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Preparation of complementary foods using household-level technologies

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Abstract
Complementary foods are the main source of nutrients for infants in developing countries but they fail to provide nutritionally adequate and safe diets for older infants and young children. The high starch content in plant based complementary foods leads to low-nutrient diets that are bulky and dense, with high levels of anti-nutritive factors. In addition, there is often microbial contamination, which leads to diarrhea, growth-faltering, and impaired development, and the presence of chemical contaminants may lead to neurological disease and goitre. 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. Traditional household food technologies have been used for centuries to improve the quality and safety of complementary foods. These include de-hulling, peeling, soaking, germination, fermentation, and drying. To increase the functionality and nutritional worth, cereals, millets and legumes are usually pre-processed by using these household level processing techniques. While modern communities tend to reject these technologies in favor of more convenient fast-food preparations, there is now a resurgence of interest in older technologies as a possible means of improving the quality and safety of complementary foods when the basic diet cannot be changed for economic reasons. This paper describes the utilization of traditional household processes that can be used at the household or community level to develop suitable food formulations from germinated cereals, pulses, millets and oil seeds in the form of cereal-pulse based complementary food to improve the quality and safety of complementary foods.

Keywords: Complementary foods, processing

1. Introduction

Complementary food plays a very important role in the total growth and development of children. Along with mother's milk, infants require nutritionally balanced and calorie-dense supplementary foods to meet the increasing nutritional demands of the growing body (Yaseen *et al*., 2014) [14]. The World Health Organization (WHO) issued a global recommendation from the previous recommendation of breastfeeding of four to six months of age to a full six months to extend the period of exclusive breastfeeding as breast milk has got all the nutrients that babies need to stay healthy and grow. But after six months of age, it may become insufficient to support the nutritional demands of the growing infants and hence, there is the need to complement breast milk with other foodstuffs which can help to improve any deficiency that can result from such inadequacy (Ikujenlola and Adurotoye, 2014) [8]. 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) [2]. 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) [2, 7, 3]. Complementary foods that are produced only from cereals are deficient in certain essential amino acids which are essential for the adequate growth of infant. These essential amino acids are present in reasonable quantities in legumes (Abiose *et al.,* 2015) [1].

Therefore, when legumes are blended with cereals in the right proportions, a mutual complementation of amino acids and consequent improvement in protein quality is achieved (Ghasemzadeh and Ghavidel 2011) [5]. To increase the functionality and nutritional worth, cereals, millets and legumes are usually pre-processed by milling, fermentation, germination, cooking etc. It has been found that germination or sprouting is a simple technique which increases and enhances the nutritive value of cereals and legumes. Several studies have reported that germination can increase the protein content in addition to dietary fibre, increases mineral bioavailability of trace elements like calcium, copper, manganese and zinc, increases the vitamin concentration of riboflavin, niacin and ascorbic acid content and also decreases the content of phytic acid and tannin. In cereals, processing increases the oligosaccharides and amino acids absorption as observed in rice, wheat and barley. Malting is useful in preparation of low bulk weaning foods as malting activates the enzyme amylase and dextrinifies starch (Ikujenlola, 2008) [6]. Since germination is affordable and more effective, it was incorporated in mixes to contribute to the improvement of nutrition value of complementary food mixes (Murugkar *et al.,* 2013) [12]. Therefore, the present study aims to develop suitable food formulations utilizing germinated cereals, pulses, millets and oil seeds in the form of cereal-pulse based complementary food and a suitable process for manufacturing them for household use and also for commercial exploitation.

2. Materials and methods

2.1 Selection of samples

Based on the guidelines given by Indian Council of Medical Research (ICMR) for complementary foods, different food ingredients for complementary food formulations under the present study were selected. Four varieties of Rice samples (*Ranjit*, *Rangoli Bao*, *Kolamai Gutiya Hali* and Black rice), Foxtail millet, Bengal gram, Green gram, Sesame seeds and Pumpkin seeds were selected. Samples of *Ranjit* were procured from Instructional cum Research (ICR) farm, Assam Agricultural University, Jorhat. *Rangoli Bao, Kolamai Gutiya Hali* (red kernel rice) and black rice were procured from Annapurna Seed Library, Meleng, Kathgaon, Jorhat. Foxtail millets were procured from Regional Agricultural Research Station (RARS), Gossaigaon. Green gram, Bengal gram and sesame seeds were bought from local markets of Jorhat. Pumpkin seeds were collected from local households and college hostels of Assam Agricultural University, Jorhat.

2.2 Processing of raw materials

2.2.1 Processing of paddy samples

Paddy samples were malted and powdered with modification of method given by Srivastava *et al*. 2015 [13]. Four varieties of rice samples were thoroughly cleaned and washed separately to remove dirt, dust and other foreign materials. The samples were put in muslin cloth bags and soaked in water for 48 hours. The bags were then kept in air rest for 48 hours to let them germinate. The germinated samples were oven dried for 28 hours at 60°C; rootlets were removed manually and de-husked in an electrical commercial de-husker (Modern Rice Mill, Sheller-D.S.6). The samples were milled in a commercial mill (Lab Hammer Mill, AI-216D) to make fine flour and sieved by 36 mesh sieves. The flour samples obtained were then kept in plastic airtight container (PET) before use in a refrigerator. The process of making malted rice flour is depicted in Fig. 1.

2.2.2 Processing of foxtail millet

Foxtail millet flour was made by the method of Malleshi and Desikachar, 1982 [10]. Foxtail millet grains were cleaned, de-husked by electrical commercial de-husker (Model – Gati: KWE) and grinded in an electric grinder. The flour was sieved using a 36 mesh size sieve. The flour was stored in airtight plastic containers (PET) before use in a refrigerator. The process of making foxtail millet flour is depicted in Fig. 2.

2.2.3 Processing of Bengal gram

The malting of Bengal gram was done by using the modification of the method described by Malleshi (1995) [9]. Bengal gram samples were thoroughly cleaned and washed to remove dirt, dust and other foreign materials. The samples were soaked in water for 15 hours and then allowed to germinate for 24 hours. The germinated samples were oven dried at 60°C; rootlets and husk were removed manually. The de-hulled samples were grinded in an electric grinder to make fine powder and sieved by 36 mesh sieve. The obtained flour were then stored in plastic airtight container (PET) before use in a refrigerator. The process of making malted Bengal gram flour is depicted in Fig. 3.

2.2.4 Processing of green gram

The malting of green gram was done by using the modification of the method described by Malleshi (1995) [11]. A known amount of whole 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 through a 36 mesh size sieve to get fine flour and stored in plastic airtight container (PET) before use in a refrigerator. The process of making malted green gram flour is depicted in Fig. 4.

2.2.5 Processing of sesame seeds

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. The process of making sesame seed flour is depicted in Fig. 5.

2.2.6 Processing of pumpkin seeds

The processing of pumpkin seed flour was done by slight modification of the method described by Zema *et al*., (2015) [15]. Pumpkin seeds were cleaned and washed, sundried for 20 hours and roasted for 5 minutes at 60°C. The samples were grinded in an electric grinder and sieved by 36 mesh size sieve. The obtained flour were then stored in plastic airtight container (PET) before use in a refrigerator. The process of making pumpkin seed flour is depicted in Fig. 6.

3. Results & Discussion

Formulation of complementary foods were done in accordance to the standards of Bureau of Indian Standards (BIS, 2006) [4] 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. Seven formulations namely T_1, T_2, T_3, T_4, T_5, T_6 and T_7 were developed containing rice flour as the major ingredient from the four different varieties (*Ranjit, Rangoli Bao*, *Kolamai Gutiya Hali* and black rice). Other ingredients used were foxtail millet, Bengal gram, green gram, sesame and pumpkin seeds. The proportions of these ingredients were kept same in all the treatments (Table1).

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 color, appearance, taste, consistency, flavor and overall acceptability. Totaled and averaged scores of the acceptability trials of the formulated complementary food mixes revealed that the mean scores of the sensory attributes were acceptable and were liked very much by the panel members.

Table 1: Preparation of complementary food mixes

Treatments	Ingredients (G)								
	R_1	R_2	R_3	R_4	FM	BG	GG	SS	PS
T_1	50	-	-	-	20	10	10	5	5
T_2	-	50	-	-	20	10	10	5	5
T_3	-	-	50	-	20	10	10	5	5
T_4	-	-	-	50	20	10	10	5	5
T_5	25	25	-	-	20	10	10	5	5
T_6	25	-	25	-	20	10	10	5	5
T_7	25	-	-	25	20	10	10	5	5

(R_1=Ranjit, R_2=Rangoli BAO, R_3=Kolamai Gutiya Hali (RED Kernel RICE), R_4=Black Rice, FM=Foxtail Millet, BG=Bengal Gram, GG=Green Gram, SS=Sesame Seeds, PS=Pumpkin Seeds)

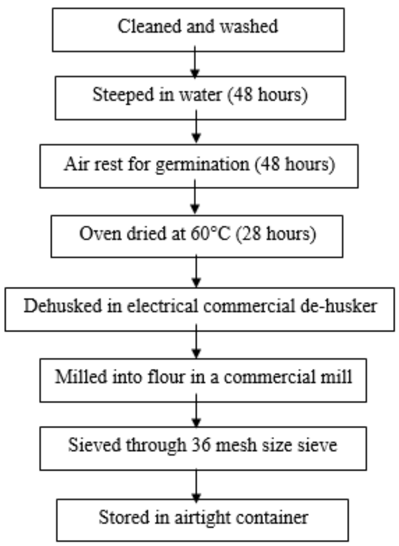

Fig 1: Flow diagram of processing of paddy samples

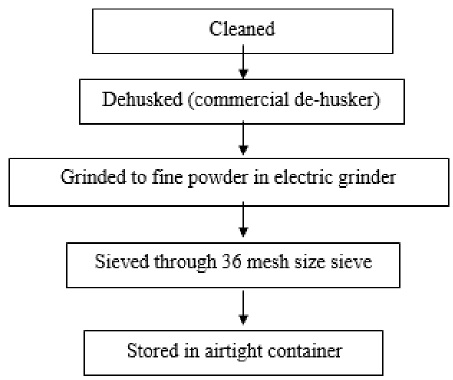

Fig 2: Flow diagram of processing of foxtail millet

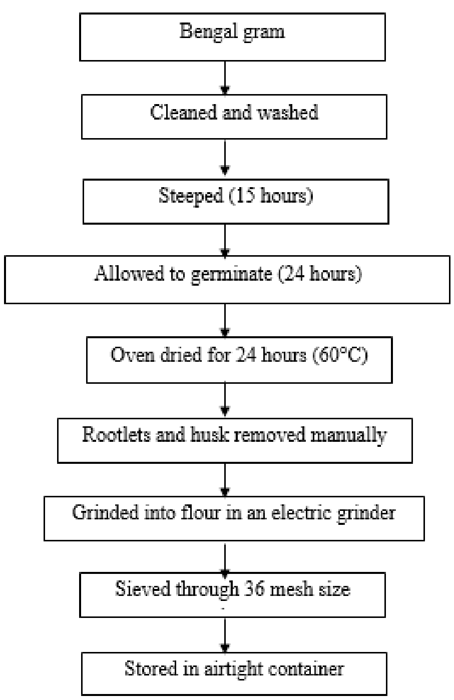

Fig 3: Flow diagram of processing of Bengal gram

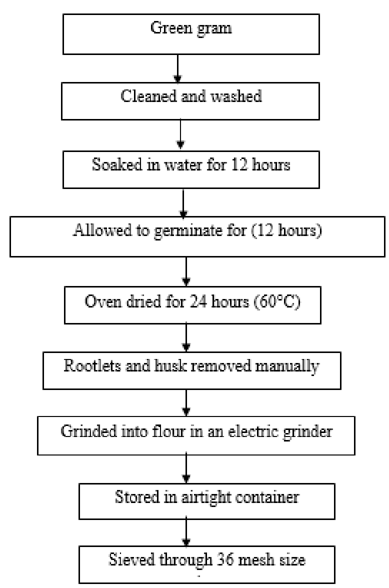

Fig 4: Flow diagram processing of green gram

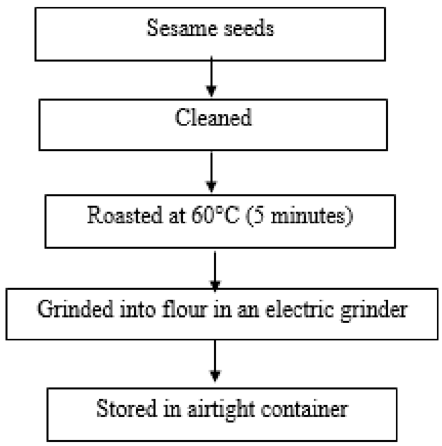

Fig 5: Flow diagram of processing of sesame seed

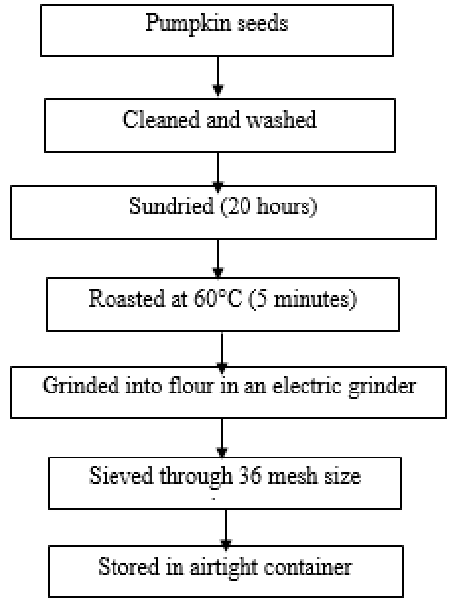

Fig 6: Flow diagram of processing of pumpkin seeds

4. Conclusions

The formulated complementary food mixes made from easily available and affordable food staples using household processing techniques have high acceptability scores on sensory attributes and may be used for popularizing among the rural and urban populations as a source of nutritious complementary food. It will provide possible opportunity to any entrepreneuring organisations to adopt the technology of developing complementary foods.

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