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Research Article

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Evaluation of Nutritional Value and Sensory Properties of *Moringa oleifera* Seed Powder Fortified Sakada (A Cassava-Based Snack)

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Abstract

In Nigeria, cassava (*Manihiot esculenta*) is grown primarily for production of staples such as *gari*, *lafun* and *fufu* but there is little information on its conversion to nutritious snacks. *Sakada* is a locally prepared cassava-based snack that is low in protein, vitamins and minerals needed for vital life processes. In this study, *sakada* was prepared from freshly harvested low-cyanide cassava roots (TME 1 with 7.38 mg HCN/100g) without and withmoringa (*Moringa oleifera*) seed powder at varying proportions (5–20%), in order to increase its protein, minerals and vitamin A contents. Unfortified sakada was the control. Proximate compositions, vitamin A and mineral contents of the unfortified and fortified *sakada* samples were determined using standard methods. Unfortified sample had low values of 2.48, 1.91, 2.06 and 0.97 % for crude protein, crude fat, crude fibre and ash contents, respectively, while moringa seed powder fortification significantly increased the proximate compositions (protein: 2.48-6.96 %, fat: 1.91-9.01 %, fibre: 2.06-4.51 %, ash: 0.97-1.41 %), minerals (iron: 1.92-5.5 ppm, calcium: 8.60-9.98 ppm, potassium: 0.64-1.05 ppm) and vitamin A (3.31 – 9.49 mg/100g) contents of the fortified *sakada* samples. Considering the quality assessments of the fortified product, the results obtained showed that 10% moringa fortified *sakada* was rated better than other fortified samples as well as the control sample (*sakada* produced from 100% cassava grit). In conclusion, fortification of *sakada* with moringa seed powder produced snack with improved nutritional value suitable for adults and children alike.

Keywords

Sakada, *Moringa oleifera* seed powder, Fortification, Low-cyanide cassava roots, Snack

Introduction

Human body needs nutrients such as carbohydrates, fats, fibre, minerals, proteins, vitamins A, B-complex, C, D and E as well as water to carry out vital life processes. These important nutrients are either needed in small (micronutrients) or large amounts (macronutrients) by the body for a wide range of essential functions such as proper growth and development. Correct combination of micronutrients such as iron, vitamin A, iodine, zinc, folate etc and macronutrients such as protein, fats and carbohydrates make healthy diets. Consumption of unhealthy diets that is deficient in one or more essential nutrients as well as excessive consumption of nutrients have not only resulted in malnutrition, but

have also led to severe diseases (epidemics) most especially among vulnerable groups [1].

Malnutrition refers to insufficient, excessive or imbalanced consumption of nutrients. For the most part, effect of not taking essential nutrients needed by the body is also known as malnutrition. In developed countries, nutritional diseases often resulted from excessive consumption of nutrients whereas in developing countries such as Nigeria, causes of malnutrition are directly linked to inadequate consumption of micronutrients and macronutrients. Usually, micronutrient malnutrition or hidden hunger is caused by either chronic or prolonged lack of essential vitamins and minerals needed for normal functioning of the body. Deficiencies of iron and iodine have resulted in anaemia and goitre respectively while weakened immune system and night blindness are deficiency symptoms for zinc and vitamin A respectively [2]. In addition, chronic diseases such as kwashiorkor (lack of dietary protein), marasmus (deficiency in calorie intake) and marasmic kwashiorkor annually accounts for human death irrespective of age in Nigeria and other developing countries.

Cultivated cassava is usually *Manihot esculenta* Crantz and contributes significantly to the nutrition and livelihood of majority of people in Tropical Africa, Central and South America [3]. Cassava is grown primarily for its starchy tuberous roots, which are important staple for more than 800 million people [4] and Nigeria is the largest producers of cassava in the world with an annual production of 35 - 40 million metric tonnes. Similarly, Nigeria, Brazil, Zaire, Thailand and Indonesia had produced more than two-thirds of the world production [5]. Cassava may be the cheapest calorie source in the world and fourth most crucial food calories source for humans in the tropics after rice, wheat and maize [6]. Since cassava is resistant to diseases and tolerant to drought, it is sometimes a nutritionally strategic famine reserve crop especially in unreliable rainfall areas [7]. Estimate of cassava in Nigeria reveals that about 84% of cassava produced yearly is processed into various foods and at times snacks for local consumption [8]. Chief among these products are gari, lafun, fufu, myondo, chikwangue and *sakada* and they are produced by fermentation [3]. Cassava products such as gari, lafun and fufu are the most widely consumed staple foodstuffs in Nigeria [9]. Besides, cassava forms an important ingredient in the manufacture of ethanol, starch, animal feed and many other products that are commercially important. Although it contains cyanogenic glycosides, primarily linamarin and a small amount of lotaustralin [10], but with suitable and appropriate processing methods such as fermentation, cyanide is either reduced to a safe level or totally removed from cassava thereby making cassava products safer for human consumption.

Sakada (a popular cassava-based snack in Oyo Town, Southwest Nigeria) is a sweetened-roasted-fermented cassava grits prepared from freshly harvested low-cyanide cassava roots. It is a creamy-white product that is consumed between meals. Usually, *sakada* is prepared from low-cyanide cassava roots that have been peeled, washed, crushed into a mash, fermented, and sieved into grits. Then, sugar and salts are mixed with cassava grits appropriately (depending on the quantity of the cassava grits) to taste. This is followed by arrangement of the cleaned, small cans that have been perforated on both sides on the oiled, roasting tray above a moderately burning fire. Then, scooping of the prepared grits into the cans, and turning of the cans with its contents to ensure thorough roasting of both sides. Finally, *sakada* is removed from the perforated cans, cooled and packaged. *Sakada* is a popular and marketable snack/product in Oyo Town, Oyo State, Nigeria, and interest in its consumption can be enhanced if fortified with plant or animal-based nutrients.

Moringa oleifera also known as "miracle plant" is one of the most recently cultivated plants in West African regions because of its usefulness from leaves to roots [11]. Globally, it is a multi-purpose plant utilized as human food and herbs. Different parts of *Moringa oleifera* plant contain an impressive range of minerals. It is also an excellent source of vitamins, protein, beta-carotene, amino-acids and various phenolics [12]. Its seeds are edible in fresh, dried or with the seed pods, and contain minerals and vitamins such as calcium, phosphorus, iron, vitamins A, B and C. These seeds are high in protein but low in fat and carbohydrates [13, 14] also reported that the protein, fat and mineral (especially magnesium) contents of moringa seed are significantly higher than that of moringa leaves. In addition to its high nutritional value, *Moringa oleifera* plant is also important for its medicinal properties [12, 13]. Many researchers had reported the use of moringa leaf and seed powders for fortification of foods such as weaning food (cereal gruel), cookies and bread [15, 16, 11].

Since moringa seed powder contains protein, beta-carotene and minerals in sufficient amount, fortifying *sakada* (which is low in these nutrients) with moringa seed powder would be a worthwhile venture. This will significantly improve its nutritional value and further promotes its consumption. In addition, consumption of locally prepared snack such as *sakada* will reduce over-dependence on imported and or foreign snacks. Therefore, objective of this study was to determine the effects of moringa seed powder fortification on the proximate, minerals and vitamin A contents of *sakada*.

Materials and Methods

Sources of raw materials

Freshly harvested low-cyanide cassava roots (*Manihotesculenta*) (7.38 mg HCN/100g) were collected from International Instituteof Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. Moringa seeds (*Moringaoleifera)*, sugar, salt and vegetable oil were bought from Oja-oba market in Ilorin, Kwara state, Nigeria.

Preparation of Moringaoleifera seed powder

Moringa seeds were cleaned, dehulled, oven- dried at 60 ^{0}C, cooled and dry-milled using an electric blender (USHA). The powder obtained was sieved and kept in an air-tight container (Figure 1).

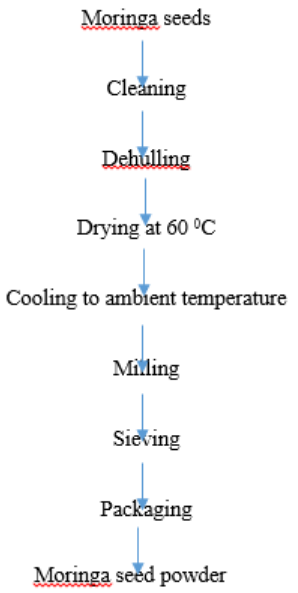

Figure 1: Flow chart for production of moringa seed powder.

Preparation of Sakada without moringa seed powder fortification

Freshly harvested cassava roots were washed, peeled, re-washed to further remove dirts and then grated using fabricated cassava grater. Cassava pulp obtained was bagged and allowed to ferment for 18 hours. In following, fermented pulp was dewatered, sifted to obtain cassava grits and then mixed appropriately with sugar and salt to taste. Sugar and salt (100 and 30g respectively) were added to the cassava grits (1 kg) (Table 1). The prepared grit was filled into cans (perforated on both sides) on oiled-tray above a moderately burning fire to roast. After thorough roasting of both sides, *sakada* was cooled to ambient temperature and packaged (Figure 2).

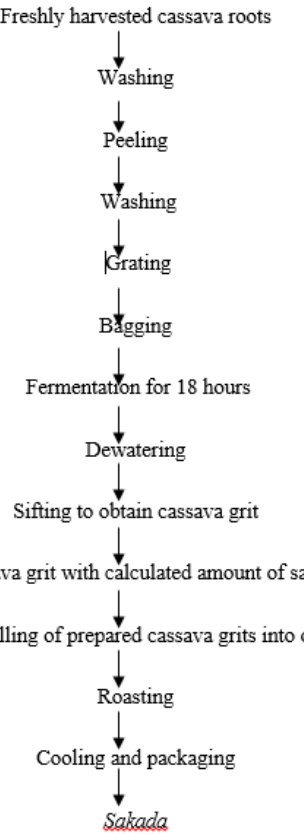

Figure 2: Flow chart for production of unfortified sakada.

Table 1: Moringa seed powder-cassava formulations for *sakada* production.

Samples	Cassava grit (g)	Sugar (g)	Salt (g)	*Moringa oleifera* seed powder (g)
A	1000	100	30	0
B	950	100	30	50
C	900	100	30	100
D	850	100	30	150
E	800	100	30	200

KEY
Sample A - (100% C + 0% M)
Sample B - (95% C + 5% M)
Sample C - (90% C + 10% M)
Sample D - (85% C + 15% M)
Sample E - (80% C + 20% M)
C= cassava grits, M= Moringa oleifera seed powder

Preparation of Sakada with moringa seed powder

Cassava grit was prepared as described above and moringa seed powder was added at different proportions as shown in table 1 [11]. It was then filled into open-ended cans and processed as described above (Figure 3).

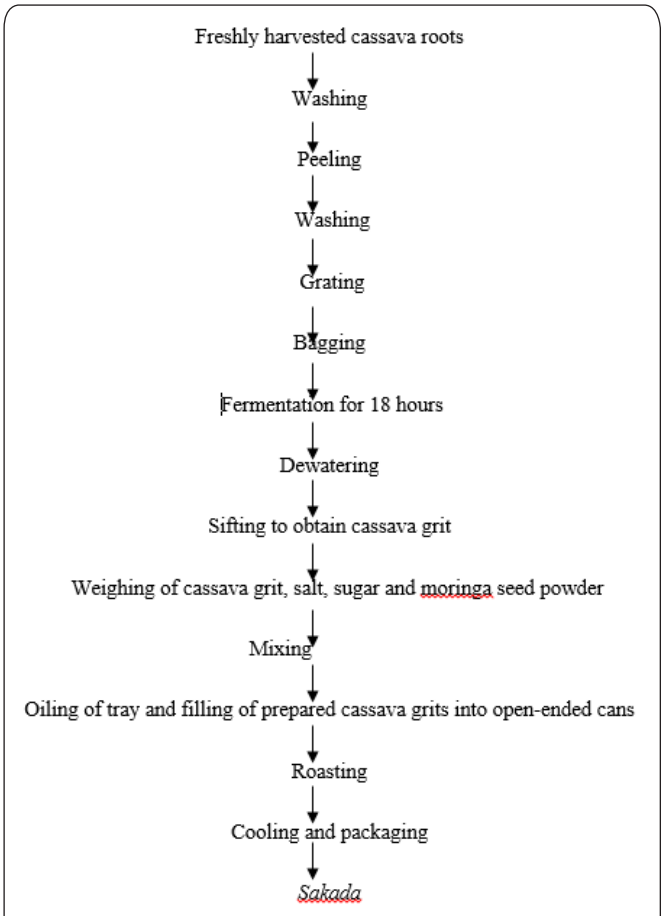

Figure 3: Flow chart for Moringa oleifera fortified sakada production.

Table 2: Proximate composition of unfortified and moringa fortified sakada samples

Sakada Samples	Moisture(%)	Protein(%)	Fat(%)	Ash(%)	Fibre(%)	Carbohydrate(%)
A	8.45^{a}±0.10	2.48^{a}±0.03	1.91^{a}±0.00	0.97^{a}±0.73	2.06^{a}±0.03	84.13^{e}±0.63
B	8.52^{b}±0.03	4.82^{b}±0.05	2.95^{b}±0.11	1.03^{b}±0.07	3.15^{b}±0.31	79.53^{d}±0.25
C	8.63^{c} ±0.19	6.04^{c}±0.13	7.53^{c}±0.06	1.36^{c}±0.07	4.38^{c}±0.25	72.06^{c}±0.15
D	8.65^{c} ±0.47	6.83^{d}±0.02	8.30^{d}±0.16	1.38^{c}±0.99	4.47^{c}±0.14	70.37^{b}±1.15
E	8.45^{a} ±0.17	6.96^{d}±0.00	9.01^{e}±0.43	1.41^{cd}±0.31	4.51^{bc}±0.05	69.66^{a}±0.66

Data presented on dry matter basis. Each value is a mean of three independent experiments. Means followed by the same superscript along the same column are not significantly different ($p > 0.05$). Sample codes are as in Table 1.

Chemical analyses of sakada samples

Proximate analysis of moringa fortified and unfortified sakada samples

The samples were analysed for moisture, crude protein, fat, fibre and ash according to procedure described by AOAC [17] while carbohydrate contents were determined by difference.

Vitamin A and mineral contents determination

Vitamin A contents of *sakada* samples were determined according to Singh et al method [18]. For mineral content determination, *sakada* samples (5g each) were ashed, and the metallic contents (calcium, potassium and iron) were determined using Perkin Elmer Analyst 200 Atomic Absorption Spectrophotometer.

Sensory assessment

Coded *sakada* samples were served to twenty (20) randomly selected semi-trained panelists. Each panellist was asked to assess *sakada* samples for appearance, taste, flavour and overall acceptability using a nine (9) point's hedonic scale rating, where 1 and 9 respectively represented dislike and like extremely. *Sakada* without moringa seed powder fortification was used as control sample.

Statistical analysis

All tests were done in triplicates and data obtained were statistically analysed using a one-way analysis of variance (ANOVA). Means were tested for significance difference by Duncan's. Multiple Range Test and Significance difference was accepted at $p < 0.05$.

Results and Discussions

Proximate compositions of unfortified and moringa fortified *sakada* samples

The proximate contents of unfortified and moringa fortified *sakada* samples are presented in table 1. Protein is an essential nutrient in human diet as it repairs and replaces damage and worn-out tissues, respectively.The protein content of the moringa fortified *sakada* increases significantly ($p < 0.05$) as the substitution level of moringa seed powder in the cassava grit increases. It increased from 2.48 to 7.60%. *Sakada* sample fortified with 20% moringa seed powder had the highest protein content (7.60 %) while the un-fortified sample had the least amount of protein (2.48 %). Bolarinwa et al., also reported significant increase in protein (8.55 - 13.46%) for moringa seed powder fortified bread [11]. The protein increments recorded in this study could be due to high level of protein in *Moringa oleifera* seed used as fortificant. The moisture content of *sakada* samples ranges from 8.45 to 8.79% while the crude fat content significantly increased ($p < 0.05$) from1.91 – 10.03 %. Sample E (80% cassava grit + 20% *Moringa oleifera* seed powder) had highest crude fat content while unfortified sample (sample A) had the least value (1.91%), and it corroborates with the findings of Saini et al., [19] that reported high amount of polyunsaturated fatty acids in tender moringa oleifera pods.In any event, ash indicates the mineral content of food. The ash content of the moringa fortified *sakada* samples was higher than its level in the unfortified sample (0.97 – 1.51 %). This follows similar trend with the findings of Haneen et al., [16] who reported significant increase in the ash content of cookies fortified with dried moringa leaves.

Fibre is essential in human diet as it absorbs water and provides roughage for easy bowel movement. The crude fibre content of the fortified *sakada* samples was also higher than its level in the unfortified sample. As moringa seed powder substitution level increases, crude fibre content also increases (2.06 – 5.28 %). Significant increase in crude fibre contents obtained in this study corroborates with the findings of Bolarinwa et al., [11] who reported crude fiber content of 0.08 – 0.6 2% for bread fortified with moringa seed powder.

On the other hand, carbohydrate content of unfortified *sakada* sample was the highest (84.13 %) while sample E (80% C + 20%M) had the least value (66.79 %).The low carbohydrate values recorded after moringa seed powder fortification may be due to increase in protein content in the fortified samples, thus consumption of fortified *sakada* may assist in preventing obesity and malnutrition.

Vitamin A composition of unfortified and moringa fortified *sakada* samples

Vitamin A is an essential component of the diet that contributes to good vision and Uchendu et al., [20] reported its consistent absence in the diet to be the leading cause of high morbidity and mortality rate recorded among the vulnerable group in most developing countries. In this study, the vitamin A contents (7.00 – 9.49 mg/100 g) of the fortified

Table 3: Sensory attributes of unfortified and moringa fortified sakada samples

Samples	Appearance	Taste	Flavour	Mouthfeel	Overall Acceptability
A	7.80^{c}±0.97	6.70^{b}±2.11	6.80^{c}±1.55	7.30^{c}±0.95	6.90^{a}±0.74
B	7.20^{b}±1.03	6.60^{a}±2.01	6.50^{b}±1.27	7.10^{a}±1.66	7.20^{b}±0.92
C	7.70^{c} ±0.95	7.50^{d}±1.35	7.00^{d}±1.41	7.30^{c}±0.95	7.60^{d}±0.84
D	7.10^{b} ±1.66	7.10^{c}±0.74	6.20^{a}±1.03	7.40^{d}±0.97	6.90^{a}±1.10
E	6.80^{a} ±0.79	6.60^{a}±1.51	6.20^{a}±1.87	7.20^{b}±0.92	7.30^{c}±1.16

Mean values along the same column with different superscript are significantly different ($p < 0.05$).

sakada samples were found to be significantly ($p < 0.05$) higher than those in un-fortified *sakada* (3.31mg/100 g). The high vitamin A content recorded in the moringa fortified *sakada* compared to the result reported by Bolarinwa et al, [11], and Olorode et al., [21] also reported more than 14 fold increase in vitamin A for ogi (cereal gruel) fortified with moringa powder. In addition, higher vitamin A contents recorded for moringa fortified *sakada* samples were in line with Hekmat et al., [22] who reported that moringa contains appreciable amount of vitamins especially A, C and E that are acutely needed for human growth, development, reproduction and proper health maintenance. Saini et al., [23] also reported that moringa is rich in carotenoids that are essential antioxidants and are known for protection against diseases and immune system enhancement. Deficiency of vitamin A can pose serious health problems especially among the vulnerable groups. Thus, inclusion of nutrient rich moringa seed powder in *sakada* and its consumption can increase vitamin A intake thereby promoting wellness, most especially among children and women of reproductive age that are prone to micronutrient deficiency disease.

Mineral content of unfortified and fortified *sakada* samples

Moringa seed fortification was reported to improve the nutritional value of foods of which its micronutrient status is not an exception [24]. Essential mineral contents of the fortified *sakada* such as iron, calcium and potassium increased significantly ($p < 0.05$) due to moringa seed powder addition. Calcium, potassium and iron contents of *sakada* were significantly higher than those recorded for the unfortified counterpart (control sample) following the addition of moringa seed powder (Figure 4). Calcium is very important in muscle contraction, building strong bones and teeth, blood clotting, nerve impulse, transmission, regulating heart beat and fluid balance within cells and it is needed in large amounts during childhood growth, pregnancy and when breast feeding [25]. The calcium contents recorded in this study ranged from 8.67- 9.98 ppm,and it agrees with Karim et al. [26] previous report for moringa leaf powder fortified stiff dough 'amala' that its mineral content improved significantly due to moringa oleifera fortification. Similarly, iron participates in many highly complex metabolic processes such as oxygen and electron transports as well as DNA synthesis [27]. In this study, iron contents increase with the level of moringa oleifera seed powder in the sakada samples. Iron contents ranged from 1.92 – 5.50 ppm, sample D had the highest iron content and

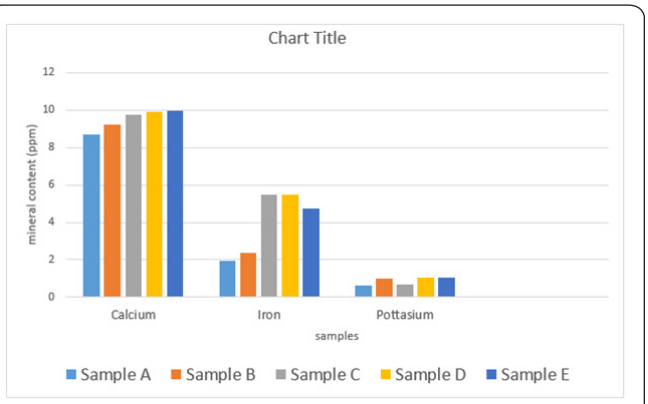

Figure 4: Mineral contents of unfortified and Moringa oleifera fortified sakada samples (Sample codes are same as in Table 1).

unfortified sample (A) had the least amount. Furthermore, potassium is another nutrient essential for human health and its roles in the body cannot be over-emphasized. It protects against hypertension and improves bone health. In fact, it is healthful for adults to increase intake of dietary potassium to reduce blood pressure and risk of cardiovascular heart disease [28]. During this study, sample D had highest amount of potassium (1.0718 ppm), while its level in the control and sample C were not significantly different ($p > 0.05$).

Sensory attributes of unfortified and moringa fortified *sakada* samples

Table 3 shows the results of sensory evaluation of the *sakada* samples. The results obtained revealed that sample A had the highest sensory rating for appearance (7.80) while sample C (10 % moringa seed powder fortified *sakada*) had highest sensory scores for taste (7.50) and flavour (7.00) and it was the most preferred sample by the panelists. This could be due to the mild herbal flavour of moringa seed powder compare to leaf [24]. However, unfortified *sakada* (sample A) was rated almost equally as samples B and D in terms of taste and overall acceptance.

Conclusion

This study revealed that fortification of *sakada* (cassava-based snack with grossly low protein, vitamins and minerals contents) with *Moringa oleifera* seed powder resulted in significant increase in its macro and micronutrients, such as protein, vitamin A, calcium, potassium and iron, which play

important roles improper functioning of vital life processes. Addition of *Moringa oleifera* seed powder to *sakada* is a worthy venture as it improved the nutritional value of *sakada* and its consumption could proffer solution to protein and micronutrient malnutrition problems especially in developing countries where conventional protein sources are expensive. *Sakada* with 10% *Moringa oleifera* seed powder had the highest sensory scores and was most preferred by the panelists.

Conflict of Interest

The authors no conflict of interest.

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