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Development and nutritional evaluation of weaning foods to prevent protein- energy malnutrition in infants

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Abstract
The aim of the study was to develop weaning foods for the infants by using locally available resources, their organoleptic evaluation and proximate composition, to combat protein-energy malnutrition. Two weaning formulations (multigrain and nut mix; banana, apple and rice kheer) were processed and evaluated for infants of age 6-12 months and 9 months onwards. After which weaning foods formulations samples were developed by mixing the ingredients. The prepared weaning foods were investigated for organoleptic evaluation and proximate composition (moisture, protein, fat, crude fibre and ash content). The mean score of overall acceptability obtained by organoleptic evaluation of the multigrain and nut mix; banana, apple and rice kheer was 8.22 and 8.36 respectively, at zero day. The proximate composition indicated that moisture content of multigrain and nut mix; banana, apple and rice kheer were 1.87 and 3.58 percent, respectively. The crude protein of multigrain & nut mix and banana, apple & rice kheer were found 21.23 and 3.99 percent, respectively. The fat content of multigrain and nut mix; banana, apple and rice kheer were found 11.34 and 2.11 percent, respectively. The crude fibre and ash content were found 7.22 percent, 4.62 percent and 5.95 percent, 4.70 percent in multigrain and nut mix; banana, apple and rice kheer, respectively. Both the weaning food formulations organoleptic ally fell in the category of "liked very much" and nutritionally have a good potential for use as weaning foods for infants.

Keywords: Weaning foods, infants, multigrain, banana, apple, rice

Introduction

Malnutrition is a major health problem in developing countries and contributes to infant mortality, poor physical and intellectual development of infants, as well as lowered resistance to disease and consequently stifles development. Protein-energy malnutrition, Apart from marasmus and kwashiorkor, deficiencies in iron, iodine, vitamin A and zinc are the main manifestations of malnutrition and generally occurs during the crucial transitional phase when infants are weaned from liquid to semi-solid or fully adult foods. The data from WHO showed that about 60% of all deaths, occurring among children aged less than five years in developing countries could be attributed to malnutrition, Salim *et al*., 2012 [7]. Malnutrition is widely prevalent in children with 6-23 months age group. Although treatment protocols for severe malnutrition have in recent years become more efficient and adequate nutrition during infancy is fundament all development of full human potential. The period from birth to two years of age is a "critical window" for the promotion of optimal growth, health and behavioural development. Growth rate in human being is maximum during the first year of life and infant feeding practices comprising of both the breastfeeding as well as complementary feeding have major role in determining the nutritional status of the child (PAHO & WHO, 2003; IYCF, 2004) [6, 3]. There are three determinants of good health, nutrition and child survival - these are food security, caring practice and disease control. Breastfeeding is an excellent example of all these three things in one. Nutritional requirements of an infant can be obtained solely from breast milk for the first six months of life. After that time breast milk must be complemented with appropriate energy-dense foods that can ensure satisfactory growth and development of the children. Breast milk is adequate to meet the energy and nutrient requirements of an infant up to four to six months of age, thereafter it is insufficient to sustain normal growth and needs to be supplemented with other foods, such as weaning foods. Weaning foods are adult foods, modified by processing the ingredients to make them easily digestible by the infant. Smooth foods are typically introduced first, followed by lumpy and finger foods.

First weaning foods should be bland and smooth, but once food is accepted from a spoon, introduction of foods with a variety of different tastes should be encouraged. The capacity of a weaning diet to meet the protein and energy requirements of infants depends on its nutritional quality as well as its dietary bulk. When a baby reaches four to six months of age, milk alone is no longer sufficient to meet its nutritional requirements. Calories and other nutrients are needed to supplement milk until the child is ready to eat only adult foods. Weaning is a time of nutritional vulnerability and represents a period of dietary transition, just when nutritional requirements for growth and brain development are high. Weaning food plays a vital role in the all-round growth, development and mental health of children. Growth in the first year influences both the well-being of the child and the long-term health of the adult. Introduction of different tastes and textures promotes speech and physiological development of the infant. By four to six months of age, most infants are able to handle more complex carbohydrate and most proteins. As the infant‘s digestive capacity develops, the strained foods of early infancy can be replaced by less finely chopped foods, with a final transition to table foods. The first weaning stage lasts from four to six months. Suitable first weaning foods include vegetable and fruit purees, non-wheat cereals, and unsweetened yogurt. The quantity, consistency, flavor, potential allergeni city, and preparation of first foods all need to be considered. Only tiny quantities are required initially. The small quantity of food consumed in the first stage of weaning is of little nutritional value. Breast milk or infant milk formula will remain the major source of nutrients until a fully mixed diet is achieved. A variety of weaning flours are commercially available with high nutritive value, which are directly used for instant preparation of gruels. In many developing countries, these products are beyond the economic means of the majority of families, so mothers use traditional gruels—watery suspensions of maize or sorghum—as complementary foods for infants. These gruels usually have low energy density and poor protein, vitamin, and mineral contents (Njongmeta *et al*., 2003) [5]. In addition, because of inappropriate processing technology, the gruels contain significant levels of contaminants and antinutritional factors, which further limit nutrient absorption by the young child (Walker and Pavitt, 1989) [10]. These factors predispose children to protein–energy malnutrition (Walker, 1980; Waslien, 1981) [11, 12].

However, when the time comes to introduce foods from six months of age to complement breast milk, many young children do not receive adequate feeding. This can result in malnutrition of young children. Children therefore require nutritionally balanced calorie-dense supplementary foods in addition to mother’s milk.

Material and Methods

The present study was carried out in the Department of Food Science and Nutrition, College of Community and Applied Sciences, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Procurement of raw material: Raw materials used in this study were procured from the Department of Food Science and Nutrition, College of Commuity and Applied Science, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Preparation of sample: The barley and wheat were first sorted and cleaned and then washed with water for 5 times and soaked in water for 8 hours. Excess water was drained; seeds were tied in a muslin cloth. These seeds were germinated/malted at room temperature for 48 hours and oven-dried. The germinated/malted barley and wheat were roasted and grounded into flour by using the electric grinder.

Flow diagram of the Preparation of flour

Barley
↓
Sorting
↓
Washing
↓
Draining
↓
Soaking (Overnight)
↓
Kept in muslin cloth for 48 hrs
↓
Water was sprinkled after every 4 hrs
↓
Germinating/malting at room temperature for 48 hours and oven drying
↓
Grinding and making flour
↓
Packed in air tight container

Preparation of weaning foods

Multigrain and nut mix; Banana, apple and rice kheer were standardized for this purpose.

Multigrain and nut mix (6-12 months infants)

Preparation Time: 25-30 minutes
Cooking Time: 15 minute
Serving size: 1

Table 1: Recipe for Multigrain and nut mix (per 100 g)

Ingredients	Amount (g)
Barley	10
Wheat Flour	10
Rice	5
Roasted moong dal	10
Groundnut	5
Jaggery/Sugar	10
Milk	15 ml
Ghee	5 ml

Method

1. Into a plate take all the groundnuts.
2. In another bowl, take germinated wheat, barley, Rice and moong dal.
3. Heat a heavy shallow pan on medium –high heat and add the grains.
4. Sauté on medium- high heat until the grain are crisp. (takes 6-8 Minutes)
5. Once they are crisp, spread them on a glass/stell plate and let it cool.
6. To the same hot pan, roast the groundnut and moong dal for a minute only.
7. Transfer the roasted groundnut and moong dal on a steel plate and let it cool.
8. Into a big containers, transfer the cooled grain mix (wheat, barley and rice)
9. To this, add the roasted groundnuts and moong dal, mix well and use when needed.
10. Multigrain and nut mix is ready.

Porridge preparation

1. Add 2 Tbsp of multigrain and nut mix into a dry grinder and Grind until fine.
2. Into a sauce pan, pour ¼ cup of water and 1 cup of milk.
3. Add the powdered multigrain and nut mix into the pan and stir.
4. Put the heat on medium-high and bring it to boil (keep stirring every 20 seconds).
5. Once it starts boiling, reduce the heat to low and cook for 5 minutes.
6. After 5 minutes, turn off the flame and pour into a serving bowl.
7. Serve when it is slightly warm.

Banana, apple and rice kheer

Preparation Time: 15 minute
Cooking Time: 15 minute
Serving size: 1

Table 2: Recipe for Banana, apple and rice kheer (per 100 gm)

Ingredients	Amount (gm)
Rice	15 g
Banana	80 g
Apple	150 g
Milk	100 ml
Jaggery	15g

Method

1. In a saucepan, add rice and water.
2. Keep gas (stove) heat on high and wait for boil to come.
3. Reduce heat to medium low and cook for 15 minutes.
4. After 15 minutes, cut the apple in uniform pieces, add and cook for another 10 minutes with lid on.
5. Turn off the heat and allow to cool.
6. Put the prepared mixture on blender.
7. Add banana with the mixture and blend until desired consistency.
8. It's ready to be served.

Organoleptic evaluation of prepared weaning foods:

The acceptability of two formulations of weaning foods, multigrain and nut mix; Banana, apple and rice kheer were evaluated by a semi-trained panel of 10 judges using 9-point Hedonic Scale to test the liking or disliking of products. The panelist asked to record the level of liking or disliking by giving marks for various characteristics of the products. On the basis of mean score of organoleptic evaluation obtained both acceptable products were selected for further nutritional studies.

Proximate composition of developed weaning foods

Moisture

Moisture content was determined by employing the standard method of analysis (AOAC, 2000) [1].

Crude protein
Crude protein was estimated by standard method of analysis (AOAC, 2000) [1], using KEL PLUS Automatic Nitrogen Estimation System. A factor of 6.25 was applied to convert the amount of nitrogen to crude protein in pulses and a factor of 5.7 was used for cereals and millets.

Crude fat
Crude fat was estimated by employing the standard method of analysis (AOAC, 2000) [1] using the Automatic SOCS plus Solvent Extraction System.

Crude fibre
The crude fibre was estimated by employing the standard method of analysis (AOAC, 2000) [1] using Automatic Fibra plus system.

Ash
Ash in the sample was estimated by employing the standard method of analysis (AOAC, 2000) [1].

Results and discussion
The present study was undertaken to develop and evaluate weaning foods, the multigrain and nut mix: banana, apple and rice kheer. The findings of the study are presented in the following figures:

Organoleptic evaluation
Multigrain and nut mix; banana, apple rice kheer were served to the panel members for organoleptic evaluation and the results obtained were -

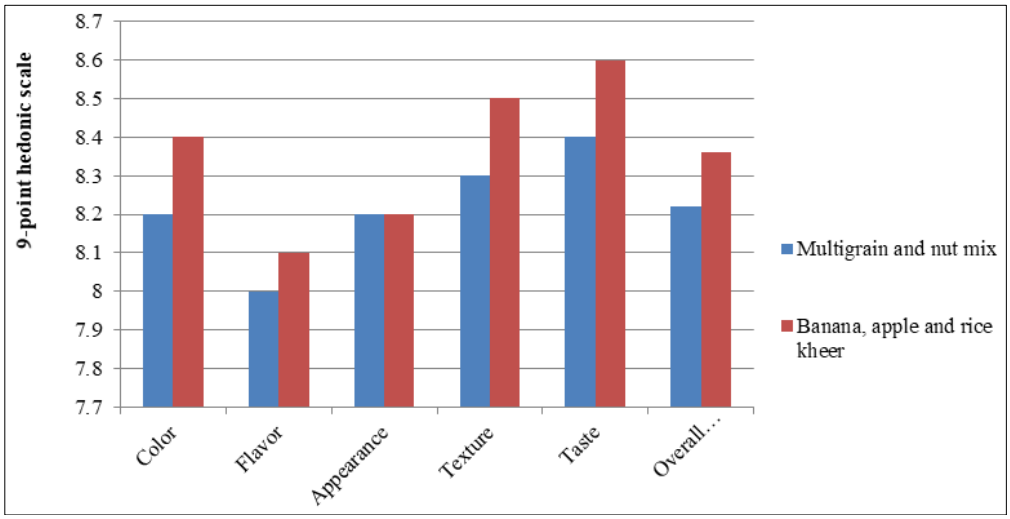

Fig 1: Mean score of organoleptic acceptability of developed weaning foods.

Fig-1 indicated that the mean score of overall acceptability obtained by organoleptic evaluation of the multigrain and nut mix; banana, apple and rice kheer was 8.22 and 8.36, rspectively, at zero day. These results are in agreement with the earlier worker (Asma *et al.*, 2006) [2], who found that Weaning blends which composed of 42% sorghum supplemented with 20% legumes, 10% oil seeds, and 28% additives (sugar, oil, skim milk powder, and vanillin) were improved sensory attributes such as colour, flavor, texture, taste and overall acceptability.

Proximate composition
Organoleptic ally acceptable weaning foods were analysed for proximate composition (moisture, protein, fat, crude fibre and ash content).

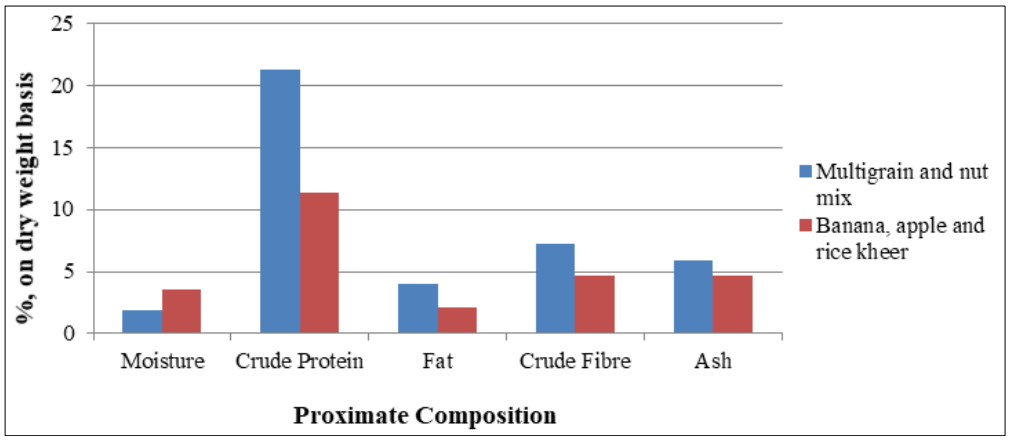

Fig 2: Proximate composition of prepared weaning foods (%, on dry weight basis)

Fig-2 showed that proximate composition such as moisture content of multigrain and nut mix; banana, apple and rice kheer were 1.87 and 3.58 percent, respectively. The crude protein of multigrain & nut mix and banana, apple & rice kheer were found 21.23 and 3.99 percent, respectively. The fat content of multigrain and nut mix; banana, apple and rice kheer were found 11.34 and 2.11 percent, respectively. The crude fibre and ash content were found 7.22 percent, 4.62 percent and 5.95 percent, 4.70 percent in multigrain and nut mix; banana, apple and rice kheer, respectively. These results

are in agreement with those of earlier workers (Asma *et al.*, 2006; Shewry *et al*., 2007; Narsih *et al.*, 2012) [2, 8, 4], who found that the time of soaking and germination improves the nutritional value of sorghum.

Conclusion

The study concluded that two types of weaning foods which were formulated based on germinated wheat, malted barley flour, moong dal and groundnut also had desirable nutritional quality as well as sensory properties. Hence, it can be recommended that germinated cereals can be used in combination with legumes for producing composite weaning mixes, which will prove to be of immense benefit especially for young children in developing countries, because of their low cost and ease of preparation. The development of weaning foods constitutes another important step in improving the nutritional status of infants or young children of developing countries. These prepared weaning foods, which should be manufactured locally and should be marketed through regular commercial channels whenever possible. The local production and distribution to the public of these weaning foods constitute only one element in the control of protein-energy malnutrition in young children which has long term effects. Provision of weaning foods should not be considered as the complete answer to the problem, but only as one of the many approaches that must be undertaken simultaneously.

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