Developing Nutrient Dense Porridge for Optimal Infant Nutrition: A Local Resource Based Approach to Improve Nutrition

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Abstract

The first year of an infant's life is a critical period for health and development, and exclusive breastfeeding alone cannot meet their nutritional requirements. Complementary feeding, which introduces solid foods alongside breast milk, becomes essential at around six months of age. This study aimed to develop nutrient-dense porridge to supplement breast milk, focusing on locally sourced ingredients and innovative preprocessing techniques and then analysing them for sensory and nutritional attributes. A variety of ingredients, including cereals, pulses, fruits, vegetables, nuts, roots and tubers, were subjected to preprocessing techniques such as soaking, malting, germination, roasting, dehusking, cooking and straining. Porridge variants were prepared by combining different cereals and pulses combinations and assessed using a 9-point hedonic rating scale. The most accepted variants were further incorporated with fruits, vegetables, nuts, roots and tubers. The nutritional analysis revealed that the most accepted variant (variant A), comprising 80g of ragi, 20g of soybean, 10g of papaya, 10g of pumpkin, 5g of sesame, 5g of sweet potato, and 70g of sugar, had lower moisture content (4.8g/100g) and higher fat (6.2g/100g), ash (3.11g/100g), and protein content (15.21g/100g) compared to the control C4. However, it had lower fiber (0.97g/100g) and carbohydrate content (69.71g/100g) than the control C4. This research demonstrates an innovative approach to complementary feeding by utilizing locally sourced ingredients and novel preprocessing techniques. The nutrient-dense porridge variants developed in this study have the potential to address nutritional deficiencies in infants, particularly in low-resource settings where protein-energy malnutrition remains a critical concern.

Keywords: complementary feeding, nutrient dense, complementary foods, nutrition, malnutrition

Introduction

Infant health is of utmost importance during their initial year, and relying solely on breastfeeding doesn't fulfill their nutritional demands. This is where complementary feeding becomes necessary. Complementary feeding

entails the gradual introduction of solid foods and dietary elements alongside breastfeeding in an infant's diet. It commences at approximately six months of age because, at this point, breast milk alone is insufficient to meet the infant's nutritional requirements. Therefore, additional foods are essential to complement breastfeeding [1]. Ensuring the appropriate intake of nutrients is particularly critical for infants as this phase represents a pivotal stage in human development [2]. During the initial six months of life, infants derive all the energy and nutrients they need from breast milk. However, by the time they reach six months of age, supplementary or extra foods become essential to fulfill their requirements for healthy growth and development [3]. Alternatively, complementary foods are typically made from locally available staple ingredients, primarily cereals, and are often prepared as a liquid gruel suitable for infants [4]. These foods are intended to serve as the primary source of essential nutrients and energy for infants as they transition to solid foods [5]. As a result, the combination of cereals and legumes has been identified as beneficial for creating amino acid profiles that support healthy infant growth [6]. In addition to ensuring proper nutrition, weaning foods should possess specific functional qualities. According to the World Health Organization (WHO) guidelines [7], high-quality weaning foods should exhibit characteristics such as appropriate texture, low bulkiness, high nutrient density and reduced viscosity. They should also be rich in essential micronutrients, energy and protein while maintaining a consistency that is easy for infants to consume. Traditional weaning foods typically consist of legumes and staple grains, which can be prepared individually or combined into composite gruels [8]. Conventional methods for making these foods involve techniques like fermentation, germination and roasting. These methods are often applied separately or in various combinations during the preparation of infant weaning foods [9]. In many developing countries, the primary nutritional challenges associated with weaning foods are protein-energy malnutrition and deficiencies in essential micronutrients and macronutrients [10]. The high cost of raw materials and the limited production of protein-rich foods have led to an increase in protein-energy malnutrition among children and other vulnerable groups in these regions [11]. Child malnutrition remains a significant issue in numerous low and middle-income countries [12]. Due to the expensive nature of raw materials and the absence of suitable processing technologies, the general population in these countries often faces difficulties in accessing high-quality weaning foods.

Methods and material

Collection of raw material

The ingredients selected for the preparation of porridge are: i)cereals: ragi, makhana, bajra; ii)pulses: chickpea, soybean, peas dry; iii)fruits: papaya, guava, banana; iv)vegetables: pumpkin, spinach, cauliflower leaf; v)nuts: sesame seeds, coconut dry, pumpkin seeds; vi)roots and tubers: sweet potato, carrot, beetroot. All these ingredients are passed from preprocessing techniques of soaking, malting, germination, roasting, dehusking, cooking, straining and then these were powdered for making porridge.

The proportion of ingredients for making porridge

Firstly porridge was developed by mixing cereals and pulses only. In cereals we have taken ragi, makhana, bajra and in pulses we have taken chickpea, soybean and peas dry.

9 porridge variants were prepared by mixing 1 cereal and 3 pulses i.e ragi with chickpea, soybean, peas dry as shown in table 1 and then assessed on 9 point hedonic scale then again 1 cereal and 3 pulses are mixed together i.e makhana with chickpea, soybean, peas dry as shown in table 2 then assessed on 9 point hedonic scale then again 1 cereal and 3 pulses are mixed togerther i.e bajra with chickpea, soybean, peas dry as shown in table 3 and then again assessed on 9 point hedonic scale. Out of these three cereals and pulses combinations the most accepted variants from them were selected for incorporating fruits, vegetables, roots and tubers as shown in table 4 and then assessed on 9 point hedonic scale and the most accepted variant was analysed for nutritional composition.

Table 1: Composition of control and other variants of ragi with chickpea, soybean and peas dry

	Ingredients
Control C1	Ragi 100g + Sugar 70g
Sample R1	Ragi 80g + Chickpea 20g + Sugar 70g
Sample R2	Ragi 70g + Chickpea 30g + Sugar 70g
Sample R3	Ragi 60g + Chickpea 40g + Sugar 70g
Sample R4	Ragi 80g + Soybean 20g + Sugar 70g
Sample R5	Ragi 70g + Soybean 30g + Sugar 70g
Sample R6	Ragi 60g + Soybean 40g + Sugar 70g
Sample R7	Ragi 80g + Peas dry 20g + Sugar 70g
Sample R8	Ragi 70g + Peas dry 30g + Sugar 70g
Sample R9	Ragi 60g + Peas dry 40g + Sugar 70g

Table 2: Composition of control and other variants of makhana with chickpea, soybean and peas dry

	Ingredients
Control C2	Makhana 100g + Sugar 70g
Sample M1	Makhana 80g + Chickpea 20g + Sugar 70g

Sample M2	Makhana 70g + Chickpea 30g + Sugar 70g
Sample M3	Makhana 60g + Chickpea 40g + Sugar 70g
Sample M4	Makhana 80g + Soybean 20g + Sugar 70g
Sample M5	Makhana 70g + Soybean 30g + Sugar 70g
Sample M6	Makhana 60g + Soybean 40g + Sugar 70g
Sample M7	Makhana 80g + Peas dry 20g + Sugar 70g
Sample M8	Makhana 70g + Peas dry 30g + Sugar 70g
Sample M9	Makhana 60g + Peas dry 40g + Sugar 70g

Table 3: Composition of control and other variants of bajra with chickpea, soybean and peas dry

	Ingredients
Control C3	Bajra 100g + Sugar 70g
Sample B1	Bajra 80g + Chickpea 20g + Sugar 70g
Sample B2	Bajra 70g + Chickpea 30g + Sugar 70g
Sample B3	Bajra 60g + Chickpea 40g + Sugar 70g
Sample B4	Bajra 80g + Soybean 20g + Sugar 70g
Sample B5	Bajra 70g + Soybean 30g + Sugar 70g
Sample B6	Bajra 60g + Soybean 40g + Sugar 70g
Sample B7	Bajra 80g + Peas dry 20g + Sugar 70g
Sample B8	Bajra 70g + Peas dry 30g + Sugar 70g
Sample B9	Bajra 60g + Peas dry 40g + Sugar 70g

Table 4: Composition of control and other variants mixing cereal and pulses combination with fruits, vegetables, nuts, roots and tubers

	Ingredients
Control C4	Ragi 100g + Sugar 70g
Sample A	Ragi 80g + Soybean 20g + Papaya 10g + Pumpkin 10g + Sesame 5g + sweet potato 5g + Sugar 70g
Sample B	Ragi 80g + Soybean 20g + Guava 10g + Spinach 10g + coconut dry 5g + carrot 5g + Sugar 70g

Sample C	Ragi 80g + Soybean 20g + Banana 10g + Cauliflower leaf 10g + Pumpkin seed 5g + Beetroot 5g + Sugar 70g
Sample D	Makhana 80g + Peas dry 20g + Papaya 10g + Pumpkin 10g + Sesame 5g + sweet potato 5g + Sugar 70g
Sample E	Makhana 80g + Peas dry 20g + Guava 10g + Spinach 10g + coconut dry 5g + carrot 5g + Sugar 70g
Sample F	Makhana 80g + Peas dry 20g + Banana 10g + Cauliflower leaf 10g + Pumpkin seed 5g + Beetroot 5g + Sugar 70g
Sample G	Bajra 80g + peas dry 20g + Papaya 10g + Pumpkin 10g + Sesame 5g + sweet potato 5g + Sugar 70g
Sample H	Bajra 80g + peas dry 20g + Guava 10g + Spinach 10g + coconut dry 5g + carrot 5g + Sugar 70g
Sample I	Bajra 80g + peas dry 20g + Banana 10g + Cauliflower leaf 10g + Pumpkin seed 5g + Beetroot 5g +Sugar 70g

Sensory evaluation

The sensory evaluation of porridge was carried out using 9 point hedonic rating scale by 20 semi trained panel members selected by triangle test. Appearance, color, flavour, mouth feel and overall acceptability were considered for evaluation [13]

Nutrient analysis

The analysis of nutrients was done for the most accepted variant (variant A) of porridge. Fat and moisture levels were assessed using the soxhlet method and oven-drying method respectively, as specified in AOAC guidelines [14]. Protein content was determined through the Kjeldahl method in accordance with AOAC standards [15]. Carbohydrate, fiber and ash content were determined using the difference method, acid alkali digestion method and dry ashing method respectively [16]

Statistical analysis

The data was analyzed for mean and standard deviation using Microsoft office excel

Results and Discussion

Sensory acceptability of nutrient dense porridge

The sensory evaluation results shown in fig 1 revealed that the mean sensory scores of porridge (R4) made up of 80g ragi, 20g soybean and 70g sugar were the most accepted variant of 1st cereal and pulses combination. Porridge (M7) made up of 80g makhana, 20g peas dry and 70g sugar were the most accepted variant of 2nd cereal and pulses combination as shown in fig 2. Porridge (B7) made up of 80g bajra, 20g peas dry and 70g sugar was the most accepted variant of 3rd cereal and pulses combination as shown in fig 3. Now the most accepted variants of these 3 cereals and pulses combinations were incorporated with fruits, vegetables, nuts, roots and tubers as shown in fig 4 and variant A were the most accepted variant made up of 80g of ragi, 20g of soybean, 10g of papaya, 10g of pumpkin, 5g of sesame, 5g of sweet potato and 70g of sugar and variant A were analysed for nutritional composition.

Fig 1: Mean sensory scores of Ragi with Chickpea, Soybean and Peas dry

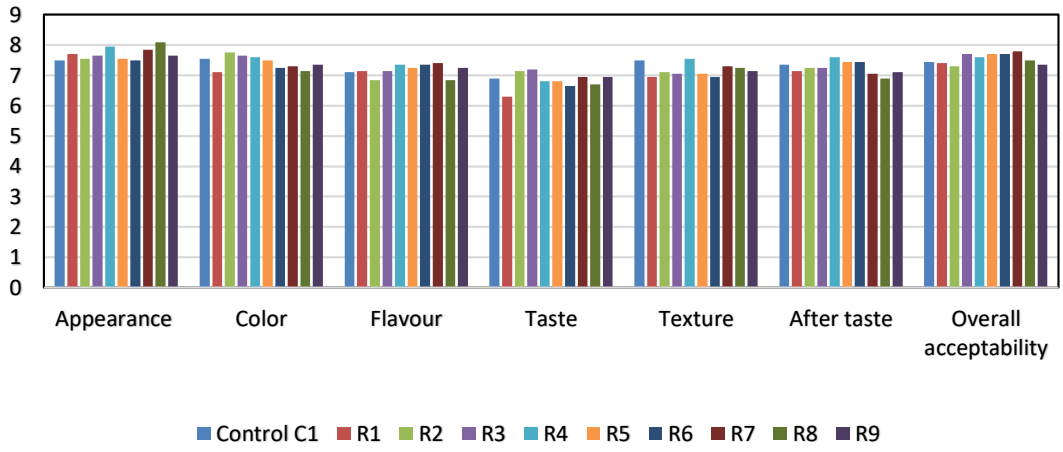


Fig 2: Mean sensory scores of Makhana with Chickpea, Soybean and Peas dry

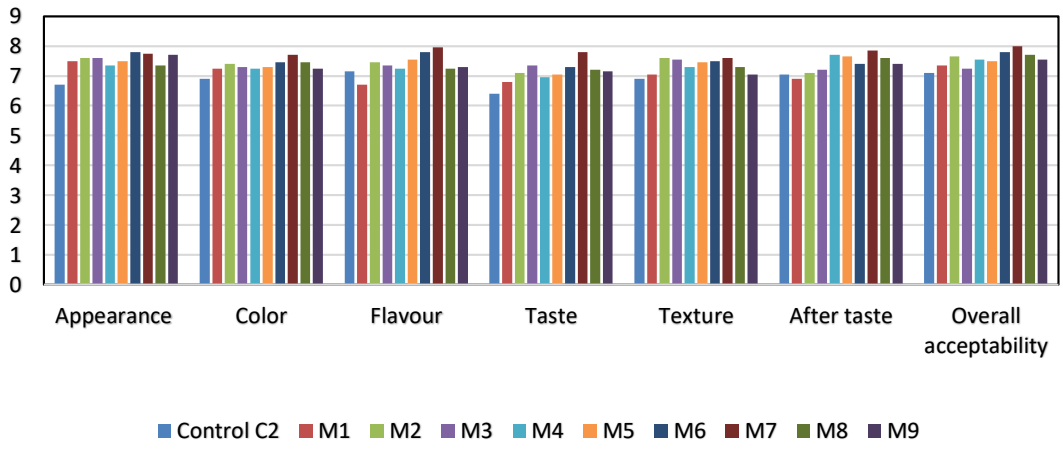


Fig 3: Mean sensory scores of Bajra with Chickpea, Soybean and Peas dry

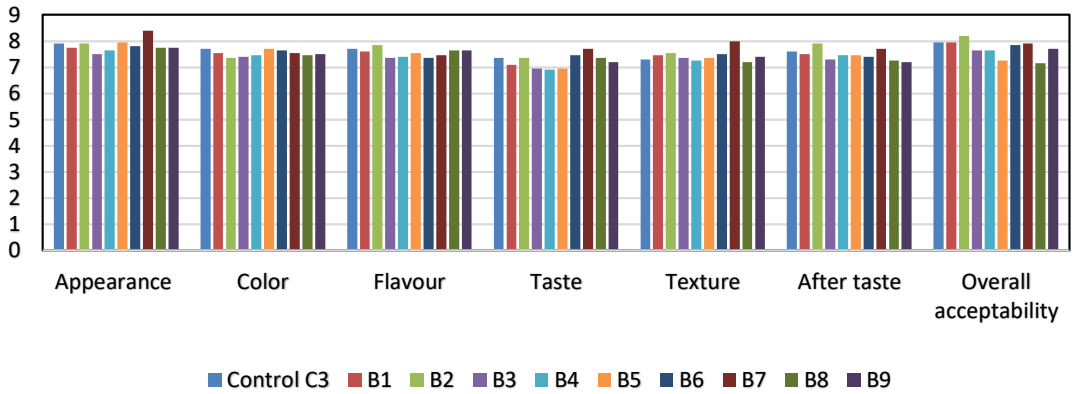
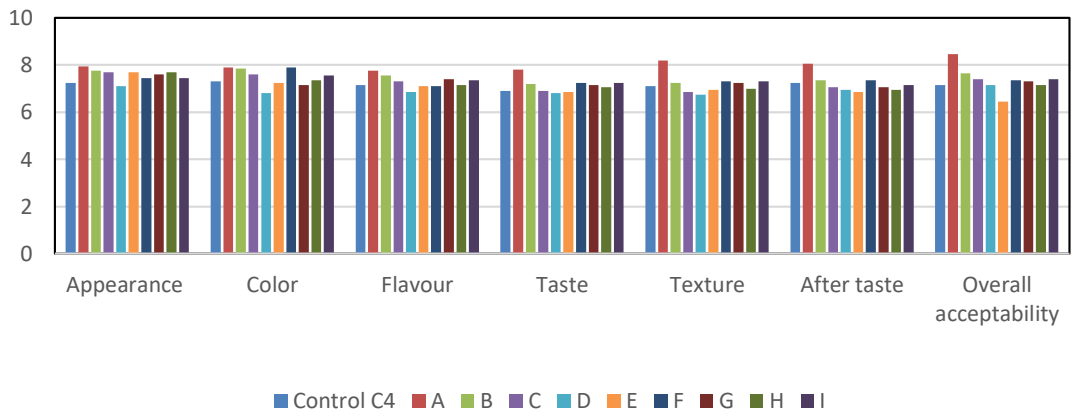


Fig 4: Mean sensory scores of porridge by of mixing most accepted variants of cereals and pulses with fruits, vegetables, nuts, roots and tubers



Nutritional composition of porridge

The results of the most accepted variant of porridge (variant A) are given below

Moisture – The moisture content of variant A (4.80g/100g) was lower than moisture content of control C4 (5.25g/100g) as shown in table 5 and fig 5

Fat – The results shows the fat content of variant A (6.20g/100g) was higher than the control C4 (1.08g/100g)

Ash – The ash content of variant A (3.11g/100g) was found to be higher than of control C4 (1.42g/100g)

Fiber – The fiber content of variant A (0.97g/100g) was found to be lower than of control C4 (3.62g/100g)

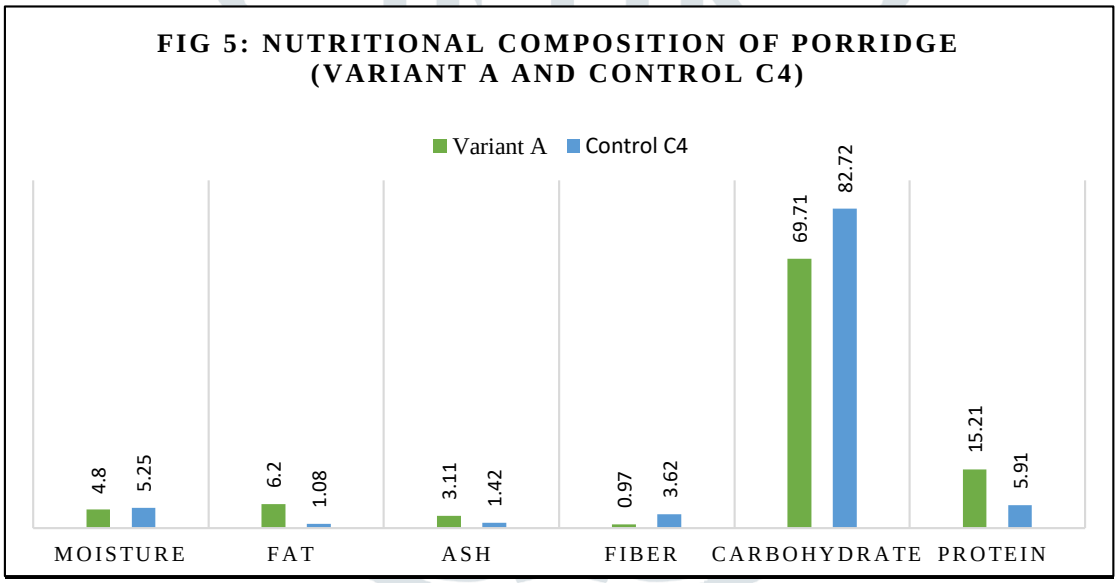
Carbohydrate – The results revealed that the carbohydrate content of variant A (69.71g/100g) was lower than the control C4 (82.72g/100g)

Protein – The protein content of variant A (15.21g/100g) was higher than the protein content of control C4

(5.91g/100g)

Table 5: Nutritional composition of porridge		
Nutrients /100g	Porridge (Variant A)	Control C4
Moisture (g/100g)	4.80±0.31	5.25±0.29
Fat (g/100g)	6.20±0.19	1.08±0.21
Ash (g/100g)	3.11±0.09	1.42±0.07
Fiber (g/100g)	0.97±0.05	3.62±0.11
Carbohydrate (g/100g)	69.71±0.27	82.72±0.19
Protein (g/100g)	15.21±0.09	5.91±0.14

Values represents in Mean±SD



Conclusion

In this study, we embarked on a comprehensive journey to develop and evaluate nutrient-dense porridge variants, with a specific focus on addressing the critical nutritional needs of infants during the complementary feeding stage. Our research centered on utilizing locally sourced ingredients and innovative preprocessing techniques to create porridge variants that are not only nutritionally rich but also culturally acceptable. By thoroughly processing a wide range of ingredients, including cereals, pulses, fruits, vegetables, nuts, roots and tubers, we aimed to develop weaning foods that could provide infants with the necessary nutrients for healthy development. The sensory evaluation phase was instrumental in identifying the most preferred combinations among the various porridge variants. Notably, combinations such as ragi and soybean, makhana and peas dry, and bajra and peas dry emerged as the top choices among our panel of evaluators. Building upon these findings, we fortified the preferred variants with fruits, vegetables, nuts, roots and tubers, resulting in a diverse array of

nutrient-dense porridge options. The subsequent nutritional analysis of the most favored variant (variant A), consisting of 80g of ragi, 20g of soybean, 10g of papaya, 10g of pumpkin, 5g of sesame, 5g of sweet potato, and 70g of sugar, yielded promising results. This particular variant A exhibited a lower moisture content and higher levels of fat, ash, and protein compared to the control, although it contained less fiber and carbohydrates. In essence, our research represents a novel and promising approach to addressing the persistent issue of protein-energy malnutrition in infants, particularly in regions with limited resources. These locally adapted nutrient-dense porridge variants not only provide a potential solution to nutritional deficiencies during infancy but also align with cultural preferences and dietary habits, increasing their likelihood of being embraced within communities.

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