PROXIMATE ANALYSIS AND SENSORY ACCEPTANCE OF DEVELOPED NATURAL DRIED BABY MEAL BASED ON MILLET AND PIGEON PEA FLOURS

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ABSTRACT

In order to fight malnutrition among children under five years, different attempts were carried out to incorporate Sudanese local food sources. This study aim at preparing dried baby meal enriched with high nutritive, natural, local and cheap ingredients. Amounts of millet and pigeon pea flours were used as protein, vitamins and minerals source in addition to other local ingredients. Proximate composition, minerals content, vitamin C, microbiological and organoleptic evaluation were determined. Formula of well mixed millet flour (400g) with amount of (130ml) warm water as well as (300g) pigeon pea were added to (130ml) and heated to (90ºC) with continuous steering for 25-30 minutes till complete homogenization. Dried powders of pumpkin and baobab, in addition to sugar, salt, and vanilla were stirred, mixed and added. The mixture was dried naturally under moving fans for 3 days at room temperature then crushed, milled sifted and packed in polyethylene bags. The results obtained mirrored that the formulated dried baby meal have appreciable amounts of protein (10.50g %), low moisture content (7.168g %) and fat content (2.05%).On top of that (381.571Kcal) of energy value was recorded. Microbiological evaluation of prepared formula revealed that prepared meal was free of pathogens.

Keywords: Millet, Pigeon pea, Baby meal, Formulation, Malnutrition.

INTRODUCTION

Malnutrition is a consequence of consumption of dietary nutrient either insufficiently or exclusively by especially children (Etim *et al*., 2017). It is considered as a risk threatening vulnerable people due to multiple factors related to poverty and food security in the country, in addition to the spread of diseases and several social factors that negatively affect the nutritional status of society (Tickell *et al*., 2020).The UNICEF annual report of nutrition for the year 2019 demonstrated that Sudan has one of the largest numbers of malnourished children in the world. A striking 2.7 million children under-five suffer from malnutrition, of which more than half a million from severe acute malnutrition (UNICEF, 2019). Although, there are huge efforts were made, Sudan is still struggling to implement strategies, policies, and regulatory measures to address malnutrition to achieve the Global Nutrition Targets in 2025 and Sustainable Development Goals (SDG) in 2030 (Shekar *et al*., 2016).Scientific efforts throughout research and studies were carried out to ascertain the nutritive adequacy of local and available materials for simple utilization as baby foods, particularly by the rural and poor urban mothers during the period of (0-5 years). Some commercial meals are simply prepared but they are so expensive and it is not handy for the families with low income. The most successful meals from a nutritional point of view are those produced of local sources, which

have a fairly harmonious balance and at the same time are reasonably low in price. With the reason of high cost of an artificial dehydration technology, the natural drying technique becomes the best solution for the families of low-income in developing countries particularly in rural areas. Diversifications of local natural resources would facilitate the preparation different complementary foods that could satisfied the nutritional requirements of children particularly children under- five years. In this regard, blending cereals with legumes is considering good pathway to ensure fully nutrients meal this can be achieved through legume supplementation of cereal-based weaning foods (Wakil and Kazeem 2012). In Sudan feeding the weaned child depends equally on the availability of milk and sorghum and millet (Dirar, 1993). Historically, Sudanese people cultivated pigeon pea, millet and pumpkin and they used them in their daily diets in different forms. In combination with cereals, pigeon peas make a well balanced human food (Akporhonor *et al*., 2006). Pigeon pea contains high levels of protein and important amino acids (methionine, lysine and tryptophan).

On the other hand, millets are highly nutrition, non-glutinous and non-acid forming food. It is rich source of vitamins and minerals especially calcium. Millets are nutritionally comparable to major cereals and serve as good source of protein, micronutrients and Phytochemical. Millets are rich source of sulphat containing amino acids, vitamin B and in certain minerals like magnesium, manganese, iron, copper, phosphorous and zinc (Kumar, 2010). Pumpkin also is an important dietary source of fibre, carotene, minerals (copper, zinc, iron and magnesium) and vitamins (Djutin, 1991). Many Sudanese studies were mirrored successfully the incorporation of pumpkin in different food recipes for instance sausage, biscuits and dried sheets (Abdelgadir *et al.,* 2019, Ahmed *et al.,* 2020).Running after achieving food availability and sustainability, the production of this formula would diversify the meals prepared for the child which nutritionally contains grand amounts of micronutrients. Therefore, this study aim at preparation a formula of Sudanese natural food ingredients to contribute to solving the problem of acquired malnutrition in children under 5 years old, as well as determines its acceptance to this target group. In addition, this meal is also suitable for children with celiac disease or gluten intolerance due to the use of millet flour, which is gluten-free, and thus may also reduces diarrhea associated with symptoms of malnutrition for children.

MATERIALS AND METHODS

Materials

Sudanese licensed varieties of millet (*Pinnesetum americanum*), pigeon pea (*Cajanus cajan*) and pumpkin (*Cucurbita moschata*) were purchased from the local market at Khartoum North City of Sudan, in addition to commercial grade of sugar, baobab powder, milk powder, salt and vanilla. The analyses of prepared formula were carried out at the labs of National Center for Research Environment, Natural Resources and Desertification Research Institute and food dehydration department of National Food Research Center (NFRC).

Raw Materials Preparation

Initially, all raw materials were manually cleaned and washed well in running tap water then distilled water.

Millet Flour Preparation

Two kilograms of millet seeds were soaked in water for (4 hours) and drain off the excess water. Millet seeds were decorticated then spread over small aluminum trays for drying naturally under the shade. The dried millet seeds were milled using hand mortar and sieved to yield fine flour. The obtained flour was packaged in polyethylene bags and stored for incorporation in the final formula.

Pigeon pea Flour Preparation

Two kilograms of pigeon pea seeds were cooked with a small amount of boiling water for (1-2 hours) until they adsorbed the water, then decorticated and placed under moving fans for a day until dried and then milled into fine flour. The obtained flour was packaged in polyethylene bags and stored for incorporation in the final formula.

Pumpkin Powder Preparation

A medium-size of pumpkin fruits were peeled and cut into cubes using dicer machine. The cubes were placed in stainless steel drying trays (46×70×5) under moving fan at room temperature (25±5°C) for a week until dried completely, then crushed and sieved to yield flour. The obtained flour was packaged in polyethylene bags and stored for incorporation in the final formula.

Formula Preparation

The formula recipes were prepared in the lab of Food Drying Technology Department, National Food Research Center (NFRC), in Sudan.

Amount of (400g) millet flour were well mixed in a beaker with amount of (1300ml) warm water. In another beaker, amount of (300g) pigeon pea were added to (1300ml water) and heated to (90°C) with continuous steering for 25-30 minutes. The first mixture (millet flour and water) was then added to the second mixture (pigeon pea and water) with continuous steering to make a homogeneous mixture. After cooling, amounts of (100g) pumpkin powder mixed with (400ml) of water, (70g) baobab powder mixed with (600ml) of water, in addition to sugar (50g) , salt (5g), milk powder (50g) and vanilla powder (25g) were added consecutively with continuous steering Table.1.

Thin layer of the final mixture was spread over drying trays under moving fans at room temperature for 3days till completely dried. The dried product collected, crushed and sifted to obtain fine powder. The formulation and manufacturing of the meal was shown in Fig.1and Table.1, respectively.

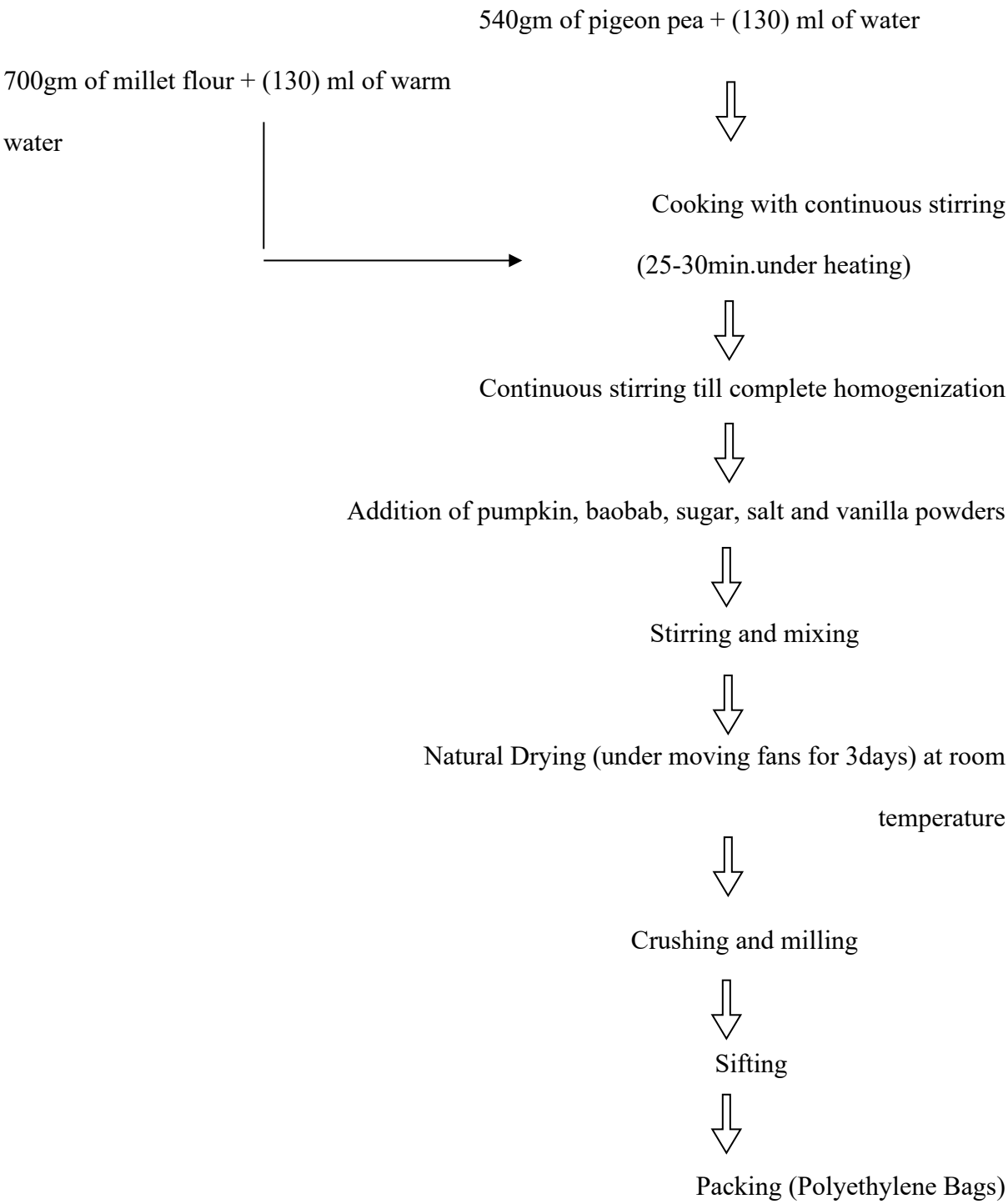

Fig.1: Flow diagram for the preparation of formula

Table.1: Formulation of prepared formula (/100g)

Ingredients	Percentage
Millet flour	40%
Pigeon pea flour	30%
Pumpkin powder	10%
Baobab powder	7%
Sugar	5%
Milk powder	5%
Vanilla	2.5%
Salt	0.5%

ANALYTICAL METHODS

Proximate Composition

Moisture, lipids (fats), ash, protein, fiber were determined according to the methods of the Association of Official Analytical Chemists (AOAC, 2000). Carbohydrate calculated by deference [100% – % (moisture + protein + ash + fiber + fat)]. The energy content of the blends was determined by a standard calculation (Atwater factor) and expressed in kilocalories.

Total Minerals Determination

Minerals were extracted from the samples by the dry ashing method as described by Chapman and Pratt (1961) using Atomic Absorption Spectroscopy (Perkin-Elmer 2380).

Vitamin C Determination

Vitamin C content was estimated as ascorbic acid level according to the method described by Ruck (1963).

The Sensory Evaluation

A group of 20 students (female) of Omdurman Islamic University, College of Science and Technology were chosen randomly for testing the prepared meal using a fife-point hedonic scale (1=dislike extremely and 5=like extremely). The prepared meal was compared with a commercial sample for children's meal. The assessment was systematically performed in triplicate according to the method described by Ihekoroney and Ngoddy (1985). The Least Significant Deference (LSD) at (0.050%) level of significance was used.

Statistical Analysis

All experiments were presented in triplicate for mean values with the standard deviation and analyzed using one way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

In view of the data presented in Table 2, the results of the proximate composition of the prepared formula of natural dried baby meal based on millet and pigeon pea reflects that the moisture content was found to be (7.15%) which is suitable for dried meal to ensure the quality and safety during storage period, while ash content was found to be (3.56%).

In terms of protein content, the prepared formula recorded (10.50%). According to FAO (1995) the protein content of millet is comparable wheat and maize. Although all studies which were carried out in different parts of Sudan have shown that calorie and protein intake were in adequate, the results of protein recorded in this study was in the line of recommended dietary

allowance for infant (RDA 2010) and within the range of protein requirement for children under five years which depend on the amount of complementary food need, some studies have shown that the functional gastric capacity (30g/kg reference body weight) A calculation can be made to identify the additional protein intake required from a complementary food. An additional complementary food per day is required to satisfy the protein needed for children less than five years was 249g/meal at 6-8 months,285g/meal at 9 – 11 months and 345g/meal at 12-23 months (The United Nations University 2003). As the proteins in the cereal grains are generally low in the contents of lysine, the combination cereal with legumes would ensure the needs of child under- five years old. On the other hand, the fat content was found to be (2.05%). Even though of fat importance as source of energy, the level of fat content can qualify the prepared meal for long storage period. The result of the crude fiber was found to be (0.69%) which is less than the maximum level (5%) of crude fiber set by the Codex for infants and preschool children (Codex, 1985). Children should have lower dietary fiber intakes than adults, with the recommended amount proportional to body weight (Hegazy *et al*, 1989)

Table.2: *Proximate composition (%) of prepared formula

Nutrition Information	
Moisture	7.17±0.032
Ash	3.56±0.001
Crude protein	10.50±0.00
Fats	2.05±0.079
Crude fiber	0.69±0.012
Carbohydrates	76.03±0.26
Energy	381.57Kcal

*Mean ± standard deviation (n=3)

The value of carbohydrate content was (76.03%) which is comparatively higher than (58%) that reported by the Codex (1985).The increase of the carbohydrate content was definitely due to the added levels of millet and pigeon pea flours, where these flours were sediment of starch, proteins and other nutrients which are concentrated in the residue.
It is known that carbohydrate and fats would perform one of three vital functions within the body that provide heat and energy.

Moreover, the energy value was found to be (381.57Kcal).This result agrees with the recommendations of FAO/WHO/UNU (1985), which specify (1.0 kcal/g) as safe for small children (2 to 5 years) of age.

Table.3: *Minerals and vitamin C contents of prepared formula

Elements	**(mg/100gm)**
Calcium (Ca)	2.13±0.063
Iron (Fe)	2.11±0.015
Sodium (Na)	56.58±0.623
Potassium (K)	137.75±2.669
Vitamins	**(mg/100gm)**
Vitamin C	2.63±0.042

*Mean ± standard deviation (n=3)

The results of minerals (Ca, Fe, Na, and K) and vitamin C contents were presented in Table 3. The calcium content was found to be (2.13mg/100g), whereas the iron content was found to be (2.11 mg/100g) which is slightly lower than that recommended by the FAO (10mg/100 g) for baby foods. Considering the fact that iron deficiency is one of the malnutrition facets, this finding necessitates the incorporation of local and available resources rich of iron when formulate baby foods. According to Dai (1983), the most important etiology of iron deficiency in developing countries is rather inadequate intake, poor absorption or bioavailability of iron from the diet.

Regarding the sodium content value, the prepared formula recorded (56.58mg/100g). This finding is within the recommended weaning food standard levels prescribed by the FAO. On the other hand, the potassium content value was (137.75 mg/100g).Generally, the findings of minerals contents can be explained on the light of ash content value recorded in this study.

For the evaluation of vitamin C content, it can be observed that the formulated sample recorded (2.63mg/100gm). This could be because of different processing operations that can affect the ascorbic acid content in the final product specifically decorticating process. Consequently, it was recommended that special attention should be paid to these sensitive ingredients. The importance of vitamin C value in this research is help to increase the absorption of iron.

Table 4: Microbiological analysis of prepared formula

Parameters	**Count (CFU/g)***
Total bacterial count	Negligible
Total yeast and mold	Nil
Spores from bacteria	Nil

*CFU: Colonies Forming Unit

Microbiological evaluation of prepared formula was given in Table 4.It is clearly evident that prepared sample was free of pathogens. These findings confirm that utilization of drying

technique can extended the shelf life of food stuffs. Noteworthy, the International Microbiological Standard recommended that the limit of bacteria contaminants for food should be less than 10^6 cfu/g (Anonymous, 1974).

Table 5: Organoleptic evaluation of prepared formula compared with commercial sample

*Samples	A					B				
Sensory Attributes	**Taste**	**Flavour**	**Color**	**Texture**	**Overall Acceptability**	**Taste**	**Flavour**	**Color**	**Texture**	**Overall Acceptability**
Total of scores	80	83	85	85	76	43	49	55	56	45
Mean of scores	4.00	4.15	4.25	4.25	3.80	2.15	2.45	2.75	2.80	2.25
D	1.85	1.70	1.50	1.45	1.55	1.85	1.70	1.50	1.45	1.55
S	0.88	1.16	1.10	0.96	0.99	0.88	1.16	1.10	0.96	0.99

df = 19 ***t value*** = 2.093

*Sample A represents the commercial sample, while sample B represents the formulated sample

Sensory evaluation was carried out according to the method of Ihekoroney and Ngoddy (1985) and results were tabulated as shown in Table 5.The method of analysis depends mainly on the significant difference using analysis of variance. The means values of the given scores for the tow samples can be compared using (t test).The samples are significantly different if ($\frac{d}{s/\sqrt{n}}$) is greater than t value ($\frac{d}{s/\sqrt{n}}$ > t value) at Least Significant Deference (LSD) of (0.050%) whereas:

(*d*) Represents difference of means between sample A and sample B.
(*s*) Represents standard division.
(*n*) Represents the number of selected panelists.
(*df*) (Degree of Freedom) represents the number of panelists minus one.

The (t value) was obtained from the statistical chart at (0.050%) level of significant.
Based on the data obtained in Table.5, it is clearly the mean scores of the commercial sample (Sample A) was significantly (0.050%) more tasty than the formulated one (Sample B).This could be due to the clear sour test appears in millet seeds particularly when used new one, therefore it needs good soaking operation. In addition to that, it might be refer to the acceptance degree of some of the panelists who are unfamiliar with the taste of millet.

On the other hand, the findings showed that sample (A) again had significant difference (0.050%) in terms of flavour compared with sample (B). It is an excepected finding as taste and flavour associate together to create the final result of taste and flavour. In this regard, utilization of artificial flavored materials could be according to the acceptable levels. For the texture, the results reflects that sample (A) high acceptable level compared with prepared sample, this could probably be explained by the decrease of swelling after addition of millet and pigeon pea flours. The addition of millet and pigeon pea flours beside the other ingredients could obviously make the texture more thickened.

Prominently, commercial sample was achieved the higher score compared with formulated sample. The huge challenge related to acceptance of such kind of meals is to make child more

familiar with the meals made out of millets and pigeon pea recopies. In general the commercial sample was more acceptable than formulated sample. The recommendation here is could be conduct preliminary evaluation to specify suitable recipes of total composition or by adding some natural materials to enhance the taste and flavour before final judging.

CONCLUSION

In light of the outcomes obtained in this research, the attempt of preparing formula from local available resource directed to fight malnutrition in children under five years was successfully executed. Appreciable amounts of protein (10.50g %), low moisture content (7.168g %) and energy value (381.571Kcal) were recorded. However, the results presented could be developed and applied to formulate readily consumed balanced and digested meal, while ensuring consumer acceptance. In conclusion, this research could encourage production and assorted baby foods based on local, high nutritive and low price materials, as well as reintegrates and support the official efforts that aim at ending malnutrition in Sudan.

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