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Full Length Research Paper

Proximate composition, mineral content and acceptability of granulated maize dumpling (Dambu Masara) with varying proportions of ingredients

Mamudu H. Badau[1] Hauwa Z. Abba[1], G. I. Agbara[1] and Abdullahi A. Yusuf[2]

[1]Department of Food Science and Technology, University of Maiduguri, P. M. B. 1069, Maiduguri, Nigeria.
[2]Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield 0028, Pretoria, Republic of South Africa

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***Dambu masara* (granulated maize dumpling) was produced using different proportions of maize, groundnut and water. The dehulled, cleaned grain was pulverized into coarse particles mixed with moringa, spices and water. The mixture was steamed and the "*Dambu masara*" produced were analyzed for their physicochemical properties, acceptability and mineral contents. The results obtained were statistically analyzed to determine the differences among the parameters studied. The moisture, ash, protein, crude fibre, soluble carbohydrate and energy contents of seven formulations of *Dambu masara* produced ranged from 15.6 – 36.0%, 3.9 – 6.0%, 12.5 – 18.3%, 1.9 – 3.1%, 31.8 – 50.76% and 8.658 to 14.812 KJ/g, respectively. Calcium ranged from 59.95 – 70.7 PPM (mg/1000g), whereas the Magnesium content ranged from 296 – 514.3 PPM. Phosphorus ranged from 700 – 1250 PPM. There were significant difference among the color, taste, aroma, texture and overall acceptability of *Dambu masara* produced from the various formulations. The traditional formulation and the samples with 70:30 ratio of (Maize to groundnut), and those with 60 g of water were the most acceptable products.**

Keywords: Cereals and grains, Chemical composition, Minerals and Sensory Evaluation

INTRODUCTION

The fruits of cultivated grasses and members of the grass family Graminae (Poaceae) are known as cereals. Cereal grains are very important crops especially in the developing world where maize (*Zea mays*), millet (*Pennisetum typhoides*), sorghum (*Sorghum bicolor*), Fonio millet (*Digitaria exilis*) formed part of the stable food. Seeds from cereal grains contain a large centrally located starchy endosperm that is rich in protein, with a protective outer coat consisting of two to three layers of fibrous tissues and an embryo or germ usually located near the bottom of the seed (Agu et al. 2008a). Most cereals contain vitamins and minerals with all the essential amino acids required by man except for lysine and tryptophan and when consumed with other food items, these can supplement for the low nutrients or even those lacking in the cereals (Ihekoronye and Ngoddy, 1995). However, deficiency in essential nutrients is not confined to cereals alone because most

Corresponding Author's Email: mamudu_badau@yahoo.com; mamudubadau@gmail.com

food consumed in developing countries either lack these nutrients (Hui 1992) or the information about their nutrient contents are lacking.

There are many traditional foods of Northern Nigerian origin produced from cereal grains. These are *inter alia* (among others) *tuwo, kunu, fura, masa, burakosko, akamu, ndaleyi, danwake, gumba, sinasin, burukutu, dekkere, mardam, dakuwa, nakiya, bulum, pate pate, mpursa, kudon kaza, pito, nyiya, lamba* and *dambu* (Nkama *et al*. 1998). Even though the word *dambu* refers to a cereal based granulated dumpling made from cereal flour, small quantity of onions, leaves and some herbs, there are various types of dambu depending on the types of raw materials and methods of production.

The various other types include *dambun nama*, those produced from either beef, mutton or poultry (Obodo 2002; Balogun 2008), *dambun kifi*, prepared from flesh of fish (Goni 2002) and those prepared from cereal grains (Nkama et al. 1998; Agu et al. 2003a,b; 2004a,b; 2007; 2008a,b). *Dambun nama* and *dambun kifi* are described as boiled, spiced, shredded, stirred and fried meat and fish products, respectively. On the other hand, *dambu* produced from cereal grains is a granulated dumpling generally produced from moistened millet, sorghum, maize and finoi millet flours or any suitable cereal flour blended with spices and steamed for about 30 minutes (Agu et al., 2003a, b).

Researchers in Nigeria have reported production of "*dambu*" from various cereal grains and also evaluated their storage qualities (Agu et al., 2003a), physicochemical and sensory qualities (Agu et al., 2003b), amino acid composition (Agu et al., 2004a), mineral composition (Agu et al., 2004b), nutrient and sensory properties (Agu et al., 2007), physicochemical and microbial qualities (Agu et al., 2008a) and storage stability of improved "dambu" (Agu et al., 2008b). The reports indicated that the ingredients used apart from cereals for the preparation of cereal based *dambu*, are cloves, ginger and black pepper. But, information on the production of cereal based *dambu* along with vegetables such as moringa (*Moringa oleifera*), groundnut (*A. hypogaea*) and sweet pepper (C*apsicum annuum*) which are basic ingredients used locally to improve the nutrient contents of *dambu* have never been investigated nor reported in the literature. Furthermore, the mode of preparation and serving for consumption of cereal based *dambu* produced along with *M. oleifera*, *A. hypogea* and *C. annuum* are different from those of other forms.

The addition of *M. oleifera* and *A. hypogaea* L. in the production of cereal based dambu are very important to human nutrition (Foidl et al., 2001; Oduro et al., 2008; Anjorin et al., 2010; Ogunsina et al., 2010; Singh and Singh, 1991; Singh and Diwakar, 1993). In view of the importance of improving human nutrition, especially among Nigerian resource poor families by using local and easily accessible ingredients, it is important to develop and standardize as well as determine the proximate composition, mineral content and acceptability of cereal based dambu produced using different compositions of maize (*Zea mays*), *M. oleifera* and *A. hypogaea* along with other ingredients. The objectives of this study were to standardize ingredients in several formulations of cereal based dambu and, determine their proximate composition, mineral content and acceptability. Thus, we hypothesize that different amounts and composition of groundnuts as well as the amount of water added to *dambu* would affect its nutrient contents and acceptance levels among consumers.

MATERIALS AND METHODS

Maize (*Zea mays* seachareta), groundnut (*Arachis hypogea*), zogale (*Moringa oleifera*), sweet pepper (*Capsicum annum*), onion (*Allium cepa*), table salt (NaCl – sodium chloride) and maggi cubes ® were purchased from Monday market in Maiduguri (11°50′0″N,13°9′0″E), Nigeria. Chemicals and reagents used were obtained from recognized reliable distributors and were of analytical grade.

Sample preparation

Maize grains were sorted with hand, washed, dehulled with Rice Huller and polishers (Amuda Multipurpose Rice Huller with Polishers, Made in India) and winnowed manually to separate the endosperm from the bran. The grain was washed to remove all dirt and dried under atmospheric condition to reduce the moisture content. The dry dehulled washed maize grain was grounded into coarse particles with a hammer mill (Gibbons Electric, Essex, UK) and passed through a sieve with an aperture size of 600 µm. Similarly, the groundnut was sorted and the outer red kin removed with the aid of a pestle and mortar manually and winnowed with a local fan. The dehulled groundnut was milled into coarse particles using same protocol as that of maize. Moringa leaves were sorted, washed and chopped into smaller pieces using a knife. Onions and sweet pepper were washed and chopped with knife.

Traditional Dambu masara formulations

For comparison purpose, we obtained traditional dambun masara from commercial processors within Maiduguri metropolitan. To standardize the preparations, all the ingredients were weighed before and after the preparation to obtain the desired quantity. The traditional formulation was designated as 700. For the laboratory formulations, the quantity of *M. oleifera*, *A. cepa*, *C. annum*, salt and

Table 1. Proportion of ingredients in traditional and standardized *dambu masara* formulations

Local and English/Scientific names of Ingredients	Traditional (700) (g)	Laboratory Formulations					
		736 (g)	646 (g)	734 (g)	738 (g)	644 (g)	648 (g)
Maize (*Zea mays*)	57	52	44	52	52	44	44
Groundnut (*Arachis hypogaea*)	15	20	30	20	20	30	30
Zogale (*Moringa oleifera*)	8	8	8	8	8	8	8
Onion (*Allium cepa*)	12	12	12	12	12	12	12
Sweet pepper (*Capsicum annuum*)	4	4	4	4	4	4	4
Salt (Sodium chloride - NaCl)	2	2	2	2	2	2	2
Maggi ® (Flavour enhancer – bullion cube)	2	2	2	2	2	2	2
Water (H_2O)	60	60	60	40	80	40	80

Traditional = 700; 736 = Maize 70%: groundnut 30% & 60 g H_2O; 646 = Maize 60%: groundnut 40% & 60 g H_2O; 734 = Maize 70%: groundnut 30% & 40 g H_2O; 738 = Maize 70%: groundnut 30% & 80 g H_2O; 644 = Maize 60%: groundnut 40% & 40 g H_2O; 648 = Maize 60%: groundnut 40% & 80 g H_2O.

Maggi ® cubes were kept constant, while the quantities of maize, groundnut and water was varried (see Table 1).

Dambu masara production

The coarse maize grain and the chopped *Moringa* leaves were mixed with 40 ml of water and steamed using a special pot which has two components and the bottom of the upper chamber has small holes which allow steam to pass through to the ingredients placed in the second [upper] chamber. The remaining ingredients groundnut, onion, sweet pepper, salt and Maggi® cubes, were added and 20 ml of water was sprinkled and re-steamed for 10 minutes (Figure 1).

Proximate composition

The moisture, protein, fat, ash and crude fibre contents of maize, groundnut, moringa oleifera, onion and sweet pepper were determined using methods of AOAC (1990). Soluble carbohydrate was determined by difference (100% - % moisture content - %protein content - % fat content – %ash content – crude fibre content). Energy values of some of the ingredients and seven dambu masara formulations were calculated using the Atwater factor (FAO, 2002).

Mineral content determinations

Mineral composition of some of the ingredients and seven dambu masara formulations were determined using the methods described by Crawford (2007). The minerals determined were calcium, iron, manganese, magnesium, phosphorus, potassium, zinc and copper. Five grams each of the samples was ashed in a muffle furnace, after which 100 ml of distilled water was added to the ash and then filtered. Ten milliliters of the filtrate was pipetted into a clean tube. This was used to determine the mineral contents with Spectrophotometer (Perlain – Elmer 2380, USA, 1976)

Sensory evaluation

Acceptability tests were conducted for each of the seven formulations of dambu masara to find the best accepted by 20 panelists. The test was blind in that none of the panelist

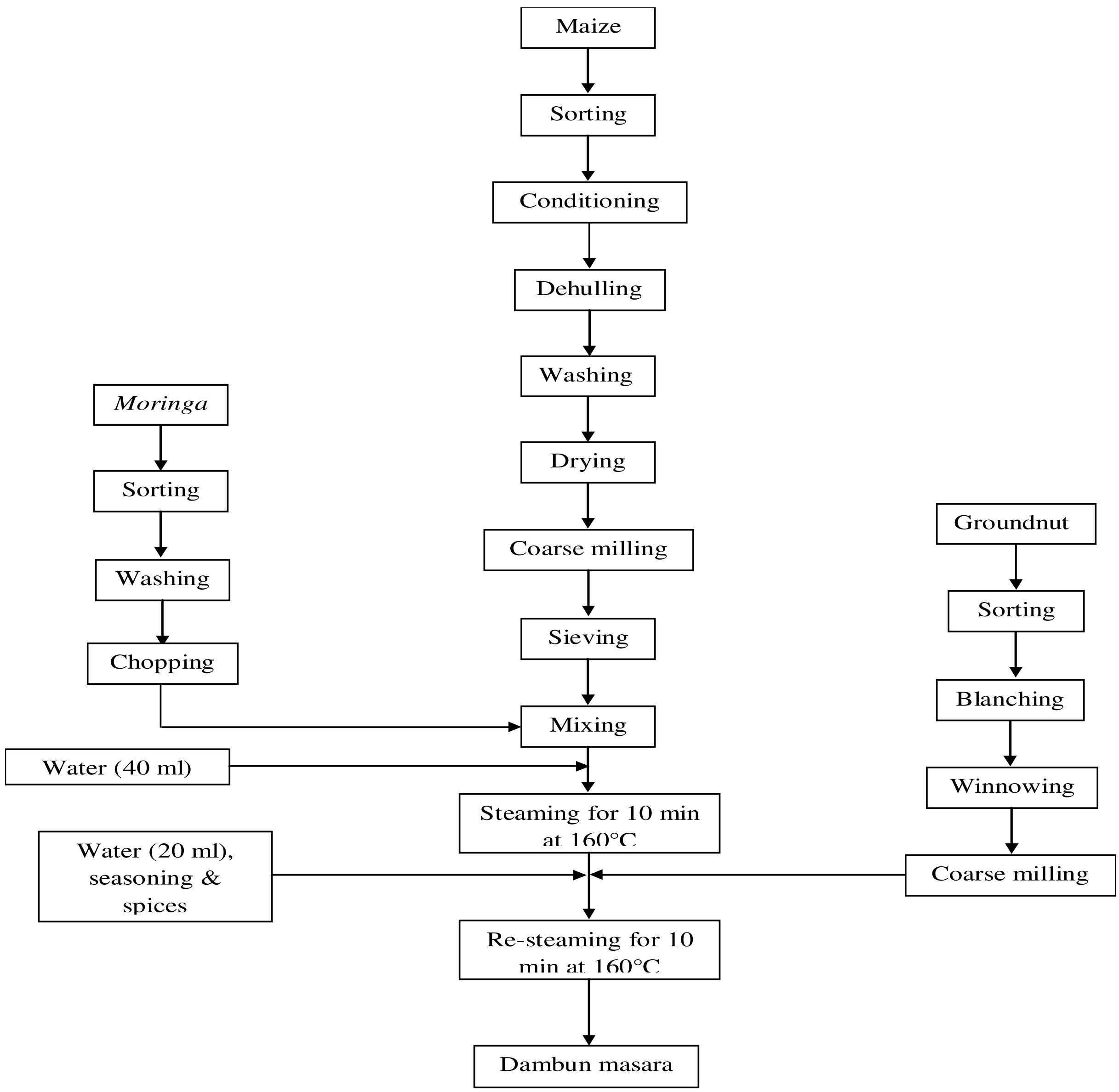

Figure 1. Flow chart for the production of *dambu masara* (Modified from Agu (2008)

knew the composition of the formulations. Although, the panelists were not trained but their selection was based on basic requirement of a panelist, such as availability for the entire period of the evaluation, interest, willingness to serve, good health (not suffering from cold), not allergic or sensitive to the products evaluated (Penfield and Campbell, 1990. Different characteristics in terms of color, flavor, texture and acceptability were determined using the Hedonic scale (where a score of 9 was the highest, and a score of 1- extreme dislike (Larmond, 1976; Badau *et al.*, 1997).

Statistical analysis

The results of proximate composition and scores of panelist were statistically analyzed using Analysis of Variance (ANOVA) (Gomez and Gomez, 1983, Mead *et al.*, 1993). The mean were separated using Duncan Multiple Range Test (DMRT).

Figure 2 Dambun masara before steaming (A), after steaming (B) and the seven different formulations produced after steaming.

RESULTS AND DISCUSION

Proximate composition

The proximate composition of ingredients used in *dambu masara* formulations are shown in Table 2. *A. hypogaea* had the highest proportions of fat, protein and energy, while the highest crude fibre, ash, moisture and soluble carbohydrate were recorded in *M. oleifera*, *C. annum* and *Z. mays*, respectively. The proximate composition of maize was within the range reported by Iken *et al*. (2002) and Nweke, (2010). The little variations could be due to differences among the varieties, and also on the type of soil where the grains were cultivated. Similarly, the chemical composition of *A. hypogaea* obtained in this study fall within the values reported by other researchers (Asibuo et al., 2008). Proximate analysis of *M. oleifera* used in the formulation of dambu masara revealed that the chemical constituent is close to those reported by Oduro et al. (2008), Anjorin et. al. (2010), Ogunsina et al. (2010) and Jongrungruangchok et al. (2010). The moisture content of the onion and sweet pepper were 86.6% and 92.15, respectively. The fat, protein, crude fibre, ash, soluble carbohydrate and energy contents were within the range reported in most literature on the subject matter.

The proximate composition of the seven formulations is presented in Table 3. The moisture, protein, fat, ash, crude fibre, soluble carbohydrate and energy values differ significantly (P<0.05) among the formulations. Formulations 738 and 648 had the highest moisture content. As it was expected addition of water had affected the moisture content of the final product significantly (P<0.05). All the dambu masara that had groundnut differ significantly (P<0.05) from the traditional formulation (Formulation 700). Therefore addition of groundnut had increased the protein contents of dambu masara significantly *(P<0.05)*. Similarly, the fat contents of dambu masara that had 60% maize, 40% groundnut and 80g of water (Formulation 648) was significantly (P<0.05) lower than the rest of the formulations (700, 736, 646, 734, 738, 644). The fat content of dambu masara Formulations 700, 736, 646, 734, 738 and 644 did not differ significantly (P>0.05). The ash content of Formulation 738 was the lowest among the formulations. However, ash content of formulation 738 did not differ from formulations 700, 736, 646, 734 and 648). Formulations 700, 646, 734, 738 and

Table 2. Chemical composition of ingredients used in *dambu masara* formulations[1]

Ingredient	Fats (%)	Protein (%)	Fibre (%)	Ash (%)	Moisture (%)	Soluble carbohydrate (%)	Energy(KJ/g)[2]
Zea mays	4.7±0.3c	11.0±0.4c	2.0±0.4b	2.0±0.3c	13.0±0.4c	67.3a	15.05
A. hypogaea	46.0±0.3a	25.0±0.3a	2.6±0.2b	2.5±0.2c	8.2±0.2d	14.7b	23.77
Moringa oleifera	8.2±0.2b	15.6±0.0b	5.1±0.0a	11.5±0.0a	53.0±0.4b	6.6d	6.81
Allium cepa	0.1±0.0d	1.2±0.1d	0.6±0.0d	0.4±0.0d	86.6±0.6a	11.1c	2.13
Capsicum annum	0.19±0.0d	0.8±0.0d	1.8±0.2c	4.0±0.2b	92.1±0.4a	6.43d	1.30

[1]Mean ± Standard deviations of duplicate determinations and three replicates
[abcd]Means within each column not having the same superscript are significantly different (*P*<0.05)
[2]Calculated using ME – system 1 (Metabolizable energy system one) = Atwater (Atwater and Woods, 1896) specific conversion, not including energy from fibre.

Table 3. Proximate composition of seven formulations of *dambu masara*[1]

Parameter (%)	Formulations[2] 700	736	646	734	738	644	648
Moisture	30.0±2.1[b]	29.1±1.93[b]	25.2±1.99[b]	15.6±1.11[c]	35.0±2.31[ab]	16.0±0.59[c]	36.0±3.01[a]
Protein	12.5±1.2[c]	15.3±0.85[abc]	16.2±1.01[abc]	15.1±0.99[abc]	13.2±1.86[bc]	18.3±0.07[a]	17.0±1.23[ab]
Fat	9.9±0.91[ab]	10.1±0.32[ab]	12.3±0.83[a]	9.8±0.87[ab]	9.7±0.95[b]	11.6±0.10[ab]	8.9±0.93[b]
Ash	4.3±0.37[ab]	4.4±0.09[ab]	4.2±0.05[ab]	5.8±0.08[ab]	3.9±0.07[ab]	6.0±0.86[a]	4.1±0.07[ab]
Crude fibre	2.3±0.11[ab]	1.9±0.03[b]	2.5±0.03[ab]	3.0±0.05[a]	2.6±0.05[bc]	3.1±0.04[a]	2.2±0.04[b]
Soluble carbohydrate	41[b]	39.2[b]	39.6[b]	50.7[a]	35.6[bc]	45.0[a]	31.8[c]
Energy (KJ/g) (12,560.4)[M] (10,222.8)[F]	8.658[d]	13.002[abc]	14.037[abc]	14.812[ab]	11.885[bc]	15.053[a]	11.589[cd]

[1]Mean±Standard deviation of duplicate determinations and three replications
[2]Traditional = 700; 736 = Maize 70%: groundnut 30% & 60 g H_2O; 646 = Maize 60%: groundnut 40% & 60 g H_2O; 734 = Maize 70%: groundnut 30% & 40 g H_2O; 738 = Maize 70%: groundnut 30% & 80 g H_2O; 644 = Maize 60%: groundnut 40% & 40 g H_2O; 648 = Maize 60%: groundnut 40% & 80 g H_2O.
[abcd]Means within each row not having the same superscript are significantly different (P<0.05)
[M]Energy requirement per day for Male Adolescents (14 to 18 years); [F]Energy requirement per day for Female Adolescents (14 to 18 years). Website: http://www.puristat.com/standardamericandiet/rda.aspx retrieved on 8th August, 2012 at 22.02 hours)

Table 4. Mineral content of ingredients (ppm) used in *dambu masara* formulations[1]

	Ingredients				
Mineral (mg/1000g)	Maize	Groundnut	Moringa oleifera	Onion	Sweet pepper
Calcium	11	760	1920	2560	69
Iron	24	31	29	14.9	5.3
Manganese	4.8	15	81	13.00	1.10
Magnesium	780	3500	420	910	130
Phosphorus	2310	1065.2	265	300	250
Potassium	3280	13580	1381	1620	2109
Zinc	18	50	27	17.5	2.35
Copper	2.9	19	10	4.16	0.17

1Mean of duplicate determinations and three replicates

644 had almost the same crude fibre content (*P*>0.05). Varying the amounts of water and addition of groundnut had little or no effect on the crude fibre content of the formulations. The soluble carbohydrate of *dambu masara* that had 70% maize, 30% groundnut and 40 g water (Formulation 734) and 60% maize, 40% groundnut and 40 g water (Formulation 644) differs significantly (*P<0.05*) being the highest compared to the rest of the formulations. This means that varying the level of water in the formulations affected the soluble carbohydrate contents. The energy value of traditional dambu masara Formulation (700) was significantly lower than those of the laboratory Formulations. Consuming 100 g of dambu masara produced from Formulations 736, 646,734 and 644 will give adequate requirement per day for Male Adolescents (14 to 18 years). Whereas consuming 100 g of dambu masara from all the formulations except Formulation 700 (Traditional Formulation) will give adequate energy requirement per day for Female Adolescents (14 to 18 years)(Puristat, 2012).

Mineral content

The mineral contents for the ingredients used in our formulations are presented in PPM (mg/1000 g) on Table 4. Onion had the highest calcium content (2560 PPM), while groundnut contained the highest iron (31 PPM), magnesium (3500 PPM), potassium (13580 PPM), zinc (50 PPM) and copper (19 PPM). On the other hand, *M. oleifera* had the highest amount of manganese (81 PPM) and maize the highest phosphorus content (2310 PPM). The ingredients used in our formulations, has reasonable amount of minerals that improved the mineral content of dambu masara produced.

Table 5 shows the mineral content (PPM) of dambu masara produced from cereal formulations. The calcium content of the various dambu masara formulations ranged from 59.5 to 70.7 PPM, while the iron, manganese, magnesium, phosphorus, potassium, zinc and copper ranged from 10.1 to 15.17 PPM, 21.2 to 48.06 PPM, 296 to 514.3 PPM, 700 to 1250 PPM, 101.5 to 132.3 PPM, 3.25 to 9.18 PPM and 2.41 to 3.17 PPM, respectively. Formulations 734, 738, 644 and 648 are good source of iron, while all the formulations are good source of manganese and copper. Consuming 300 g of all the dambu masara formulations can provide adequate daily requirement of Calcium and zinc. Therefore optimum level of minerals can be achieved by varying the levels of most of the ingredients until products that can provide all the daily requirements are obtained.

Sensory acceptability of dambu masara produced from seven formulations

The sensory scores for color, taste, aroma, texture and

Table 5. Mineral content (mg/1000g) of seven formulations of *dambu masara*[1]

Mineral	Formulations[2]						
	700	736	646	734	738	644	648
Calcium (1300 mg/day)*	59.95	61.5	69.02	62.12	62.72	69.75	70.7
Iron (11 mg/day)	10.2	10.9	10.1	12.0	12.32	13.26	15.17
Manganese (2.2 mg/day)	21.2	31.3	34.0	28.39	43.68	32.27	48.06
Magnesium (410 mg/day)	296	326	319.6	307.3	364	514.3	483.3
Phosphorus (1250 mg/day)	700	708	880	703	840	1250	918
Potassium (4,700 mg/day)	121.8	136	137	101.5	112.6	129.1	132.3
Zinc (11 mg/day)	3.25	4.3	9.18	3.67	5.21	4.86	7.29
Copper (0.890 mg/day)	2.84	2.8	2.41	3.17	2.97	3.09	2.97

[1]Mean of duplicate determinations and three replications
[2]Traditional = 700; 736 = Maize 70%: groundnut 30% & 60 g H_2O; 646 = Maize 60%: groundnut 40% & 60 g H_2O; 734 = Maize 70%: groundnut 30% & 40 g H_2O; 738 = Maize 70%: groundnut 30% & 80 g H_2O; 644 = Maize 60%: groundnut 40% & 40 g H_2O; 648 = Maize 60%: groundnut 40% & 80 g H_2O.
*Recommended daily intake for Adolescence 14 to 18 years both male and female (Website: http://iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity%20Files/Nutrition/DRIs/RDA%20and%20AIs_Vitamin%20and%20Elements.pdf retrieved on 8th August, 2012 at 22.30 hours)

overall acceptability is shown in Table 6. The color of dambu masara produced from Formulations 700 (Traditional formulation) and Formulation 648 were most preferred ($P<0.05$) by the panelists. Formulations 700, 736, 734 and 648 had the highest ($P<0.05$) taste score. Whereas the panelists preferred ($P<0.05$) the aroma, texture and overall acceptability of dambu masara produced from formulations 700, 736, 734 and 648. Therefore the nutrient quality of dambu masara can be improved by adding groundnut without affecting its acceptability.

CONCLUSION

Addition of groundnut to *dambu masara* increased the nutrient content of the product without affecting the acceptability of the product. Therefore, *dambu masara* can be produced by combining 60% maize, 40% groundnut and 40 g of water along with 8% *Moringa oleifera*, 12% onion, 4% sweet pepper, 2% sodium chloride and 2% maggi – a flavor enhancer Maggi ® cube without altering the overall acceptability of *dambu masara*.

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Table 6. Acceptability of seven formulations of *dambu masara*[1]

Panel's sensory scores[3]	Formulations[2]						
	700	736	646	734	738	644	648
Colour	8.25[a]	6.25[bc]	5.50[cd]	7.05[b]	5.00[d]	5.80[cd]	8.30[a]
Taste	8.25[a]	8.45[a]	4.65[b]	8.00[a]	4.90[b]	4.95[b]	8.35[a]
Aroma	8.55[a]	8.45[a]	6.30[c]	7.75[a]	4.90[d]	4.75[b]	8.45[a]
Texture	8.25[a]	8.00[a]	5.35[b]	7.75[a]	4.70[b]	4.75[b]	4.90[a]
Overall Acceptability	8.25[a]	8.55[a]	5.65[c]	8.15[a]	5.65[c]	6.45[b]	8.25[a]

1Mean scores of twenty panelists and three replications
[2]Formulations: Traditional = 700; 736 = Maize 70%: groundnut 30% & 60 g H_2O; 646 = Maize 60%: groundnut 40% & 60 g H_2O; 734 = Maize 70%: groundnut 30% & 40 g H_2O; 738 = Maize 70%: groundnut 30% & 80 g H_2O; 644 = Maize 60%: groundnut 40% & 40 g H_2O; 648 = Maize 60%: groundnut 40% & 80 g H_2O.
[abcd]Means within each row not having the superscript are significantly ($P<0.05$) different
[3]Nine point hedonic scale where 1 – dislike extremely and 9 – like extremely

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