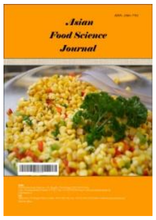

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Proximate Composition and Sensory Properties of *Dakere* (A Nigerian Steamed Agglomerated Dumpling) as Affected by Differential Sieving and Fortiftcation with Legume Flour

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Authors' contributions

AGI designed the study, subjected the generated data to statistical analysis; USG processed the materials and supervised the physicochemjcal analysis of the same and the products (dakere) as well as organize the sensory evaluation, USG also joined in the surfing of the WWW for literature and produced the first manuscript draft; OAI and AGI collectively revisited the draft and further elevated it to the present standard. All authors collaboratively revised the draft and authorized its publication.

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ABSTRACT

Dakere is a traditional steamed agglomerated dumpling produced from either millet (M) or sorghum (S) flour or both (MS). In the current study, millet and sorghum flours were separately fractionated into fine (f) (<250um), medium (m) (250-350um) and coarse (350-500um) fractions. Similar fractions from millet and sorghum were blended to obtain MfSf,MmSm and McSc. Each fraction was fortified separately with 30% toasted bambara groundnut or sesame seed flour or both (20% bambara groundnut and 10% sesame seed flour), blends were coded: MfSf, MmSm, McSc, MfSfB, MmSmB, McScB, MfSfSe, MmSmSe, McScSe, MfSfBSe, MmSmBSe and McScBSe. Experimental design corresponding to a 3x2x2 factorial design was used to generate runs and *dakere* were produced applying the traditional method of agglomeration of stiff dough followed by steaming, and thereafter dried. Traditional dakere was the experimental control. The blends and the dried modified *dakere* were evaluated for proximate composition and sensory properties. The moisture,

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crude protein, crude fat, crude fibre, total ash and carbohydrate contents of the blended fractions and the fortified blended fractions varied significantly (p<0-05): 9.40-10.55%,11.42-15.80%,1.20-2.22%, 0.62-0.96%, 3.62-7.38% and 63.56-72.30% respectively and for the various modified *dakere:* 9.20-10.255, 11.70-16.82%, 1.23-2.77%, 0.55-0.88%, 4.64-8.30% and 60.22-70.86% respectively. Blended fractions and fortified blended fractions had greater nutrient density than the control, however more in the blends containing both bambara groundnut and sesame seed flours. As for sensory attributes of the modified *dakere*, the blended fractions especially MfSf had the best appearance, fortified *dakere* the best aroma and taste scores especially *dakere* with sesame seed meal despite the dull appearance. Dakere produced with blended coarse fractions or fortified coarse fractions were crispier and were desired more than others. The overall acceptability scores were generally high, the highest score observed in the sesame seed meal treated *dakere*. The study had succeeded in enhancing the nutrient density and sensory properties of *dakere,* an agglomerated stiff dough through the blending of similar flour fractions from millet and sorghum and fortification of the same with grain legume flours.

Keywords: Pearl millet; sorghum; bambara groundnut; sesame seed; flour fractionation; dough agglomeration; dakere.

1. INTRODUCTION

Dakere is a Nigerian traditional steamed cereal–based agglomerated dumpling, prepared from either millet or sorghum flour or a combination of the two. The product is a known snack, meal or beverage depending on how it is reconstituted. Traditionally, *dakere* is made from 50:50 dehulled millet and sorghum flour, the flour is mixed with water to form a stiff dough. The dough is agitated to form agglomerates which are then steamed to produce fresh dakere and thereafter dried for storage stability. Dekare is a common food item among the numerous tribes of northeastern Nigeria, it's consumed either fresh or dried, consumed alone or reconstituted with water or milk and sweetened to form a refreshing beverage. Dried *dakere* is shelf–stable, a common snack for farmers, normads or school children because it is a ready source of calorie. The semi arid environment of northeastern Nigeria favours the cultivation of grain sorghum (sorghum bicolor) and pearl millet (Pennisetum glaucum) [1]; and *dakere* also called *dambu dawa* or *gero* is one of the traditional food items produced from these coarse cereals. In Asia and Africa continents, millets serve as the main component in assorted traditional foods and beverages [2], mostly thick and thin porridges, and assorted snacks which are made of millet especially among the resource poor segments of the societies [3]. It has also been reported that millet proteins are a rich source of essential amino acids except lysine and threonine but is relatively higher with methionine and a rich source of micronutrients (Mal et al., 2010; Ahmadou et al. [4]). Similarly, sorghum bicolor thrives in arid or semi arid tropical or sub-tropical regions of the world [5], a major supplier of dietary energy and micronutrients. Tasie and Gebreyes [6] reported the proximate composition of thirty five sorghum cultivars: moisture 9.66-12.94%, ash 1.12-2.29%, fat 2.48- 4.60%, fibre 2.17-4.9%, protein 8.20-16.48% and carbohydrate 67.56-76.42%, indicating that it is a rich source of micro- and micronutrients.

The grain legumes generally are important source of vegetable protein, two to three times greater than the amount available in cereals therefore, they are used for the fortification of existing foods or for fabrication of novel ones in order to curb the menace of malnutrition ocassioned by food insecurity among the low income class in developing world.

Bambara groundnut (*Vigna subterranea* Verdc) is a pulse of West Africa origin [7], Nigeria is the leading producer where it serves various food uses. Bambara bean is regarded as a complete food with 16-21% protein, 4.5-6.5% fat, 3- 5% fibre, 63-65% carbohydrate [8]. The lysine (6.5ug/16gN), methionine (1,14g/16N) .and cysteine (1.80g/16N) of bambara bean protein are comparable to that of soybean protein [9,10]. Sesame seed (*Sesamum indicum* L.) on the other hand, is largely grown in Nigeria in a commercial quantity [11,12]. It is a good source of protein (18-25%), minerals, fibre (5%), fat (44-58%), vitamins and carbohydrates (13.5%) Kahyaoglu and Kaya [13]. In grain milling outer fibrous coat and germs are separated from the endosperm and through differential sieving fractions are obtained, each fraction is characterized by unique particle size distribution which in turn influences the functional and compositional properties of flour. Therefore, the objectives of present study were to fractionate millet and sorghum flours into fine, medium and coarse flour fractions, blend similar fractions and thereafter supplement each of the blended fractions with either bambara groundnut or sesame seed meal or both in a predetermined ratios and the same were used to produce dakere. The proximate composition and sensory properties of the modified *dakere* were evaluated.

2. MATERIALS AND METHODS

2.1 Sources of the Grains Used for *Dakere* Preparation

Pearl millet (SOSSAT C88) and sorghum (Chakalari white) were procured from the Lake Chad Research Institute, Maiduguri Borno State, Nigeria. Bambara groundnut (cream-coloured) and Sesame Seeds (white) were also purchased from Custom Area market, Maiduguri.

2.1.1 Processing of the grains into flours

Millet and sorghum were cleaned by winnowing to remove foreign materials like sand, immature seeds and weed seeds. The sound grains were conditioned, decorticated ,washed, dried and milled into flour and sieved. Bambara groundnut and sesame seeds were lightly toasted, milled into flours. The resulting flours were stored in transparent plastic containers prior to use for formulation and instrumental analysis.

2.1.2 Pearl millet and sorghum flour fractionation

Four sieves (250um, 350um, 450um and 500um) were stacked in descending order with 500um sieve at the top. The stacked sieves were mounted on the sieve shaker (Model EL08-30, Endecotts UK) and with the flour on the top sieve, the machine was operated to obtain the different fractions through differential sieving which were arbitrarily classifief as fine (>250um), medium (250-350um) and coarse (350-500um) fractions.

2.1.3 Formulations and sample codes

Fine (f) millet (M) and sorghum(S) fractions, medium (m) millet and sorghum fractions and coarse (c) grained millet and sorghum flour fractions were blended (1:1) a total of three samples were obtained namely, MfSf, MmSm and McSc. Blended fractions (MfSf, MmSm and McSc) were each fortified with 30% bambara groundnut(B) flour which resulted to three extra samples coded as : MfSfB, MmSmB and McScB (70:30), the same blended fractions (MfSf, MmSm and McSc) were again fortified with 30% sesame flour (Se) each, three more samples generated coded as; MfSfSe, MmSmSe and McScSe (70:30); again bambara groundnut and sesame flours combined (20:10) were used to fortify MfSf, MmSm and McMc which yielded further three samples coded thus; MfSfBSe, MmSmBSe and McScBSe (70:20:10). The total number of samples were 12 and unfractionated blend of millet and sorghum flours blended (1:1) served as the control. The samples were placed in different plastic buckets bearing the respective sample code names and stored at room temperature prior to production of *dakere* and determination of functional properties and particle size distribution of the mult-flour blends.

2.2 Experimental Design and statistical analysis

A factorial design (3x2x2) was used to generate the experimental runs. Three flour fractions: (fine (f) <250um, medium (m) 250-350 and coarse (c)350-500um from two (2) cereal grains: millet(M) and sorghum (S) each blended fraction supplemented with either bambara groundnut (30%) or sesame seed flour (30%) or both (20:10%) yielding 12 samples. Control represented the unfractionated, unsupplemented blend of millet and sorghum flours. The analytical procedures were replicated, the mean and standard deviation calculated, the data were subjected to analysis of variance and the treatment means were separated using Duncan's Multiple Range test and the critical difference set at 5% probability ($p<0.05$). SPSS version 16 was the statistical software that enabled the statistical analysis of the generated data.

2.3 Proximate Composition of the Blends, Modified and the Control *Dakere*

Proximate composition was determined according to the established procedures of AOAC [14]: Moisture AOAC method 915.10, drying in hot air oven at (130•C, 60 min), crude Protein (Nx6.25) AOAC method 960.52, crude fat by soxhlet extraction AOAC method 963.15, crude fibre using neutralisation method AOAC method 945.38, total ash by dry ashing, AOAC method 923.03 and carbohydrate obtained by 'difference'. The calorific values of the *dakere* were calculated using Atwater conversion factors.

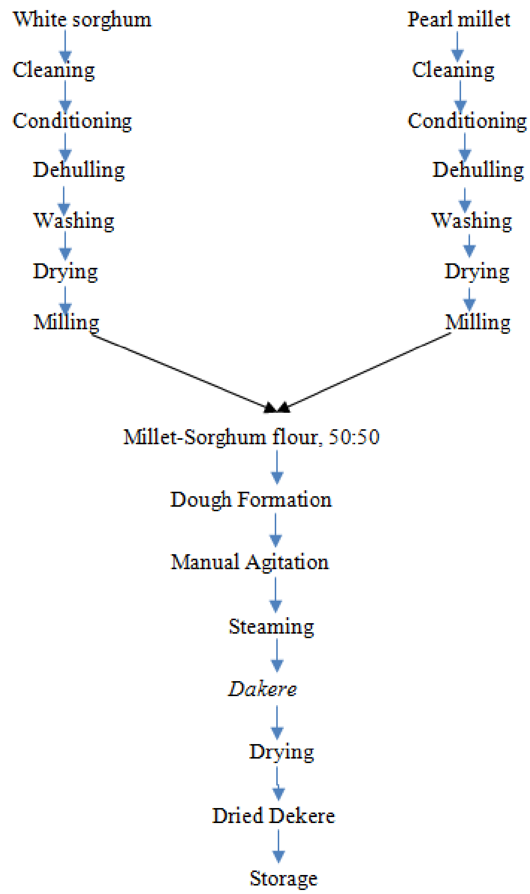

Fig. 1. Flow chart illustrating the processing of traditional *Dakere*

2.4 Sensory Evaluation of the Various *Dakere*

Twenty test panellists were selected from the faculty of Engineering University of Maiduguri comprising 10 males and 10 females comprising staff and students, age ranged from 23 to 47 years; they had eaten dakere before and know about traditional dakere; these evaluated the color, texture, aroma, taste, and the acceptability of the various modified *dakere* using the traditional *dakere* as a reference point on a 9 – point Hedonic Scale where 9 represents extremely liked 5 neither like nor disliked and 1 represented extremely disliked [15]. Coded *dakere* samples were presented to the panellists randomly on disposable plastic plates, containing. There were four sessions, a session daily after 13.30pm prayer for unfortified, Bambara fortified, sesame seed fortified and both Bambara and sesame seed fortified dakeres nutinvolved. Each panelist was provided with warm water for gargling of bucal cavity before proceeding to the next sample.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of the Raw Material Used for *Dakere* Preparation

The proximate composition of each of the whole grain used for *dakere* preparation is presented in Table 1.

Sesame seed had the least moisture (5.51%), carbohydrate (18.07%), but the highest amount of crude fibre (6.60%), fat (48.30%), ash (4.11%) and the protein content of sesame seeds were not significantly different from those of bambara groundnut which indicates that sesame seed is highly nutritious, therefore a better food fortificant than other oil seeds. El-Kheir et al. [16] reported higher oil and protein contents for sesame seeds than obtained in this study. Proximate values for two bambara nut varieties reported by Aremu et al. [17] were comparable to the proximate composition of bambara bean used in this study.The crude protein of pearl millet and sorghum were comparable and significantly not different(p>0.05), both had higher carbohydrate contents than bambara groundnut and sasame seeds [18]. The proximate composition of whole pearl millet grain obtained in this study is in tandem with the values reported by Fashakin et al. [19] although it was revealed that sorghum bicolor have higher amount of carbohydrate than the pearl millet. Alaise and Linden [20] reported that pearl millet and sorghum have comparable nutrient composition which this study revealed as well as the findings of Tastie and Gebreyes [6].

3.2 Proximate Composition of Blended Flour Fractions and the Blends Fortified with Bambara Groundnut or Sesame Seed or Both

Presented in Table 2 is proximate composition of blends used in production of modified *dakere*. The general trend observed was gradual increase in protein, fat, ash, crude fibre and decreased carbohydrate contents with the addition of bambara groundnut or sesame seed or both and higher levels of nutrients were recorded in flour fractions fortified with both bambara and sesame (70:20:10). There were reductions in ash, crude fibre, and the fats contents of the blends compared with those of the whole grain flours shown above. Significant variation was not observed in the moisture content of the blends, they were either slightly greater than 10% or less than 10%, a range of 9.40 – 10.55%. The moisture contents of blends were generally low reflecting the dryness of the environment(May/June). The control had the least protein content of (11.42%), protein content gradually increased in the flour fractions fortified with bambara groundnut or sesame or both for obvious reasons.

Ash contents were generally high, the lowest level was noticed in the control (3.62%) and highest in the blends containing both bambara groundnut and sesame, the range was 3.62-7.38%, on the other hand, crude fibre contents were very low (0.51- 0.95%) perhaps due to debranning of the grains before milling. MS, the control had the highest carbohydrate level of 72.30%, the least ash, protein, fibre and fat contents. Formulations containing both bambara nut and sesame had greater contents of fat, protein, ash and crude fibre and the least carbohydrate content. Dehulling , milling and sieving reduced the nutrient density of the blended fractions as whole grain values revealed in Table 1. Blended fractions had slightly higher proximate composition than the control, justifying the use of fortified blended fractions for *dakere* or for any other food product production. A similar enhancement of the proximate composition of the wheat-pearl millet-cowpea composite flours for the flat bread called gurasa was reported by Bade et al. [21]. However, the protein, fat and crude fibre contents of the modified blends were lower than reported by Zakari et al. [22] for complementary food produced from a blend of millet, soybean and African Locust bean fruit pulp flour.

3.3 Proximate Composition of Modified *Dakere* and the Control

The moisture contents of the modified and unmodified *dakere* were generally low as a result of the drying process and hovered around 9% to 10% indicative of shelf stability (Table 3), however were significantly different ($p < 0.05$). The protein contents of various *dakere* ranged from 11.90% to 16.82%. *Dakere* containing both bambara groundnut and sesame seed had higher protein contents while the control MS (1:1) contained the least followed by the unsupplemented blended flour fractions.

Crude fibre of the different modified *dakere* varied from 0.44% to 0.88%, blended fine millet and sorghum flour fractions(MfSf) alone or fortified with sesame or bambara groundnut had the lowest crude dietary fibre, grain decortication was responsible for the lower level of dietary fiber for all the *dakere,* the highest amounts were observed in *dakere* containing both bambara groundnut and sesame seed flours. In same vein, *dakere* with both bambara groundnut and sesame had greater crude fibre contents than untreated *dakere*. Although no clear pattern of variation was observed in the ash contents of the various *dakere*, however ash contents were appreciably high and ranged from 4.64% to 8.36%, higher in the *dakere* produced from blended coarse flour fractions: McScBSe (8.36%), McScSe (7.81%) and McScB (7.56%).

Table 1. Proximate composition of raw materials used for *Dakere* production

Grain	Crude fibre%	Ash%	Crude protein%	Fat%	Moisture%	Carbohydrate%
Millet	$2.037^{b} \pm 0.02$	$2.101^{c} \pm 0.01$	$12.301^{c} \pm 0.04$	$2.401^{c} \pm 0.03$	$11.060^{b} \pm 0.03$	$70.104^{b} \pm 0.08$
Sorghum	$2.013^{b} \pm 0.02$	$2.402^{b} \pm 0.03$	$11.205^{d} \pm 0.02$	$2.302^{c} \pm 0.04$	$11.305^{b} \pm 0.03$	$70.770^{a} \pm 0.05$
Bambara bean	$4.612^{b} \pm 0.01$	$3.506^{a} \pm 0.02$	$18.301^{a} \pm 0.04$	$6.851^{b} \pm 0.02$	$8.201^{a} \pm 0.02$	$58.529^{c} \pm 0.02$
Sesame seed	$6.602^{a} \pm 0.04$	$4.110^{a} \pm 0.03$	$17.412^{b} \pm 0.03$	$48.301^{a} \pm 0.04$	$5.508^{a} \pm 0.03$	$18.067^{d} \pm 0.06$

Mean $\pm$ SEM (n=3) means not followed by the same super scripts in a columns are significantly difference ($p \leq 0.05$)

Table 2. Proximate Composition (%) of the blended flour fractions and the fortified blended fractions

Sample code	Moisture	Crude Protein	Crude Fat	Crude Fibre	Ash	Carbohydrate
M:S	$10.55^{a} \pm 0.05$	$11.42^{gg} \pm 0.06$	$1.44^{cd} \pm 0.03$	$0.62^{d} \pm 0.05$	$3.62^{e} \pm 0.03$	$72.30^{a} \pm 0.09$
Mf-Sf	$9.88^{b} \pm 0.02$	$12.70^{f} \pm 0.01$	$1.52^{b} \pm 0.04$	$0.75^{c} \pm 0.02$	$5.40^{c} \pm 0.01$	$69.74^{b} \pm 0.04$
Mm-Sm	$9.40^{e} \pm 0.02$	$13.60^{e} \pm 0.02$	$1.65^{b} \pm 0.06$	$0.56^{e} \pm 0.03$	$5.61^{c} \pm 0.05$	$69.25\ ^{b} \pm 0.03$
Mc-Sc	$9.51^{cd} \pm 0.03$	$13.80^{e} \pm 0.04$	$1.48^{c} \pm 0.05$	$0.51^{f} \pm 0.04$	$5.02^{cd} \pm 0.02$	$69.66^{b} \pm 0.02$
Mf-SfB	$9.62^{c} \pm 0.06$	$14.67^{cd} \pm 0.02$	$1.30^{e} \pm 0.04$	$0.88^{ab} \pm 0.01$	$5.42^{cd} \pm 0.02$	$67.92^{d} \pm 0.08$
Mm-SmB	$9.52^{cd} \pm 0.02$	$14.88^{c} \pm 0.01$	$1.40^{c} \pm 0.02$	$0.96^{a} \pm 0.04$	$5.66^{c} \pm 0.03$	$68.20^{c} \pm 0.08$
Mc-ScB	$9.66^{c} \pm 0.03$	$14.61^{c} \pm 0.01$	$1.63^{b} \pm 0.04$	$1.03^{e} \pm 0.03$	$6.56^{b} \pm 0.03$	$66.77^{a} \pm 0.08$
MfSfSe	$9.73^{c} \pm 0.02$	$14.20^{d} \pm 0.02$	$1.20^{f} \pm 0.07$	$0.58^{e} \pm 0.02$	$6.54^{b} \pm 0.02$	$73.82^{a} \pm 0.07$
Mm-SmSe	$9.80^{c} \pm 0.02$	$14.50^{c} \pm 0.04$	1.300 ± 0.09	$0.57^{e} \pm 0.03$	$6.77^{b} \pm 0.02$	$67.11^{d} \pm 0.08$
Mc-ScSe	$9.81^{c} \pm 0.02$	$14.71^{c} \pm 0.04$	$1.46^{c} \pm 0.04$	$0.48^{f} \pm 0.02$	$6.72^{b} \pm 0.03$	$66.82^{f} \pm 0.01$
Mf-SfBSe	$10.05^{b} \pm 0.03$	$15.42^{b} \pm 0.04$	$2.12^{a} \pm 0.09$	$0.83^{b} \pm 0.01$	$7.20^{a} \pm 0.04$	64.38 ± 0.07
Mm-SmBSe	$10.06^{b} \pm 0.02$	$15.55^{b} \pm 0.07$	$2.22^{a} \pm 0.09$	$0.95^{a} \pm 0.04$	$7.19^{b} \pm 0.03$	$64.16^{h} \pm 0.06$
Mc-ScBSe	$10.118^{ab} \pm 0.05$	$15.803^{a} \pm 0.07$	$2.213^{a} \pm 0.07$	$0.941^{a} \pm 0.04$	$7.38^{a} \pm 0.03$	$63.562^{i} \pm 0.07$

Mean $\pm$ SEM (n=3) means not followed by the same super scripts in a column are significantly difference ($p < 0.05$)

- *Fine (f), Medium (m), Coarse (c) flour fractions of millet (M) and Sorghum (S)*

blended (1:1) (M_fS_f, MmSm. McSc) . Fortification of blended flour fractions with 30% bambara bean (B) f lour (70:30), MfSfB, MmSmB and McScB

- *Fortification of blended flour fractions with 30% sesame seed flour (70:30), M_fSfSe, MmSmSe and McScSe.*
- *Fortification of blended flour fractions with both bambara bean (20%) and sesame seed flour (10%) , (70:20:10), MfSfBSe, MmSmBSe, McScBSe.*

Table 3. Proximate Composition of *dakere* obtained from unfortified blended flour fractions and fortified blended fractions

Formulation	Crude Fiber (%)	Ash (%)	Protein (%)	Fat (%)	Moisture (%)	Carbohydrate (%)	Calorie (Kcal)
M-S	$0.55^{d}\pm0.05$	$4.64^{e}\pm0.12$	$11.90^{g}\pm0.65$	$1.58^{cd}\pm0.03$	$10.25^{a}\pm0.03$	$70.86^{a}\pm0.05$	345.28
Mf-Sf	$0.68^{c} \pm 0.02$	$6.47^{c}\pm0.31$	$12.983^{f}\pm0.17$	$1.81^{b}\pm0.06$	$9.977^{b}\pm0.02$	$68.18^{b}\pm0.11$	340.94
Mm-Mc	0.47e± 0.02	$6.60^{c} \pm0.05$	$14.76^{e}\pm0.22$	$1.65^{c}\pm0.04$	$9.20^{e}\pm0.26$	$67.60^{c}\pm0.10$	344.29
Mc-Sc	$0.44^{f}\pm0.04$	$6.11^{cd}\pm0.09$	$14.88^{e}\pm0.16$	$1.83^{b}\pm0.06$	$9.69^{cd} \pm0.03$	$67.16^{cd}\pm0.06$	344.60
Mf-SfB	$0.78^{ab}3\pm0.01$	$6.497^{c}\pm0.02$	$15.66^{cd} \pm0.20$	$1.61^{c}\pm0.05$	$9.76^{c}\pm0.04$	$66.50^{d}\pm0.05$	343.09
Mm-SmB	$0.86^{a}\pm0.04$	$6.68^{c}\pm0.02$	$15.88^{c}\pm0.12$	$1.46^{e}\pm0.04$	$9.69^{cd}\pm0.02$	$65.77^{e}\pm0.02$	339.79
Mc-ScB	$0.88^{a} \pm0.02$	$7.56^{b}\pm0.03$	$15.77^{c}\pm0.12$	$1.47^{e}\pm0.02$	$9.87^{c}\pm0.03$	$65.75^{e}\pm0.02$	339.33
MfSfSe	$0.48^{e} \pm0.02$	$7.56^{b}\pm0.03$	$15.27^{d}\pm0.02$	$1.86^{b}\pm0.04$	$9.88^{c}\pm0.02$	$65.15^{ef}\pm0.04$	338.42
Mm-SmSe	$0.48^{e} \pm 0.03$	$7.68^{b}\pm0.02$	$15.97^{c}\pm0.02$	$1.23^{f}\pm0.07$	$9.88^{c}\pm0.02$	$64.88^{f}\pm0.05$	334.51
Mc-ScSe	$0.45^{f} \pm0.02$	$7.81^{b}\pm0.02$	$15.85^{c}\pm0.04$	$1.49^{d}\pm0.03$	$9.78^{c}\pm0.02$	$64.50^{f}\pm0.04$	334.83
Mf-SfBSe	$0.78^{b}\pm0.01$	$8.19^{a}\pm0.03$	$16.41^{b}\pm0.05$	$2.64^{a}\pm0.07$	$10.15^{b}\pm0.03$	$62.23^{g}\pm0.07$	338.31
Mm-SmBSe	$0.85^{a}\pm0.04$	$8.20^{a}\pm0.04$	$16.53^{b}\pm0.07$	$2.65^{a}\pm0.09$	$10.18^{b}\pm0.02$	$61.8^{h}\pm0.06$	337.30l
Mc-ScBSe	$0.88^{a}\pm0.02$	$8.36^{a}\pm0.03$	$16.82^{a}\pm0.76$	$2.77^{a}\pm0.10$	$10.06^{ab}\pm0.05$	$60.22^{i}\pm0.07$	333.05

Mean ± SEM (n=3) means not followed by the same super scripts in a column are significantly difference ($p < 0.05$)

- *Fine (f), Medium (m), Coarse (c) flour fractions of millet (M) and Sorghum (S) equally blended (1:1) (M_fS_f, MmSm. McSc) . Fortification of blended flour fractions with 30% bambara bean (B) f lour (70:30), MfSfB, MmSmB and McScB*
- *Fortification of blended flour fractions with 30% sesame seed flour (70:30), M_fSfSe, MmSmSe and McScSe.*
- *Fortification of blended flour fractions with both bambara bean (20%) and sesame seed flour (10%) , (70:20:10), MfSfBSe, MmSmBSe, McScBSe.*

Fat contents were generally low and ranged from 1.23% to 2.77%, *dakere* with both sesame seed and bambara groundnut had slightly higher fat contents. Carbohydrate (by 'difference') were higher in *dakere* from unfortified blended fractions and the control, the carbohydrate contents of all the *dakere* were high and ranged from 60.22% (McScBSe) to 70.86% control (MS).

The general observation was that the control (MS) had the least proximate values followed closely by the *dakere* produced from unfortified blended fractions, and fortified blended fractions had the highest nutrient density especially *dakere* fortified with both bambara nut and sesame seed flour reflecting higher nutrien density of these two grains.

3.4 Sensory Attributes of Modified *Dakere* and the Control

3.4.1 Colour

The colour scores of modified *dakere* samples ranged between 5.84 and 7.51, *dakere* with 30% sesame seed flour had a dull colour that put off the test panelists. *Dakere* made from MfSf was brightly coloured therefore had the highest colour score (7.52), not significantly different from the colour score of MS (7.51) and McScBSe(7.34) on a 9-point hedonic scale. Modified *dakere* had poorer colour than unmodified *dakere* especially sesame flour containing *dakere* (with colour scores around 5 indicating neither liked nor disliked on a 9 point hedonic scale.

The modified *dakere* samples with the least colour scores were MfSfSe (5.84), MfSfBSe(5.90), and McScB (5.87), the lower sensory scores may be attributed to dull colour originating from sesame flour with relatively coarse flour particles (Table 4).

3.4.2 Taste

All fortified *dakere* had greater taste scores than those without bambara groundnut or sesame seed meal supplementation. Taste scores of the *dakere* samples ranged from 8.91 (MmSmSe) the highest, followed by MmSmB (8.34), MmSmBSe (8.58), McScB (8.34) and MfSfB (8.34) and McScBSe had the least taste score (5.65) the lower score could be attributed to bigger flour particles in the coarse fractions. Hirach and Kokini (2002) indicated that product from coarser fraction showed significantly lower scores for colour, taste, texture and overall acceptability. This is because its granular nature put off some of the product consumers.

3.4.3 Aroma

There was significant difference in the aroma scores(4.73-7.77) of all the *dakere*. Higher aroma scores were observed in the sesame seed flour fortified *dakere*. MmSmBSe had the highest score, 7.77 followed by MfSfSe(7.51,) McScB (7.39) and MmSmBSe (7.01). The higher aroma scores might be attributed to supplementation with sesame seed that contains high flavonoid content. Roasted oil seeds are full of aroma and tasteful. The control (MS) *dakere* made from the unfractionated flours had the least aroma score and those fortified with either bambara groundnut or sesame or both had better scores.

3.4.4 Texture

Crispy texture (crispness) is desired, if *dakere* is used as a snack consumed direct while softness is desired for easy reconstitution if used as a beverage or gruel or *tuwo*(stiff dough) Texture scores of *dakere* samples ranged from 4.04 to 6.89. McSc had the highest score (6.89) and was the most preferred for mouth feel followed by McScBSe (6.70), MfSfBSe (6.39), MmSmBSe (6.37), McScSe (6.23) MfSfB (6.17) and McScB had the least (4.04). Mouth feel properties of cereal products is a function of grain texture and flour particle size which translates to hardness. The texture of grain endosperm is reported by Givon (1995) to affect particle size and product quality. McSc had more coarse particles and gave the most liked mouth feel and texture. Gupta and Primavalli [23] observed that higher level of radish fibre in a snack produced snacks with better texture, and in this study coarse-textured *dakere* scored better than *dakere* made from the blended fine flour fractions. Texture of the control (MS) and *dakere* containing both bambara groundnut and sesame seed meal in the blended coarse flour fractions were significantly higher . Bambara groundnut containing *dakere* had poorer texture which was improved in *dakere* containing both Bambara bean and sesame seed flours indicating sesame seed meal influenced the texture scores.

Table 4. Sensory properties of modified *Dakere*

Sample Code	Color	Taste	Aroma	Texture	Overall acceptability
M-S	7.514[a] ±0.05	6.57[cd] ± 0.02	4.66[c] ± 0.03	6.65a[b] ± 0.02	6.17[e] ± 0.03
Mf-Sf (1:1)	7.16a[b] ± 0.02	6.35[d] ± 0.02	4.52[f] ± 0.03	6.09[c] ± 0.03	6.65[d] ± 0.02
MmSm (1:1)	6.553[b] ± 0.02	6.45[c] ± 0.026	4.61[e] ± 0.01	5.60[d] ± 0.04	7.07[b] ± 0.02
McSc (1:1)	6.24[b] ± 0.02	8.08[bc] ± 0.02	5.31[e] ± 0.01	6.89[a] ± 0.01	7.65[ab] ± 0.02
MfSfB (70:30)	6.26[b] ± 0.02	8.34[b] ± 0.03	5.48 ± 0.03	6.17[bc] ± 0.01	7.88[a] ± 0.03
MmSmB (70:30)	6.12[bc] ± 0.01	8.84[a] ± 0.04	5.49[e] ± 0.03	5.28[e] ± 0.03	7.88[a] ± 0.01
McScB (70:30)	5.90[c] ± 0.01	8.34[b] ± 0.03	7.39[b] ± 0.03	4.04[f] ± 0.02	6.96[c] ± 0.02
MfSfSe (70:30)	5.84[c] ± 0.02	8.56[ab] ± 0.01	7.51[ab] ± 0.02	4.89[ef] ± 0.02	6.97[c] ± 0.02
MmfmSe (70:30)	6.09[bc] ± 0.03	8.91[a] ± 0.02	7.77[a] ± 0.01	5.59[d] ± 0.02	6.98[c] ± 0.01
McScSe (70:30)	6.18[bc] ± 0.01	8.12[bc] ± 0.02	6.94[c]± 0.02	6.23[b] ± 0.02	7.07[b] ± 0.02
MfSfBSe (70:20:10)	5.88[c] ± 0.01	8.27[b] ± 0.02	6.81[c] ± 0.03	6.39[b] ± 0.01	7.15[b] ± 0.02
MmSmBSe (70:20:10)	7.34[ab] ± 0.02	8.58[ab] ± 0.01	7.01[c] ± 0.01	6.37[b] ± 0.05	7.15[b] ± 0.01
McScBSe (70:20:10)	7.16[ab] ± 0.02	5.65[e] ± 0.02	4.37[f] ± 0.03	6.69[ab] ± 0.02	6.06[f] ± 0.02

Mean ± SEM (n=3) means not followed by the same super scripts in a column are significantly difference ($p < 0.05$)

1) *Fine (f), Medium (m), Coarse (c) flour fractions of millet (M) and Sorghum (S) equally blended (1:1) (M_fS_f, MmSm. McSc) . Fortification of blended flour fractions with 30% bambara bean (B) f lour (70:30), MfSfB, MmSmB and McScB*
2) *Fortification of blended flour fractions with 30% sesame seed flour (70:30), M_fSfSe, MmSmSe and McScSe.*
3) *Fortification of blended flour fractions with both bambara bean (20%) and sesame seed flour (10%) , (70:20:10), MfSfBSe, MmSmBSe, McScBSe.*

3.5 Overall Acceptability

Overall acceptability scores of various *dakere* ranged from 6.06 to 7.88 with slight variation among the various *dakere* . MfSfB and MmSmB had equivalent scores of 7.88 and McSe (7.65), and had the best overall acceptability scores followed by MmSm (7.07) and MfSfBSe (7.15) MmSmBSe (7.15). And other *dakere* showed only slight difference with the exception of McScBSe that had the least acceptability score (6.06) This implied that all *dakere* were accepted none was rejected, and despite the dull colour of toasted sesame seed treated *dakere*, they had the best aroma scores and generally fortified *dakere* the best acceptability scores (Table 4).

4. CONCLUSION

Blending similar fractions of millet and sorghum flours enhanced the proximate composition of the blended flour fractions as well as the sensory properties of dakere obtained using them. Fortification of the blended fractions further enhanced the nutrient density of the blends and the various *dakere* especially those fortified with both bambara groundnut and sesame seed flours. Dull appearance impacted by the toasted sesame seed meal on the *dakere* did not prevent the same from having the best taste and aroma while blended coarse fractions were crispier. The study has succeeded in improving the overall proximate composition and sensory attributes of *dakere*.

This research could be extended further towards industrial *dakere* production including appropriate packaging, distribution and storage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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