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Development of Healthy Snack Meal for School-Age Children

Nawal Abdel-Gayoum Abdel-Rahman

mobile: 00249918206536, e-mail: ibreez2005@gmail.com
Department of Canning Technology
Food Research Centre, P.O. Box 213, Khartoum North, Sudan

Abstract

For a long time before, human tried to use the available substances to make suitable and enough daily needs meals for children. at the present, the scientists and food technologists discovered many nutritive materials. The aim of this study was to process and formulated paste (ready to use snack) as snack meal (ready-to-use) to school-age children from some local Sudanese common fruits, banana (*Musa spp.*); forest fruits, godeim (*Grewia tenax*) and baobab (*Adansonia digitata*), vegetables, pumpkin (*Telfairia occidentalis*) and chickpea (*Cicer arietinum*). As well as, to determine the physico-chemical characteristics, suitability of storage and organoleptic attributes of the product. The results conducted that the paste is high protein (23.18 %), carbohydrates (56.16 %), vitamin C (450.00mg /100 g), and energy value (389.09 kcal). The product is rich in phosphorous and iron, excellent amounts of magnesium, calcium and potassium. Whereas, its poor source of sodium for school age children. The microbial and physico-chemical of product is stable throughout storage period (12 months) at ambient temperature. On the other hand, the panelists are preference the children meal in sensory attributes comparable to market paste meal.

Key words: Common fruits; forest fruits; nutrients; protein; energy; minerals

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Intoduction

Most growing children are very active, so they require abundance of power and nutrient dense foods. Those children have little stomachs and large energy needs, their meals to be more than normal and regular than adults (Abdel-Rahman *et al*., 2011). The school years before adolescence represent a time of gradual, stable growth and nutritional risks are lower at this time than during the pre-school years and later during the adolescent growth spurt (VS, 2010). In several developing countries the occurrence of under nutrition and micronutrient deficiencies is high between children (Black *et al*., 2008). The diets usually fed to them do not include adequate energy and micronutrient to meet daily requirements (Tontisirin *et al*., 2002). Children and adolescents are need healthy diet to maintain their growth needs (CDC, 2013). They require an adequate quantity of energy, proteins, and vitamins (A, C and D), also many kinds of minerals, especially iron, calcium and potassium (Ickes *et al*., 2012). The children as well as the adulterants that did have snack meals at their home; they be supposed to have an access to snack foods (WHO, 2003). Sudan is on of the developing countries, ISHS (2002) reported the chronic and sensitive protein-energy malnutrition are a major children diseases throughout developing countries. In general, conventional suggestions for recover these requires of school children are provide for them locally obtainable rich in nutrients (Jilcott *et al*., 2010). In addition, the components used for children products must be satisfactory to the children and their families.

Traditionally, a number of Sudanese edible plants and many varieties will be used in fortification of many suitable food products such as infant foods, pre-school children foods, puddings, soups, and porridge. Banana (*Musa spp.*) is an extremely accepted fruit grown in the tropical and semi-tropical regions (Berz *et al*., 2005). Banana fruits are rich in carbohydrates and have accepted amount of vitamin A. Baobab (*Adansonia*

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digitata) has white flesh covering with hard husk. The taste is ranges from acidic sweet to acidic and locally used to make a drink (Abdel-Rahman *et al*., 2011). Baobab fruit has special attention because it rich in vitamin C (150 – 499 mg/100g) compared to highest known fruits (Sidibe and Williams, 2002; Manfredini *et al*., 2002; Lghodalo *et al*., 1991).

Godeim (*Grewia tenax*) is one of best iron source; traditionally used to prepare popular beverage (Abdel Muti, 2002). Pumpkin (*Telfairia occidentalis*) is a good source of beta-carotene, ascorbic acid, as well as contains high amount of potassium, sodium and phosphorous (Egbekun *et al*., 1998).

The purposes of this investigation are: 1) to develop new formula rich in energy, macro and micronutrients for school-age children, 2) to find other industrial applications for edible plants in Sudan, 3) decrease of the high occurrence of some nutritional effects of rural and displaced Sudanese children.

Materials and methods

Banana, godeim, baobab and pumpkin as well as chickpea, starch and sugar were obtained from Khartoum North local market. Banana and pumpkin were washed, peeled and cut, followed pulped using an electric blender (model: Reeves, size: IVIF - 18). Baobab and godeim fruits were prepared according to method described by (Abde-Rahman *et al*., 2011). Above ingredients were processed as paste form and filled in glass jars to 145 g, at food research centre; and stored for 12 months at ambient temperature. The paste was determined at zero time (as control) and at every three months intervals for microbiological growth, and physico-chemical properties.

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Microbiological analyses of the paste

The microbiological analyses include: total bacterial counts, total yeast and moulds, spore-forming, coliform bacteria and *salmonella* spp. according to Harrigan and MacCance (1976).

Physico-chemical properties

The physic-chemical properties include total soluble solids (T.S.S), crude protein, crude fibre, fats, ash and carbohydrates (AOAC, 2003). The pH, total titratable acidity, TAA (as citric acid), total and non-reducing sugars, and vitamin C (ascorbic acid) were evaluated according to Ranganna (2001). The caloric values of the paste were calculated according to IMNA (2002).

Minerals: Minerals profile were determined according to AOAC (2003) by atomic absorption (Carbolite – Bam ford S30 2 AU. Sheffield, England), except sodium by flame photometer (Instrument shimadzu - AA - 6800).

Sensory evaluation: The sample of paste was evaluated for colour, flavour, taste, consistency and overall quality; by fifteen panelists using the method described by Ali and El-Faki (2006).

Statistical analysis*:* The sample was analyzed using Statistical Analysis System (SAS), by randomized complete design (RCD). The analysis of variance (ANOVA) and least significant difference ($p \leq 0.5$) were used to separate the means according to Bozkurt and Erkmen (2007).

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Results and discussion

The sample under investigation was free from bacterial or fungal growth during storage period. The proximate analyses of raw materials were shown in Table 1. The results of banana fruit were closed with results recorded by Jaworsks *et al*. (2004) and Cano *et al*. (1997). Moreover, the findings of proximate analysis of baobab were agreement with findings mentioned by Mohammed *et al*., 2013; Wilkison and Hall, 2007. While, the godeim fruit recorded values similar to values obtained by Fasoyiro *et al.*, (2005); Gebauer *et al.*, (2002) and Saka *et al*., 1994. Furthermore, analyses of pumpkin were found higher and lower than levels recorded by Anonymous (2010), Akwaowo *et al*. (2000); Cunningham *et al*. (2000). Table 3 showed the mineral profile of ingredients, all the data was agrees with those reported by Abdel-Rahman *et al*. (2014); Gunes, *et al*., (2007); Sankat *et al*. (1996).

The results of proximate compositions of children paste were tabulated in Table 2, the moisture percentage of 67.36 %. Whereas the level of crude protein to be 19.36 %, according to FAO (2005) 100 grams of this paste gave 104.42 % for children in ages 4 - 6 years with 18.2 kg weight. As well as, a 90.04 % for 7 – 9 years old (52.2 kg), also 55.08 % and 55.76 % for girls and boys (10 - 17 years) with weight 46.7 and 49.7 kg, respectively.

ISHS (2002) reported that the children foods based on fruits and vegetables must contain at least 0.60 % fibre. The value of fibre of this paste was found to be 3.73 %. Furthermore, the contents of fat and ash of the product were 4.54 % and 12.39 %. The snack meal was found excellence source for ascorbic acid; it is proximately provided 23, 12 and 9. % per day from recommended require of this vitamin for the ages of (4-8, 9-13 years) and adults (14-18 years), respectively (IM, 2001). As well as, compared

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with FAO/WHO (2004), a 100 g of this product supplied of 27% for (4-6 years), 17 % for (7-9 years), 8 % for girls (10-17 years) and 7 % for boys (10-17 years) of ascorbic acid.

Youthful children do not have the ability to eat big quantities of food; consequently they require little and frequent meals. Their diet should not include too many items that are largely or liquidly. This product (100 g) containing about 365.00 kcal/100 g, this level supplying about 27, 22, 16, and 13 % of daily requirement of energy for children in ages 4 – 6, 7 – 9 and 10 - 17 years (girls and boys), respectively (FAO, 2005).

The mineral contents of the snack meal were presented in Table 3, and it is obvious that the paste rich in several minerals. The table shows that the product is supply high percentage of some minerals for children (4-8 years), male and female (9-13 years) and adults (male and female, 14-18 years). WHO/ FAO (1996) recorded that food fortification with iron is recommended when dietary iron is insufficient or the dietary iron is of poor bio-availability. Hundred grams of paste almost providing of 68 % for children (4-8 years), 85 and 62 % for male and female (9-13 years) as well as 62and 77 % for adults (male and female, 14-18 years) of iron. Whereas, according to the FAO/WHO (2004) this snack meal providing 3.32 % for (4-6 years), 1.60 % for (7-9 years) and 0.56 %, 0.43 % (10-17 years, girls, boys, respectively) of Fe. Also, according to the above reference, the bodies depend on usual zinc provide by the daily diet because foods are fairly limited. Thus, A 100 g of the product supplied of 44 %, (28, 20 %) and (28, 24 %) of Zn for the years illustrated above, respectively (IOM, 2001).

The provided percentages of Ca (in this product) referring to (COEX, 2004) are 17, 15 and 8 % for children (4-6 years, 7-9 years and 10-18 years) of daily recommended intake. DGAC (2010) recorded that decreased sodium resulted in decrease in resting

diastolic blood pressure. WHO (2012) reported that the mean in sodium intake ranged from 2.0 to 4.79 g/ day, according to that and CODEX (2009) this meal under investigation is provided only 2 % from the minimum limit. Potassium is the major intracellular cation in the body, is required for normal cellular function. On the other hand, the paste containing about 63, 53 and 51 % of potassium adequate intake (AI) for ages 4 – 8, 9 – 13 and 14 – 18 years, respectively (IOM, 2004). Moreover, according to NHMRC (2015) this meal provides almost 80 % (boys, 9 – 13 years), 96 % (girls, 9 – 13 years), 67 % (boys, 14 – 18 years) and 92 % (girls, 14 – 18 years). The Magnesium was found abundant compare to dietary reference intake/day of 53 % (4 – 8 year), 40 % (9 – 13 year), 26 % (14 – 18 year, girls) and 23 % (14 – 18 year, boys), (IOM, 2011).

The school-age pate was free of any microbial growth during 12 months storage at ambient temperature. Table 4 shows the effect of storage period on physico-chemical composition of the paste. As well as the results illustrated that, no significant difference ($P \leq 0.05$) in TSS% throughout stored at ambient temperature. This finding was agrees with the same as mentioned by Nour *et al.* (2011) for some varieties of Sudanese mangoes jam. Moreover, there were significant differences ($P \leq 0.05$) in pH and TAA, with a minor increased and slight decreased, respectively. Abdel-Rahman (2012) reported the same results for sweet potato jam. The total and reducing sugars were significantly enlarging from 31.69 to 32.41% and from 2.95 to 4.92 %, respectively. Similar outcomes were recorded by Shakir *et al.* (2007) in reducing sugars of apple and pear mixed fruit jam. The explanations of this increase either the hydrolysis reaction of starch or the conversion of sucrose to glucose and fructose. As well, as may be due to inversion of non-reducing sugars during storage by acids (Safdar *et al.*, 2012). As a result, significantly ($P \leq 0.05$) there was no variation in sucrose value. There are significant ($P \leq 0.05$) differences in ascorbic acid during storage period. The findings

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ranged from 450 to 370mg/100g, the percentage of decrease reaches to 17.78 %. Torezan (2002) recorded that the decreases of ascorbic acid due to thermal and oxidative degradation. Table 5 shows the organoleptic evaluation of the paste comparable to control sample. Significantly ($P \leq 0.05$) there were different in score of characteristics among school-age paste and control. The investigated paste was acceptable for all sensorial tests under experiment.

Conclusion

It could be concluded uses of local common fruits, vegetables with forest fruit and legumes helps to supplying many nutrients and energy to pre-school, school-age children and adults from 4 to 18 years old.

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Table 1. Proximate analyses (%) of the ingredients.

Content	Banana	Godeim	Baobab	Pumpkin	Chickpea
Moisture	73.50	16.55	4.96	89.63	10.30
C. Protein	1.50	4.41	2.24	0.75	20.40
C. Fibre	0.82	8.91	4.53	0.74	3.76
Fat	0.33	0.26	0.37	0.23	6.83
Ash	1.02	4.72	6.62	1.21	3.14
Carbohydrate	22.83	65.15	81.28	7.44	55.57
Vitamin C (mg/100g)	8.13	68.31	397.22	8.79	0.91

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Table 2. Proximate composition (%) of children paste (on D. B).

Moisture	Crude Protein	Crude fibre	Fat	Ash	Carbo-hydrate	Vitamin C (mg/100g)	Energy (kcal/100g)
67.36	23.18	3.73	4.54	12.39	56.16	450.00	389.09

Table 3. Mineral profile (mg/100g) of the raw materials and paste.

Mineral	Banana	Godeim	Baobab	Pumpkin	Chickpea	Paste
Fe	0.41	7.17	1.59	3.77	7.20	6.79
Zn	0.13	1.64	1.44	4.06	5.35	2.20
Ca	6.40	402	261	13.15	130	102.58
Na	1.50	9.63	7.81	1.29	850	43.00
P	27.25	84.35	64.11	42.92	318	90.91
K	375	1413	2590	295	530	2400
Mg	37.49	172	150	23.00	2.15	95

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Table 4. Effect of storage period on physico-chemical composition of paste

Parameter	Storage period (months)					$Lsd_{0.05}$	SE±
	0	3	6	9	12		
T SS (%)	32.60 [a]	32.40[a]	32.95[a]	33.00[a]	33.70[a]	1.629	0.517
pH	3.90 [b]	4.06[d]	4.07[d]	4.20[c]	4.40[a]	0.0005753	0.0001826
Acidity (%)**	0.38 [a]	0.30[b]	0.30[b]	0.31[c]	0.29[d]	0.0005753	0.0001826
Total sugars (%)	32.41[a]	32.05[b]	31.69[c]	31.34[d]	31.00[e]	0.08136	0.02582
Reducing sugars %)	2.95[e]	3.64[d]	4.22[c]	4.63[b]	4.92[a]	0.0005753	0.0001826
Sucrose (%)	29.32[a]	26.60[c]	28.14[b]	29.05[a]	29.16[a]	0.8136	0.2582
Vitamin C (mg/100 g)	450.00[a]	424.52[b]	409.00[c]	399.50[d]	370.00[e]	0.8177	0.2595

* Means±SD having different superscript letters in columns and rows are significantly different (P≤0.05).

** As citric acid.

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Table 5. Organoleptic evaluation of the paste*.

Sample	Colour	Flavour	Taste	Consistency	Acceptability
A	27.00[a]	33.00[a]	31.00[a]	29.00[a]	32.00[a]
B	19.00[b]	20.00[b]	22.00[b]	23.00[b]	21.00[b]
$Lsd_{0.05}$	4.1587	12.5196	6.5984	2.3214	10.9546
SE±	2.5671	7.6301	3.0609	0.9657	5.1232

* Means±SD having different superscript letters in columns and rows are significantly different (P≤0.05).

A. School-age children paste.

B. Control paste from local market.