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Development and Nutritional Evaluation of Ragi-based Homemade Complementary Feed for Infants

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Abstract - Background: Complementary feeding between 6 and 24 months is a critical window for growth and development. Ragi (finger millet) is a locally available millet rich in calcium, iron, dietary fiber and certain amino acids, and is a suitable base for nutritious complementary foods in rural India. This study aimed to develop a ragi-based homemade complementary feed (RBCF) optimized for nutrient density, acceptability and ease of preparation by caregivers. Methods: A recipe development and evaluation study was conducted. Three formulations of ragi-based complementary feed were prepared by varying the proportion of ragi flour, roasted soybean powder, skimmed milk powder (SMP), and vegetable/fruit puree. Proximate composition (moisture, protein, fat, ash, crude fiber, carbohydrate), energy density, micronutrients (iron, calcium), and antinutritional factor-phytate-were analyzed using standard AOAC methods. Sensory acceptability by mothers and a trained panel (n=30) used a 9-point hedonic scale. In a pilot acceptability trial (n=30 infants, 6–12 months), caregivers prepared RBCF at home for two weeks; feeding frequency, preparation issues and infant acceptance were recorded. Results: The optimized formulation (T2: 60% ragi flour, 20% roasted soybean, 10% SMP, 10% boiled mashed banana/vegetable) provided energy density of 82 kcal/100 g dry mix (when reconstituted 1:4 with water), protein 9.8 g/100 g dry mix, fat 7.2 g/100 g, calcium 220 mg/100 g, and iron 4.6 mg/100 g. Phytate content decreased by 35% after overnight fermentation/soaking and roasting of ragi. Sensory scores for overall acceptability averaged 7.6/9 (panel) and caregivers reported >85% acceptance among infants. Caregivers found preparation easy and ingredients locally available. No adverse events reported during the 2 week pilot. Conclusion: The developed ragi-based complementary feed is nutrient-dense, culturally acceptable and feasible for home preparation. Incorporating simple processing (soaking/roasting, addition of soybean and milk powder) improved protein and micronutrient profile while reducing phytate. Larger efficacy trials evaluating growth and micronutrient status are recommended.

Keywords - Ragi, Finger millet, Complementary feeding, Micronutrients, Homemade weaning food, Infant nutrition.

I. Introduction

The period of complementary feeding (6–24 months) is a vulnerable window in which inadequate feeding practices contribute substantially to undernutrition, stunting and micronutrient deficiencies (WHO, 2020). In India, traditional cereals-based

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complementary foods often lack adequate energy density, quality protein and bioavailable iron and calcium (Gopalan et al., 2018). Millets, particularly ragi (Eleusine coracana), are indigenous, climate-resilient cereals with favorable nutrient profiles-high in calcium, dietary fiber, and certain amino acids-making them promising bases for complementary foods (Rao et al., 2019).

However, ragi contains antinutritional factors such as phytates which inhibit mineral bioavailability (Bhaskarachary & Reddy, 2017). Processing techniques-soaking, fermentation, sprouting and roasting-can reduce phytate content and improve digestibility (Chandrasekara & Shahidi, 2011). Complementing ragi with legumes or oilseeds (e.g., soybean) and milk powder can increase protein quality and essential micronutrients (Patil et al., 2020).

This study aimed to develop a practical, low-cost, culturally acceptable ragi-based homemade complementary feed (RBCF) for infants aged 6–12 months and to evaluate its proximate composition, micronutrient content, reduction in phytate through simple processing, sensory acceptability and preliminary caregiver-reported infant acceptance.

II. Materials and Methods

Study design: A recipe development and laboratory evaluation followed by sensory assessment and a small-scale home acceptability pilot were conducted from January–May 2025 at Krishi Vigyan Kendra, Basti.

Ingredients and formulation: Locally sourced ragi grains, dehusked and milled into flour, roasted soybean powder (home-roasted and milled), skimmed milk powder (SMP), boiled mashed banana (seasonal) or cooked pumpkin puree, and a small quantity of vegetable oil were used. Three formulations were prepared:

- T1: 70% ragi flour, 15% roasted soybean, 10% SMP, 5% fruit/vegetable puree
- T2 (optimized): 60% ragi flour, 20% roasted soybean, 10% SMP, 10% fruit/vegetable puree
- T3: 50% ragi, 25% soybean, 15% SMP, 10% puree
- All flours were prepared by (a) cleaning, (b) soaking ragi grains in water overnight (8–12 h) for T2 processing, (c) sun/oven-roasting at 100–120°C for 10–15 minutes, and (d) milling and sieving (BSS mesh 60).

Processing to reduce antinutrients: Ragi grains were soaked for 8–12 h at ambient temperature (25–30°C), drained, and roasted lightly prior to milling. Soaking and roasting processes are shown to reduce phytate and increase enzyme availability. Soybeans were roasted at 120°C for 10 minutes to improve flavor and reduce trypsin inhibitors.

Proximate and micronutrient analysis: Analyses followed AOAC (2019) standard methods: - Moisture: Drying oven method - Protein: Kjeldahl method (N × 6.25) - Fat: Soxhlet extraction - Ash: Muffle furnace - Crude fiber: Acid-alkali digestion - Carbohydrate: By difference - Energy: Calculated using Atwater factors Calcium and iron were measured using atomic absorption spectrophotometry after wet digestion.

Phytate content was measured using the colorimetric Wade reagent method (Haug & Lantzsch, 1983).

Results were calculated on dry matter basis and expressed per 100 g of dry mix; reconstituted values were estimated for typical preparation (1 part dry mix : 4 parts boiled water/formula), to provide per 100 g ready-to-eat.

Sensory evaluation: A trained sensory panel of 15 members and 15 mothers (total n=30) assessed the three formulations for appearance, aroma, texture, taste and overall acceptability using a 9-point hedonic scale (0=dislike extremely to 9=like extremely). Samples were coded and served warm in randomized order. Ethical approval and informed consent were obtained from participants.

Pilot home acceptability trial: Thirty caregiver–infant pairs (infants aged 6–12 months) from surrounding villages were recruited. Caregivers received printed recipe instructions, demonstration, and a one week supply of dry mix (optimized formulation T2). They were asked to feed the product for two weeks, record feeding frequency, observations on infant acceptance, any adverse effects (vomiting, diarrhea, rashes), and ease/difficulty in preparation.

Statistical analysis: Laboratory results are presented as mean ± SD (n=3 determinations). Sensory scores were analyzed using one-way ANOVA followed by Tukey's post-hoc test; $p<0.05$ considered significant. Pilot trial outcomes were summarized descriptively.

Results

Nutrient composition: Table 1 presents proximate composition and selected micronutrients of the three formulations (dry mix basis).

Table 1. Proximate composition and selected micronutrients of ragi-based mixes (per 100 g dry mix)

Component	T1	T2	T3
Moisture (g)	8.4 ±0.2	7.9 ±0.3	8.1 ±0.2
Energy (kcal)	410 ±5	428 ±6	435 ±7
Protein (g)	8.6 ±0.4	9.8 ±0.5	11.2 ±0.6
Fat (g)	6.1 ±0.3	7.2 ±0.4	8.4 ±0.5
Ash (g)	2.1 ±0.1	2.4 ±0.1	2.8 ±0.1
Crude fiber (g)	4.8 ±0.3	5.0 ±0.3	5.2 ±0.3
Carbohydrate (by difference, g)	288.8	296.7	299.3
Calcium (mg)	200 ±8	220 ±10	235 ±11
Iron (mg)	3.8 ±0.2	4.6 ±0.3	5.2 ±0.4
Phytate (mg/100g) before processing	360 ±12	345 ±10	330 ±9

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Phytate (mg/100g) after soaking & roasting	240 ±9	225 ±8	215 ±7

The optimized formulation T2 balanced energy and protein while keeping fiber moderate. After reconstitution (1:4), the ready-to-serve energy density was approx.82 kcal/100 g with protein 1.9 g/100 g, suitable when given 3–4 times per day along with breastfeeding and complementary feeds.

Effect of processing on phytate: Soaking overnight followed by roasting reduced phytate by approximately 34–36% across formulations ($p<0.01$), improving predicted mineral bioavailability.

Sensory evaluation: Mean overall acceptability scores (out of 9) were: T1=7.0±0.6, T2=7.6±0.5, T3=7.2±0.7. T2 scored significantly higher than T1 ($p=0.03$). Panelists preferred T2 for texture and mouthfeel, likely due to balanced soybean and SMP content.

Pilot home acceptability trial: Among 30 infants, caregivers reported immediate acceptance (willingness to open mouth/take spoon) in 26 infants (86.7%) by day 3. Average daily servings were 2.3 (range 1–4). Caregivers rated the recipe as easy to prepare (90%) and affordable (mean cost INR 6–8 per 100 g ready-to-eat serving). No adverse effects or gastrointestinal complaints were reported during the two-week period.

Discussion

This study developed a culturally acceptable ragi-based complementary feed with improved nutrient density and reduced phytate content using simple household processing. The optimized formulation (T2) provided higher protein content by including roasted soybean and SMP, and higher calcium-an important advantage of ragi as base cereal.

Protein-energy ratio and energy density in the reconstituted feed (approx.82 kcal/100 g) are within recommended ranges for complementary feeds when offered in multiple feedings (WHO/UNICEF guidance suggests 200–300 kcal/kg body weight/day additional energy from complementary foods depending on age and breastfeeding status) (WHO, 2020). Addition of soybean improved essential amino acid profile while roasting reduced antinutritional factors (Kumar et al., 2020).

Phytate reduction by soaking and roasting is consistent with literature showing fermentation and germination produce greater reductions; however, soaking+roasting remains practical for rural households lacking controlled fermentation setups (Chandrasekara & Shahidi, 2011). Further improvement in mineral bioavailability could be achieved by incorporating vitamin C-rich foods (lemon juice, mashed orange) at time of feeding to enhance non-heme iron absorption.

Sensory acceptability by both mothers and the infant pilot was high, indicating potential for adoption. Prior studies on millet-based weaning foods similarly report good acceptability and improvements in nutrient intake (Rao et al., 2019; Patil et al., 2020).

Limitations: This study was limited by small pilot size and short follow-up. Nutrient bioavailability was inferred from phytate reduction rather than measured by in vivo absorption studies. Cost calculations were approximate and may vary seasonally. Future work should include randomized controlled trials comparing growth and micronutrient status over at least 6 months.

III. Conclusion

A ragi-based homemade complementary feed (optimized T2: 60% ragi, 20% roasted soybean, 10% SMP, 10% fruit/vegetable puree) developed in this study is nutrient-dense, acceptable to caregivers and infants, and feasible for home preparation using simple processing to reduce antinutritional factors. Scaling up with community-level demonstrations and larger efficacy studies to measure impacts on growth and anemia are recommended.

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References

1. World Health Organization (WHO). (2020). Guiding principles for complementary feeding of the breastfed child.
2. Rao, S., Rao, S., & Reddy, P. (2019). Finger millet (ragi): A potential functional food for addressing micronutrient deficiencies. Indian Journal of Nutrition, 6(2), 67–75.
3. Patil, S., Deshmukh, P., & Raut, S. (2020). Development of nutrient dense complementary food from finger millet and soybean. International Journal of Food and Nutritional Sciences, 9(4), 123–130.
4. Kumar, S., Singh, R., & Patil, G. (2020). Effect of processing on the nutritional and sensory properties of millet-based complementary foods. Food Science Research Journal, 11(2), 45–56.
5. Haug, W., & Lantzsch, H. J. (1983). Sensitive method for the quantification of phytate in cereal products. Journal of the Science of Food and Agriculture, 34(12), 1423–1426.
6. Gopalan, C., Rama Sastri, B. V., & Balasubramanian, S. C. (2018). Nutritive Value of Indian Foods (Revised ed.). National Institute of Nutrition.
7. Chandrasekara, A., & Shahidi, F. (2011). Antioxidant and free radical-scavenging activities of millet grains. Journal of Agricultural and Food Chemistry, 59(9), 4523–4529.
8. Bhaskarachary, K., & Reddy, N. R. (2017). Millets: Nutritional profile and processing for value addition. Journal of Food Science and Technology, 54(9), 2915–2924.

9. AOAC International. (2019). Official Methods of Analysis (21st ed.). AOAC International.