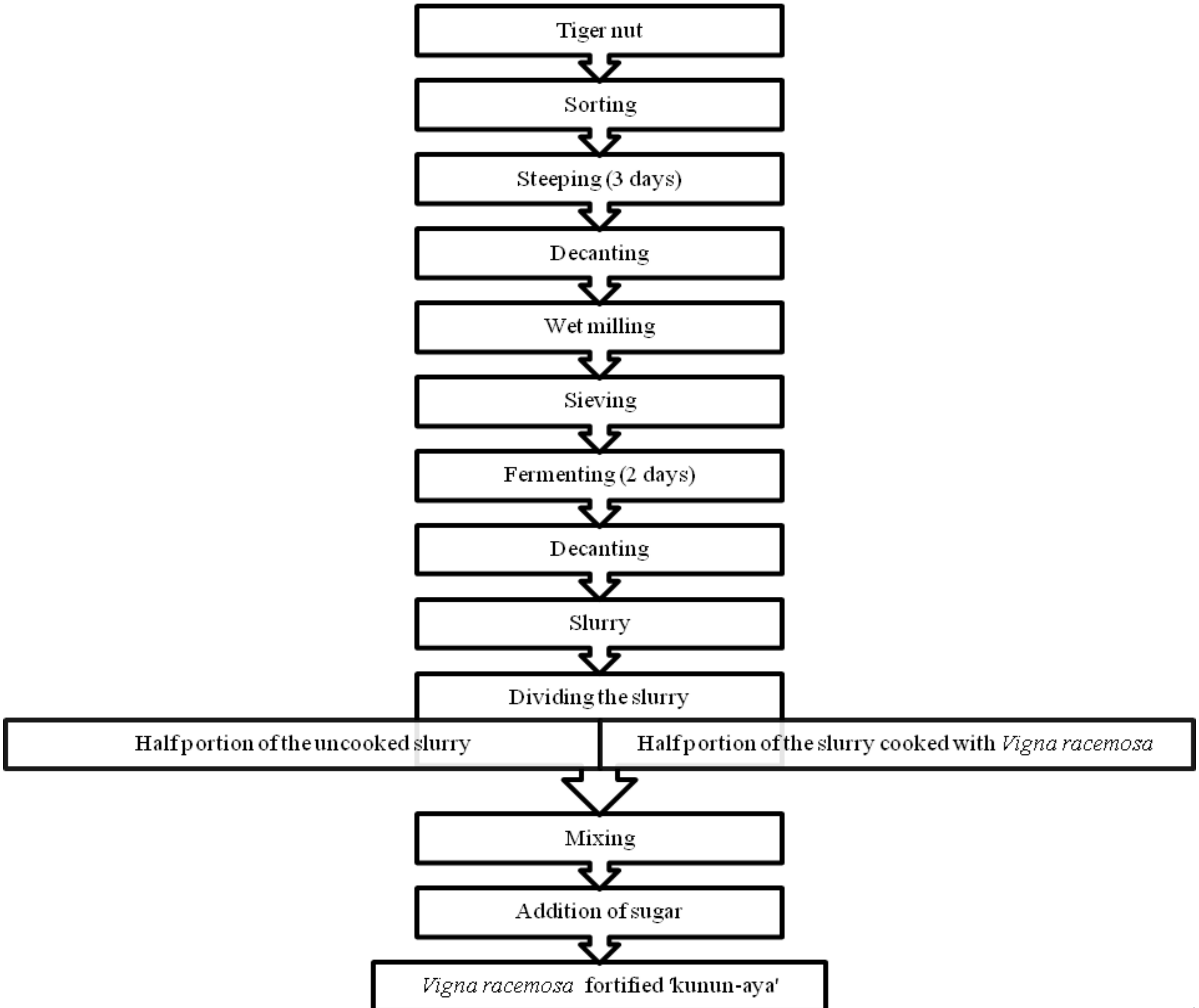

Figure 1. Flow diagram for the production of *Vigna-racemosa* fortified 'kunnu-aya'

Sensory analysis

The *Vigna-racemosa* fortified 'kunnu-aya' and the control (unfortified 'kunnu-aya') were coded and presented to 20 member panelists, comprising of students and staff members of the Department of Food Science and Engineering, Ladoke Akintola University of Technology (LAUTECH). The panelists were asked to evaluate the samples based on the following sensory attributes; colour, taste, flavour, sweetness, smoothness and overall acceptability, and score them using A 9-point hedonic scale, where 1 represent like extremely and 9 represent dislike extremely.

Statistical analysis

Data obtained in this study were analyzed using the Statistical Package for Social Sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL USA). Statistical differences between means were compared using paired T-test. Differences in means were considered statistically significant at $p<0.05$.

RESULTS AND DISCUSSION:

Proximate Composition of Vigna-racemosa Fortified 'Kunnu-aya'

The proximate content of the various *Vigna-racemosa* fortified 'kunnu-aya' samples are presented in Table 1. The unfortified kunnu (Sample A) had the highest moisture content (65.3%) compared with the moisture content (63.5 – 65.1%) of the fortified kunnu. *This* indicates that addition of *Vigna-racemosa* to the 100% 'kunnu-aya' decreases the moisture content of the beverage and thus, increases its solid content. The moisture content of the *Vigna-racemosa* fortified kunnu reported in this study (63.5 - 65.1%) is lower than the moisture content (63.6-80.7%) of kunnu produced from sorghum and sesame seeds [20] and moisture content (63.0-82.5%) of commercially-available 'kunnu-aya' [13].

Table 1: Proximate composition of Vigna-racemosa Fortified 'Kunnu-aya'

Sample Code	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre (%)	Carbohydrate (%)
A	$65.30^{d}\pm0.20$	$1.67^{a}\pm0.08$	$9.73^{f}\pm0.15$	$0.80^{a}\pm0.08$	$1.89^{b}\pm0.06$	$20.61^{a}\pm0.21$
B	$65.13^{d}\pm0.11$	$2.10^{b}\pm0.12$	$9.17^{e}\pm0.11$	$0.85^{b}\pm0.10$	$1.80^{ab}\pm0.10$	$20.97^{b}\pm0.22$
C	$64.77^{ab}\pm0.13$	$2.33^{c}\pm0.07$	$8.93^{d}\pm0.06$	$0.87^{b}\pm0.06$	$1.77^{ab}\pm0.05$	$21.33^{c}\pm0.25$
D	$64.73^{c}\pm0.15$	$2.60^{d}\pm0.10$	$8.53^{c}\pm0.08$	$0.90^{b}\pm0.10$	$1.77^{ab}\pm0.08$	$21.47^{c}\pm0.38$
E	$64.03^{b}\pm0.12$	$3.03^{e}\pm0.08$	$8.13^{b}\pm0.12$	$0.90^{b}\pm0.11$	$1.67^{a}\pm0.06$	$21.97^{c}\pm0.20$
F	$63.53^{a}\pm0.21$	$3.37^{f}\pm0.06$	$7.57^{a}\pm0.06$	$0.97^{c}\pm0.05$	$1.67^{a}\pm0.11$	$22.89^{d}\pm0.36$

Values are expressed as mean ± standard deviation of triplicate determination. Means with the same letters along the same column are not significantly different ($p>0.05$). A: 100% 'Kunnu-aya'; B: 95% 'Kunnu-aya' + 5% *Vigna reacemosa*; C: 90% 'Kunnu-aya' + 10% *Vigna reacemosa*; D: 85% 'Kunnu-aya' + 15% *Vigna reacemosa*; E: 80% 'Kunnu-aya' + 20% *Vigna reacemosa*; F: 75% 'Kunnu-aya' + 25% *Vigna reacemosa*.

The protein content of the fortified kunnu samples range from 2.1 to 3.4 %. Protein content of the fortified kunnu increases as the addition of *Vigna-racemosa* increases in the blends. The kunnu sample fortified with 25% *Vigna-racemosa* had the highest (3.4%) protein content while the sample fortified with 10% *Vigna-racemosa* fortified sample had the least protein content (2.1%). The protein content of the unfortified kunnu-aya was lower (1.7%) than those of the fortified kunnu (Table 1). The protein content of the *Vigna-racemosa* fortified kunnu-aya produced in this study is higher than the protein content (1.2 – 2.3%) of tigernut drink [21] and soymilk (2.19 – 2.99) protein [22]. The increment in the protein content of the fortified kunnu-aya compared to the unfortified kunnu, is an indication of its potential to increase the protein intake of its consumers.

The fat content of the fortified kunnu samples decreases as the level of fortification of the kunnu with *Vigna-racemosa* increases. The unfortified kunnu sample had the highest fat content (9.73%) while the kunnu sample fortified with 25% *Vigna-racemosa* had the least fat content (7.57%). Highest fat content was recorded for the control sample (unfortified kunnu-aya) because the main ingredient for the kunnu production was tigernut, which is an oil seeds [23]. The fat content (7.57 – 9.17%) of the fortified kunnu produced in this study is higher than the fat content (2.0 – 2.8%) of soymilk kunnu blends produced by Sowonola et al. [24], but lower than the fat content (27.6 – 34.6%) of cow milk [25]. The relatively high fat content of the fortified kunnu indicates that the beverage will be palatable.

Ash is an indication of the mineral content of a food. The slight increase in the mineral content (0.87 – 0.97%) of the *Vigna-racemosa* fortified kunnu compare with unfortified kunnu-aya, is a confirmation of the ability of the legume in increasing the mineral content of the beverage. The ash content (0.80 – 0.97%) of the fortified kunnu produced in this study is higher than the fat content (0.2 – 0.7%) of tigernut milk [21].

Table 2: Mineral content of Vigna-racemosa fortified Kunnu-aya

Sample Code	Calcium (mg/100g)	Potassium (mg/100g)	Magnessium (mg/100g)	Iron (mg/100g)	Phosphorous (mg/100g)
A	2.67^{a}±2.19	10.67^{a}±1.16	8.50^{a}±0.01	1.37^{a}±0.13	91.67^{a}±2.84
B	2.83^{b}±2.90	12.33^{a}±2.51	11.33^{b}±0.29	1.51^{a}±0.15	103.13^{b}±2.80
C	3.67^{c}±2.87	14.00^{ab}±1.73	13.17^{c}±0.19	1.87^{b}±0.11	108.36^{c}±2.35
D	4.83^{d}±2.89	17.67^{bc}±2.52	16.17^{d}±0.28	2.32^{c}±0.13	113.20^{d}±2.75
E	5.50^{e}±0.01	21.67^{c}±2.89	17.83^{e}±0.31	2.53^{c}±0.10	118.41^{e}±2.89
F	6.33f±2.89	26.77^{d}±2.87	20.67^{f}±0.29	2.80^{d}±0.11	125.00^{f}±0.01

Values are expressed as mean ± standard deviation of triplicate determination. Means with the same letters along the same column are not significantly different (p>0.05). A: 100% 'Kunnu-aya'; B: 95% 'Kunnu-aya' + 5% *Vigna reacemosa*; C: 90% 'Kunnu-aya' + 10% *Vigna reacemosa*; D: 85% 'Kunnu-aya' + 15% *Vigna reacemosa*; E: 80% 'Kunnu-aya' + 20% *Vigna reacemosa*; F: 75% 'Kunnu-aya' + 25% *Vigna reacemosa.*

Table 3: Sensory Attributes of Vigna-racemosa fortified 'Kunnu-aya'

Samples	Colour	Taste	Flavour	Sweetness	Smooth-ness	Overall acceptabil-ity
A	2.13^{ab}±0.83	2.07^{a}±0.81	2.53^{a}±1.36	2.20^{a}±1.01	2.53^{a}±1.13	2.33^{a}±1.05
B	2.90^{bc}±1.20	3.67^{c}±1.16	3.00^{a}±1.93	3.27^{b}±1.58	3.60^{ab}±1.55	3.27^{ab}±1.28
C	1.94^{a}±0.99	2.53^{ab}±1.13	2.40^{a}±1.06	2.187^{b}±1.44	3.20^{ab}±1.52	2.40^{a}±1.06
D	3.27^{c}±1.10	3.40^{bc}±1.52	3.40^{a}±1.22	3.07^{ab}±0.79	3.47^{ab}±0.90	3.20^{ab}±0.56
E	3.33^{c}±1.29	3.27^{bc}±1.10	3.20^{a}±1.52	3.07^{ab}±1.13	3.80^{b}±1.61	3.73^{b}±1.39
F	3.47^{c}±1.52	3.07^{bc}±1.54	3.47^{a}±1.25	2.87^{ab}±1.41	3.73^{b}±1.64	3.80^{b}±1.61

Values are expressed as mean ± standard deviation of triplicate determination. Means with the same letters along the same column are not significantly different (p>0.05). A: 100% 'Kunnu-aya'; B: 95% 'Kunnu-aya' + 5% *Vigna reacemosa*; C: 90% 'Kunnu-aya' + 10% *Vigna reacemosa*; D: 85% 'Kunnu-aya' + 15% *Vigna reacemosa*; E: 80% 'Kunnu-aya' + 20% *Vigna reacemosa*; F: 75% 'Kunnu-aya' + 25% *Vigna reacemosa.*

The crude fibre (1.67 - 1.80%) of the fortified kunnu produced in this study was lower than the crude fibre (1.87%) of the unfortified kunnu-aya. content ranged from a mean value of 1.8% to 1.7%. kunnu prepared from 100% tigernut had the highest 1.8% while that of 25% *Vigna-racemosa* had least value 1.7%. The reduction in the crude fibre content of the fortified kunnu beverage was due to low fibre content of the legume used for the fortification. The low fibre content of the fortified kunnu beverage indicates that the beverage will be tolerated by children. The fibre content of the fortified kunnu produced in this study is however higher than the fibre content (0.20 - 0.24%) of tigernut- soymilk drinks [26].

The carbohydrate content of the kunnu samples ranged from 20.7 to 21.3% with the control having the lowest (20.7%)percentage of carbohydrate when compared to the *Vigna-racemosa* fortified samples. The low level of carbohydrate in the samples could be due to low carbohydrate content of the major ingredient (tigernut). Ukwuru and Ogbodo [21] recorded carbohydrate content of 5.1 to 11% for tigernut milk. The carbohydrate content of the fortified kunnu produced in this study is slightly lower than the carbohydrate content (25.6 – 28.2%) of kunnu-zaki produced from millet and *Vigna-racemosa* blends, but similar to the carbohydrate content of commercially available raw cow milk [25].

Mineral Composition of Vigna-racemosa Fortified Kunni-aya

The mineral content of the *Vigna-racemosa* fortified kunnu samples are presented in Table 2. The calcium content of the fortified kunnu samples increases from 2.8 to 6.3 mg/100g. The sample fortified with the highest level of *Vigna-racemosa* had the highest calcium content. The high calcium content of the fortified kunnu could be due to high calcium content of the legume used for fortification. The calcium content (2.8-6.3 mg/100g) of the fortified kunnu-aya produced in this study is higher than the calcium content (0.12-0.15 mg/100g) of soymilk fortified kunnu-zaki [24] but lower than the calcium content (5.44-7.35 mg/100g) of calcium supplement fortified kunnu-zaki [8]. The relatively high content of the fortified kunnu-zaki produced in this study indicates that the beverage will promote strong teeth and bone development in children and adults, respectively.

Potassium is an essential nutrient with important role in the synthesis of amino acids and proteins [27]. The potassium content (12.33-26.77 mg/kg) of the fortified ‘kunnu-aya’ increases as the substitution level of *Vigna-racemosa* increases in the blends. Similar result was observed by Makinde *et al.* [20] who reported that potassium composition of sorghum-sesame kunnu ranged from 24.5 to 30.0 mg/100g. The potassium content of the fortified ‘kunnu-aya’ produced in this study is also within the range of the potassium content (21.9-28.5 mg/100g) of zobo drinks [28].

Magnesium in conjunction with calcium and phosphorous helps in building strong bone and in the metabolism of vitamin D. Magnessium also helps to relax body muscles. The magnesium content (20.7%) of the 25% *Vigna-racemosa* fortified ‘kunnu-aya’ is more than two times higher than the magnesium content (8.5%) of the unfortified ‘kunnu-aya’.

Iron is an important element in the diet that supplies the red blood with hemoglobin and prevents anaemia and other related diseases in pregnant women, nursing mothers, infants and elderly people [29]. The iron content (1.51-2.80 mg/100g) of the fortified ‘kunnu-aya’ produced in this study is significantly higher than the iron content (1.37 mg/100g) of the unfortified ‘kunnu-aya’. The iron content of the ‘kunnu-aya’ reported in this study is higher than the iron content (1.86-1.78 mg/100g) of soymilk fortified with carrot powder [30] but lower than the iron content (3.1-16.5 mg/100g) of pito that are commercially available in Ghana [31]. Differences in the ingredient used for kunnu and pito beverage could be responsible for the variation in their iron content.

The phosphorus content of the kunnu samples increased from 91.7 to 125 mg/100g, with the control having the lowest (91.7mg/100g) while 25% *Vigna-racemosa* fortified sample had the highest (125mg/100g) phosphorus content.

Sensory Attributes of Vigna-racemosa Fortified ‘Kunnu-aya’

The sensory scores of the *Vigna-racemosa* fortified kunnu-aya are presented on Table 3. The kunnu samples were not significantly different ($p \geq 0.05$) in terms of flavor. However, all other sensory properties were significantly ($P \leq 0.05$) different. The unfortified kunnu had the lowest mean score in sweetness, smoothness, taste and overall acceptability while the 25% *Vigna-racemosa* fortified kunnu had the highest score. Overall acceptability of the fortified kunnu samples was higher than that of the control (unfortified ‘kunnu-aya’). The higher acceptability (2.4-3.8) of the fortified kunnu suggests that it was more acceptable by judges compared with the unfortified kunnu. This could be as a result of the increase in the consistency of the fortified kunnu as the level of *Vigna-racemosa* increases in the kunnu blends.

CONCLUSION

The study indicates that fortification of ‘kunnu-aya’ with *Vigna-racemosa* enhances the nutritional quality of the beverage. The addition of 25% *Vigna-racemosa* resulted in kunnu with high nutritional value and overall acceptability. Thus, *Vigna-racemosa* fortified ‘kunnu-aya’ could help in solving the problem of protein-calorie malnutrition in developing countries, in addition to increasing the utilization of *Vigna-racemosa* legume in Nigeria.

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