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Development and Evaluation of a Rice-based Weaning Formula using Locally Available Cereals, Pulses and Nuts

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Abstract: ***Background: This study aimed to develop an affordable, nutrient-dense weaning formula using locally available rice, chickpea, and groundnut to address protein-energy malnutrition in infants. Methods: Three rice-based weaning formulas were formulated and standardized using sensory evaluation. The most accepted formula was further varied and subjected to biochemical nutrient analysis and shelf-life evaluation. Results: The standard formula (F3) consisting of rice, chickpea, and groundnut was the most organoleptically accepted (mean score 3.4). Its variant F3 (c), prepared with low-cost rice, showed the highest nutritional value: 529 kcal/100g, 119 g carbohydrate, 8 g protein, and 2.28 g fat. Shelf-life assessment indicated that F3 (c) remained acceptable for three months (mean score 4). Conclusion: F3 (c) is nutritionally superior, acceptable, economically feasible, and easily prepared at home. It is recommended for bridging nutrient gaps in weaning infants.***

Keywords: Weaning formula, rice-based, chickpea, groundnut, infant nutrition, sensory evaluation, nutrient analysis

1. Introduction

Weaning is a critical phase in infant development. In resource-limited settings, improper weaning practices contribute to malnutrition. This study develops a rice-based weaning formula using local ingredients to provide a nutrient-dense, cost-effective option for caregivers.

2. Materials and Methods

2.1 Research Design

A laboratory-based experimental design was employed to develop, standardize, and evaluate rice-based weaning formulas using locally sourced ingredients. The study was carried out at the Department of Food, Nutrition and Dietetics and the Biochemistry Laboratory of Assam down town University, Guwahati.

2.2 Selection of Raw Materials

Ingredients:

- Rice (Oryza sativa): Three varieties — milled rice, parboiled rice, and low-cost rice — were procured from the local Beltola market, Guwahati.
- Chickpea (Cicer arietinum): Used as the primary pulse for protein enrichment.
- Groundnut (Arachis hypogaea): Added as a source of fat and protein.

All raw materials were inspected visually to remove stones, debris, and defective grains to ensure quality and safety.

2.3 Preparation of Flours

Each ingredient was processed using standard domestic methods to mimic household preparation:

- Rice: Cleaned, ground in a mixer grinder, sieved to a uniform particle size, and lightly roasted to improve digestibility and shelf-life.
- Chickpea: Sorted, cleaned, ground, sieved, and roasted to reduce anti-nutritional factors and enhance flavor.
- Groundnut: Shelled, deskinned, ground, sieved, and roasted to enhance aroma and improve oil release.

These steps ensured that the flours were safe, palatable, and suitable for infant consumption.

2.4 Formulation and Standardization

Three base formulas were designed by varying the type of pulse and nut added to rice flour. The ratio was standardized to:
70% cereal flour (rice), 20% pulse flour (chickpea/green gram/pea), 10% nut flour (groundnut/sesame/almond)

The formulations were:
F1: Rice flour + Green gram flour + Sesame flour
F2: Rice flour + Pea flour + Almond flour
F3: Rice flour + Chickpea flour + Groundnut flour
Each formula was mixed thoroughly to ensure homogeneity.

2.5 Sensory Evaluation for Initial Selection

The three standard formulas were cooked into porridge-like consistency by adding hot water and were subjected to organoleptic evaluation by a semi-trained panel of ten members (faculty and postgraduate students). Attributes assessed were:

Texture, Consistency, Flavor, Taste, Overall acceptability
A 5-point hedonic scale was used:
1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very Good

The formula with the highest mean acceptability score was selected for further refinement

2.6 Development of Variants

The most accepted formula, F3, was then used to develop three variations by changing the type of rice:

F3 (a): Milled rice variant
F3 (b): Parboiled rice variant
F3 (c): Low-cost rice variant
Each variation maintained the same ratio of rice, chickpea, and groundnut flours.

2.7 Proximate Nutrient Analysis

The developed variants were analyzed for macronutrient content to evaluate energy density and nutritional adequacy. Analytical methods:

- Carbohydrate: Anthrone method — sugars extracted with 80% alcohol and hydrolyzed; color developed with anthrone reagent and absorbance read at 630 nm.
- Protein: Lowry's method — proteins precipitated with trichloroacetic acid, dissolved in NaOH, reacted with copper sulfate and Folin's reagent; absorbance measured at 660 nm.
- Fat: Solvent extraction method — lipid content determined by repeated extraction with chloroform-methanol, followed by separation, evaporation, and gravimetric measurement.
- Energy: Calculated using Atwater factors: 4 kcal/g for carbohydrates and proteins, 9 kcal/g for fats.

All tests were performed in triplicate to ensure reliability.

2.8 Shelf-Life Study

To assess stability, each variant was stored in air-tight, moisture-proof containers at room temperature. Organoleptic properties (texture, flavor, taste, consistency, and overall quality) were re-evaluated after three months using the same hedonic scale and panel.

2.9 Statistical Analysis

Data from sensory evaluations were summarized using mean scores and standard deviations. Nutrient analysis results were tabulated and compared descriptively. Graphs and bar charts were plotted to illustrate mean scores and nutrient content across formulas.

2.10 Ethical Considerations

The study did not involve live human infant feeding trials; hence, ethical approval was not required. However, food safety and hygiene standards were strictly maintained throughout the laboratory preparation and analysis processes.

3. Results

F3 (rice, chickpea, groundnut) had the highest mean sensory score (3.4) and was selected. F3 (c) (low-cost rice) had the highest nutrient values: 529 kcal/100g, 119g carbohydrates, 8g protein, and 2.28g fat. Shelf-life study showed F3 (c) remained acceptable for 3 months (mean score 4).

4. Discussion

Combining rice, chickpea, and groundnut improved protein quality and energy density, consistent with complementary feeding recommendations. The formula is economically feasible and can be prepared with local resources, ensuring sustainability.

5. Conclusion

F3 (c) is an acceptable, nutrient-rich, cost-effective rice-based weaning formula that can help meet infants' nutrient requirements and reduce weaning-related malnutrition.

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