FORMULATION, SENSORY EVALUATION AND NUTRIENT ANALYSIS OF PUMPKIN INCORPORATED COMPLEMENTARY FOOD

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Abstract
Nutrient fortified cereals are the first complementary foods introduced to the infant when they are of six months of age and then it is followed by fruits and vegetables in most of the developed societies. In under-developed and developing countries, cereal based complementary foods are very common. Number of convenient and commercially available fortified proprietary formulas is available in developing countries but they are often too expensive and out of the reach of lower income families. Therefore the present study was undertaken to formulate complementary foods for infants, children and elderly with the use of locally available and nutrient dense food stuffs like rice, legumes, oilseeds and vegetables. The formulation of complementary foods was done in according to standards of BIS (2006). The formulated food mixes were subjected to sensory evaluation, nutrient analysis and the mean scores obtained from the results showed that all treatments were well accepted and had good scores and a good nutritional profile. These food mixes ensures availability, affordability as well as help in alleviating some economic and time related constraints faced in child feeding practices. The complementary food can be cooked in milk or water with sugar or honey or salt according to the likes and dislikes of the individual and can also be recommended for adult and elderly people to meet their requirements.

Keywords: Complementary food, Formulation, Nutrient analysis, Pumpkin, Sensory evaluation

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1. INTRODUCTION

Complementary feeding is the process by which infant progresses from a diet composed of only breast milk or infant formula milk to a family diet consisting of wide varieties of food which is necessary to ensure that nutrient intakes continue to be adequate for healthy growth and development throughout childhood (WHO, 2003). Processed-cereal based complementary food, commonly called as weaning food or supplementary food means foods based on cereals and/or legumes, nuts and edible oilseeds, processed to low moisture content. It shall contain milled cereal and legumes combined not less than 75 per cent and the product is intended to be mixed with milk or water before consumption. All ingredients, including optional ingredients, shall be clean, safe, suitable and of good quality. The material shall be manufactured and packed under hygienic conditions. The flavour and odour of the processed-cereal based weaning food in the powder form or when reconstituted with water/milk shall be fresh and sweet (BIS, 2006). The product shall be packed in containers which will safeguard the hygienic and other qualities of the food and the containers, including packaging materials, shall be made only of substances which are safe and suitable for their intended uses (CODEX, 1991). Appropriate complementary feeding practises involves a combination of techniques while maintaining the breast milk intake of the child and, simultaneously, improve the quantity and quality of other solid or semi-solid foods suitable for children. Good complementary foods should be high in energy content and also other necessary nutrients to ensure adequate growth and development of children. Complementary foods should be soft, thin in consistency and easily digestible and should not contain any hard pieces which may cause choking during swallowing. Foods should be given frequently since infants have small stomachs and cannot eat much at one time.

Complementary foods should neither have strong flavour and odour and nor it should be spicy and salty foods (USAID, 2011).

Nutrient fortified cereals are the first complementary foods introduced to the infant, followed by fruits and vegetables in most developed societies. A number of convenient fortified proprietary formulas are available in developing countries but they are often too expensive and out of the reach of lower income families. The use of home based complementary food that can be easily prepared, available and affordable, is one feeding alternative that has been recommended to remove the effect of malnutrition on infant and young children (Akinola *et al.,* 2014). To prepare complementary foods for infants and children the use of high nutrient dense food stuffs like cereal, legumes, fruits, vegetables and animal food products has been suggested by a number of researchers (Akinola *et al.,* 2014; Ikujenlola and Fashakin, 2005; Bala *et al*., 2014).

VAD in children may impair vision, causes xerophthalmia, weaken immune function and increase severity of infectious diseases like measles and diarrhoea. These micronutrients have especial benefits due to their impact on physical and cognitive development of children. Chronic low intake of zinc and vitamin A rich foods is primary cause for their deficiencies. Food-based approach is the best way for combating malnutrition of vitamin A and others among infants and young children in developing world. Incorporating high ß-carotene foods like pumpkin is cost effective food-based approach to improve vitamin A intake of young children and tackle vitamin A related health problems. It was also noted that pumpkin seed flour supplemented complementary mix is an economical nutritious food with highly acceptable sensory property (Zema *et al*., 2015). Keeping the above facts in mind, the present research study aims to develop suitable food formulations utilizing cereals, pulses and oil seeds with the fortification of pumpkin flour in three variations of 10%,15%, 20%, in the form of cereal-pulse based complementary food and a suitable process for manufacturing them for household use and commercial exploitation with the objectives of formulation of complementary foods by using low cost easily available ingredients like rice, green gram, sesame and pumpkin and to evaluate the sensory characteristics of the developed food.

2. MATERIALS AND METHODS

Masuri rice, green gram, sesame and pumpkin were purchased from the local market of Garali, Jorhat, Assam in October 2019. The ingredients selected and used were of high grade. Each ingredient was processed into flour and kept in separate airtight plastic containers in refrigerated temperature.

2.1 Preparation of Rice flour

The rice grains were sorted, cleaned and washed. The seeds were soaked in water for 5 hours and then the water was drained. Rice grains were then sun dried (29°C) for 2 hour, grinded and sieved (36 mesh size) to obtain rice flour. It was stored in plastic airtight container (PET) and kept in refrigerated temperature to be used later.

2.2 Preparation of Green gram flour

Green grams were soaked in water for about 12 hours and allowed to germinate for 12 hours at room temperature. The germinated legumes were dried in oven at 60°C and dehulled by manual rubbing. The dehulled samples were grinded in an electric grinder and sieved (36 mesh size) to get fine flour and stored in plastic airtight container (PET) before use in a refrigerator.

2.3 Preparation of Sesame flour

Sesame seeds (white) were cleaned and roasted (60°C) in a pan for 5 minutes, grinded in an electric grinder and stored in plastic airtight container (PET) before use in a refrigerator.

2.4 Preparation of Pumpkin flour

Pumpkin fruits were obtained from the local market. The rind, fibrous matter and seeds were removed and the flesh cut into 1 inch cubes. The pumpkin pieces were then cut into slices of 1 mm thickness using a stainless steel knife and were then dried in a tray drier at 60°C for 24 hours. The dried slices of pumpkin were grinded to flour in an electrical grinder and then sieved through a standard sieve (36 mesh size). The

flour was stored in plastic air tight container (PET) before use in a refrigerator.

2.5 Formulation of the Complementary food

The formulation of complementary foods were done in accordance to the standards of Bureau of Indian Standards (BIS, 2006) which states that complementary foods should contain cereals and legumes combined not less than 75% and the product is intended to be mixed with milk or water before consumption. Three formulations namely T_1, T_2, and T_3 were developed containing rice flour as the major ingredient from *Masoori* variety. Other ingredients used were green gram, sesame and pumpkin. The proportions of these ingredients are given in Table I. A sample of 100 g of each variation was taken in separate pans and mixed with 400 ml of luke warm milk with 15 grams of sugar. The mixture was then simmered, stirred continuously and cooked till done and it formed a soft gel and the top of the mixture was observed to have a glassy appearance.

Table I- Details of the treatment combinations

Treatments	T1 (%)	T2(%)	T3(%)
Rice flour (%)	60	55	50
Green gram flour (%)	20	20	20
Sesame flour (%)	10	10	10
Pumpkin flour (%)	10	15	20

2.6 Sensory Evaluation

Sensory evaluation was conducted by trained and semi-trained panel of twenty members from the Department of Food Science and Nutrition and Department of Food Science and Technology, Assam Agricultural University. Scoring was done on nine-point hedonic scale. The acceptability of the formulated complementary mixes was assessed for sensory characteristics. All the seven formulations were prepared in the form of porridge made with milk and sugar to find out the acceptability of the products. Porridges were prepared carefully to have the correct consistency and taste and were presented simultaneously at room temperature along with the score cards. The session for evaluation was held in a well-lighted and ventilated laboratory with no disturbance. The judges were in good health at the time of evaluation. Judges were allowed to be seated on chairs at counters of comfortable height. The samples were served in identical bowls with a separate bowl and spoon for tasting. Glasses of water were provided for rinsing the mouth. At the beginning of each tasting session, the descriptive term for each quality to be evaluated were explained to the panel members. The panel members evaluated the samples on the basis of colour, appearance, taste, consistency, flavour and overall acceptability. The samples were labelled with codes (T1, T2 and T3) and a side-by-side presentation protocol was followed for all the three samples. The rating of the scale ranged from 1 (dislike extremely) to 9 (like extremely) as described by Peryam and Pilgrim (1957). The scores for each quality were totalled and averaged.

2.7 Nutrient analysis

Moisture, crude protein, crude fat, crude fibre and total mineral content of the samples was determined as per the A.O.A.C. (2010) procedure. The carbohydrate content of the sample was determined by difference method (Gopalan *et al.,* 2000). Iron and calcium content was determined according to the method described by Ranganna (1986) and A.O.A.C, 2000 respectively.

2.8 Statistical analysis

To assess whether the relationship observed between the formulations characteristics and sensory responses, were likely to be real, the methods of statics were used to analyze evaluation data. All the data of the experiment were statistically analysed and methods applied for the statistical analysis of the recorded data are Mean, Standard deviation and Analysis of variance (ANOVA) in completely randomized design which was performed on the data using Statistical Package for Social Sciences (2006) and the means were tested for significance at 5% probability level. Means were separated using Duncan's multiple comparison tests where applicable.

3.RESULTS AND DISCUSSION

3.1 Formulation of complementary food mixes

Three formulations namely T_1, T_2 and T_3 were developed containing *Masoori* rice flour as major ingredient. Other ingredients used were green gram, sesame and pumpkin flour in different proportions. Composition of the formulated complementary food mixes are given in Table II.

Table II - Composition of the formulated complementary food mixes

Ingredients	Formulation name	Mixing ratios
Rice, green gram, sesame, pumpkin	T_1	Rice(60g), green gram(20g), sesame(10g), pumpkin (10g)
	T_2	Rice(55g), green gram(20g), sesame(10g), pumpkin (15g)
	T_3	Rice(50g), green gram(20g), sesame(10g), pumpkin (20g)

3.2 Sensory evaluation of the formulated complementary food mixes

The formulated foods were evaluated for sensory attributes and results are presented in Table III. The mean scores obtained from sensory evaluation showed that all treatments were well accepted. Appearance is important attribute in food choice and acceptance. Outcome of sensory evaluation indicated that some samples were similar in appearance while others differed significantly. Taste is an important parameter when evaluating sensory attribute of food. The product might be appealing and having high energy density but without good taste, such a product is likely to be unacceptable. Smell is an integral part of taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing acceptability of formulated foods.

The sensory parameters in each formulation scored significantly different scores at ($p \leq 0.05$). T_1 scored highest (8.1±0.03) in colour; T_3 scored highest (8.0±0.04) in flavour; T_2 scored highest (8.1±0.02) in consistency; T_2 scored highest (8.0±0.03) in appearance; T_3 scored highest (7.5±0.02) in taste; T_3 scored highest (8.1±0.02) in overall acceptability. This difference in the scores of different attributes of sensory parameters may be attributed to the proportion of rice and pumpkin flour used in the formulations.

Similarly, results of sensory evaluation of the complementary foods made from maize, pumpkin pulp and its seed were liked very much (4.32±0.77 to 4.72±0.4 on a five point hedonic scale) by the sensory panel members. However, with increase in amount of pumpkin pulp and its seeds in blends, there was a decrease in the scores in appearance. (Zema *et al.*, 2015).

3.3 Nutrient composition of the formulated complementary food mixes

The nutrient composition in terms of moisture, crude protein, crude fat, crude fibre, total mineral, carbohydrate, iron and calcium of the formulated complementary food mixes are presented in Table IV.

The moisture content of these formulated complementary food mixes were above the value recommended by Bureau of Indian Standards, 2006 (4%) and Codex International Standard, 1994 (10%). The difference in the moisture content between the formulations may be due to use of rice flour and sesame flour in different proportion in the preparation of the food mixes. Gopalan *et al*., (2000) stated that the higher moisture content of formulated weaning mixes could be due to use of ingredients like sesame and rice flour. Another contributing factor could be due to high humidity and climatic variation existing in the study region.

Table III - Mean scores of sensory evaluation

Formulations	Appearance	Colour	Flavour	Taste	Consistency	Overall Acceptability
T1	7.4 ± 0.01^b	8.1 ± 0.03^a	7.2 ± 0.01^b	7.0 ± 0.03^b	7.8 ± 0.01^b	7.8 ± 0.04^b
T2	8.0 ± 0.03^a	8.0 ± 0.01^a	7.0 ± 0.01^b	7.4 ± 0.02^a	8.1 ± 0.02^a	8.0 ± 0.02^a
T3	7.5 ± 0.03^b	7.8 ± 0.06^b	8.0 ± 0.04^a	7.5 ± 0.02^a	8.0 ± 0.03^a	8.1 ± 0.02^a

Values are mean ± SD of 20 replications
Means with different superscript within the same row are significantly different at $p \leq 0.05$

Table IV: Nutrient composition of the formulated complementary food mixes:

	T_1	T_2	T_3	CD $_{0.05}$
Moisture (g/100g)	10.07±0.03	10.19±0.03^{d}	10.32±0.06^{a}	0.17
Crude protein(g/100g)	14.12±0.02	14.33±0.14^{b,c}	15.85±0.03^{b,c}	0.28
Fat(g/100g)	09.76±0.01	09.10±0.13^{c}	10.81±0.07^{a}	0.46
Fibre(g/100g)	01.50±0.05	01.66±0.05^{a,b}	01.81±0.01^{c,d}	0.15
Total mineral(g/100g)	01.62±0.04	01.86±0.05^{a}	02.01±0.04^{a,b}	0.11
Carbohydrate(g/100g)	67.87±0.02	62.37±0.11^{e}	59.90±0.09^{b}	0.28
Iron(mg/100g)	04.08±0.07	04.26±0.40^{b}	04.64±0.34^{a,b}	0.75
Calcium(mg/100g)	171.3±0.03	173.2±0.32^{a,b}	180.8±0.40^{a,b}	2.44

The protein content of the formulations satisfies the protein content recommendation of Prevention of Food Adulteration Rule (1991) which ranges from 10.0 to 16.0 %, thereby making the present formulations suitable as a nutritious complementary food. The difference in the results between the formulations may be due to differences in the proportion of ingredients used. The fat content of these formulated food mixes were within the recommended value (<9.0) of Prevention of Food Adulteration Rule (PFA, 1991). The crude fibre content of these formulated complementary food mixes were within the value recommended by Bureau of Indian Standards, 2006 (1%). According to recommendations of Bureau of Indian Standard (2006), the total mineral content of cereal based weaning food should be 5.0 percent. According to BIS (2006), the carbohydrate content should be 55 g/100g. The codex specified a minimum standard level of 58% carbohydrates. Bureau of Indian Standards (2006) recommendations of iron content of weaning foods should be 5.0mg/100g. The recommended calcium content of complementary foods according to Bureau of Indian Standards (2006) is 1g/100g and Prevention of Food Adulteration Rule (1991) is 230mg/100g respectively. The required daily allowance (RDA) for calcium content in the complimentary foods is 400-425 mg (CODEX 1991). The calcium content of the mixes will increase and meet the recommended value when cooked in milk.

4. CONCLUSION

Supplementary feeding has to be adopted to maintain the needs for growth of infants and to bridge the gap of energy, protein and other micro-mineral requirements. The vulnerable segment of population suffering from malnutrition does not have access to expensive protein concentrates. So, this problem can be solved through the use of inexpensive local foods available easily. In this study attempt have been made to formulate a complementary food sample that will be of higher nutritive value and easily affordable. The blends formulated in this study could be used by rural and urban mothers to feed their infant and children during the complementary feeding period. It ensures availability and affordability as well as help in alleviating some economic and time related constraints faced in child feeding practices. The results obtained showed that acceptable complementary food could be produced from rice flour, green gram flour, sesame flour and pumpkin flour. The complementary food can be cooked in milk or water with sugar or honey or salt according to the likes and dislikes of the individual and can also be recommended for adult and elderly people to meet their requirements.

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