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Standardization and quality evaluation of infant food developed using "Shree Ann"

Natarajan S Nimisha[1], Prasad Ranu[2], Verma Anisha[2]
[1] Research Scholar, Department of Food Nutrition and Public Health, Sam Higginbottom Institute of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India
[2] Professor, Department of Food Nutrition and Public Health, Sam Higginbottom Institute of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Abstract
Children's future hinges on proper nutrition, making weaning foods vital in combating malnutrition. Ideal weaning foods are nutrient-dense, easily digestible, and safe, fulfilling essential dietary needs during critical growth phases. With the decline in breast milk's nutrient density after six months, complementary foods become crucial for healthy development. The research undertaken for formulating an optimal infant diet was a meticulous exploration of nutritional science aimed at addressing the critical needs of early childhood development. This investigation focused on the careful selection and combination of nutrient-rich ingredients, ensuring that each component contributes to the overall health and growth of infants. In this endeavor, emphasis was placed on integrating locally available, wholesome foods that provide essential macronutrients and micronutrients. Each ingredient was chosen for its unique nutritional profile—bajra for its rich carbohydrates and fiber, green mung dal for its high-quality protein and vital micronutrients, sesame seeds for healthy fats and calcium, foxnuts for energy and texture, and carrot flour for its vibrant beta-carotene content. The research also included rigorous organoleptic evaluations to ascertain the sensory qualities of the prepared weaning foods. Among all, T3 emerged as the best treatment, excelling in color, appearance, taste, flavor, and consistency. This blend stood out not only for its superior sensory appeal but also for its impressive nutritional value, fulfilling the Recommended Dietary Allowances (RDA) for infants as per ICMR 2020 guidelines. Moreover, the study focused on processing techniques that enhance the digestibility and safety of the food, alongside storage practices that maintain its nutritional integrity over time. The findings of this comprehensive research provide a solid foundation for creating weaning foods that are not only nutritionally beneficial but also enjoyable for infants, thus laying the groundwork for a healthier future generation.

Keywords: Infants, malnutrition, weaning food, Shree Ann, balanced nutrition

Introduction

Children have long been regarded as the cornerstone of a nation's future, yet in many developing countries, they have faced the harsh realities of poverty, malnutrition, and disease. Among these, malnutrition stood as the most insidious threat, with Protein Energy Malnutrition (PEM) and micronutrient deficiencies claiming far too many lives. In this battle, weaning food emerged not just as a simple dietary addition but as a lifeline—rich in biological value and packed with essential nutrients that bridged the dangerous nutritional gaps during a child's early years. By offering the right nutrients at the right time, weaning food had the power to counter malnutrition and give children a healthier start in life, laying the foundation for a stronger, more prosperous nation. In an era where consumers became increasingly aware of health, the importance of weaning foods was reframed. While commercial giants churned out products for various age groups, often touting "balanced nutrition," the deeper essence of true health was often lost in the noise. Weaning, a critical phase in a child's development, demanded more than just nutrition labels—it required a thoughtful combination of ingredients crafted with care. Many grew up with the wisdom that homemade food was best, a belief rooted in tradition and practicality. Locally sourced, affordable ingredients not only provided balanced nutrition but also offered the health benefits celebrated in functional foods globally. By turning to nature's bounty, it became possible to craft weaning foods that promoted healthy growth, proving that the answers to some of the biggest challenges lay within reach. According to the Academy of Pediatrics, the optimal time to introduce solid foods into an infant's diet was between two and a half to three months, a pivotal moment that set the stage for lifelong health. At this pivotal stage in a child's growth, the introduction of semisolid foods— commonly known as weaning foods—became essential (G. Sajilata *et al*., 2002) [5]. These weaning foods were essentially modified versions of adult meals, carefully processed to be gentle on an infant's developing digestive system. But what exactly made for an ideal weaning food? Let's break it down:

Nutrient powerhouse: The food had to be packed with calories and loaded with high-quality protein, vitamins, and minerals—everything needed to fuel a child's rapid growth and development.

Easily consumed: Once mixed with water, milk, or any liquid, the food should have turned into a smooth, soft slurry that was easy for the baby to swallow without any trouble.

Nutrient-dense, not Bulky: The goal was to provide nutrition, not filler. An ideal weaning food had to have low dietary bulk but be rich in essential nutrients.

Convenience at its best: For busy parents, the food should have been precooked and processed to require minimal preparation, ensuring that it was easy to digest and quick to serve.

Safe and gentle: It should have steered clear of any harmful antinutritional factors and been low in indigestible fiber, ensuring that it was safe and gentle on the child's digestive system.

Pure and natural: No artificial colors or flavors should have been added. The food needed to adhere strictly to standards set by trusted bodies like the Bureau of Indian Standards, ensuring quality and safety.

Nutrition was the cornerstone of a child's healthy development, especially between 6 to 12 months. During this period, an infant required 650 to 720 Kcal and 9-10.5g of protein daily. But after six months, breast milk alone provided only about 500 Kcal and 5g of protein, leaving a nutritional gap that could hinder growth. That's why introducing complementary foods was vital. According to the National Institute of Nutrition and ICMR (2020) [10], infants in this rapid growth phase required higher nutrients per kilogram of body weight. While breastfeeding remained crucial, the nutrient density and volume of breast milk began to decline after six months, making it essential to complement it with solid foods to support optimal growth.

The American Academy of Pediatrics and WHO recommended introducing solid foods at six months, acknowledging breast milk as the best nourishment for infants. However, many Indian infants, though breastfed, did not receive adequate nutrition from breast milk alone. This created a growing demand for nutrient-rich weaning foods. Yet, wheat—a common ingredient in many weaning foods—could trigger allergies like celiac disease and asthma, as highlighted by WHO.

Here's where millets, known as "Shree Ann," came into the picture. Celebrated globally during the International Year of Millets 2023, these ancient grains were a powerhouse of nutrition—high in protein, fiber, and essential vitamins and minerals like iron and magnesium. Gluten-free and with a low glycemic index, millets were ideal for infants and those with gluten intolerance. Their high fiber supported digestion, while their antioxidant properties strengthened immunity. Moreover, millets were resilient, requiring minimal water and thriving in harsh climates, making them a sustainable, eco- friendly choice for food security. As weaning foods, millets were a game-changer—nutrient-dense, easy to digest, and protective against allergies. By embracing millets, health promotion and sustainable agriculture went hand in hand.

Pearl millet, a standout substitute for major cereal crops, played a critical role in combating global food shortages, offering superior nutrition with its rich content of energy, protein, fats, and minerals (Singh *et al*., 2018) [13]. Complementing this, sprouted green mung dal boosted protein content, enhanced digestibility, and increased the bioavailability of vitamins and minerals—making it ideal for weaning foods.

Carrots, rich in β-carotene, were a key source of vitamin A, vital for vision and overall health, while also providing dietary fiber and antioxidants (Strube *et al*., 1999) [16]. Sesame seeds further elevated nutrition with omega-3 fatty acids, soluble fiber, and minerals like calcium, iron, and zinc, supporting heart health and digestion (Anon, 2006; Morris, 2004) [1, 9].

Lastly, fox nuts, or "Makhana," were a powerhouse of magnesium, potassium, fiber, and antioxidants. Low in calories and rich in essential amino acids, they supported health and helped manage conditions like diabetes and arthritis (Das *et al*., 2006; Kumar *et al*., 2011) [2, 11]. Together, these ingredients formed a nutrient-packed combination perfect for balanced diets and optimal growth. The FAO/WHO/UNICEF (2008) [4] underscored the importance of utilizing locally available ingredients to create home- formulated weaning foods, adhering to the following principles: (i) ensuring high nutritional content to complement breastfeeding, (ii) promoting acceptability, (iii) maintaining affordability, and (iv) utilizing local food resources while ensuring appropriate consistency (Dewey and Brown, 2003) [3].

When developing weaning foods from regionally sourced raw materials, considerations such as food processing techniques, storage methods, distribution practices, socio-economic factors, cultural and religious considerations, sensory attributes, and food safety and quality standards were taken into account (Yewelsew *et al*., 2006; Amuna *et al*., 2000) [19]. This approach not only highlighted the nutritional advantages of these local ingredients but also promoted sustainable and health-conscious food choices for early childhood development.

The present study aimed to meticulously evaluate the nutritional profile of homemade weaning foods made from local ingredients, ensuring they aligned with recommended dietary standards for infants, and compared these findings with the Recommended Dietary Allowance (RDA).

Materials and methods

Raw materials procurement: The grains essential for the experiment were procured from the local market in Prayagraj, including millet, pulses, vegetables, sesame seeds, and fox nuts. These ingredients were meticulously washed and dried. Subsequently, they were processed using an electric grinder to produce a fine flour. The detailed steps of this process are elaborated further, ensuring each component was carefully prepared to achieve the desired consistency and nutritional quality for the study.

a. Preparation of Pearl millet FLOUR (100gm)

Pearl Millet and whole moong dal was cleaned, dried separately and then roasted and ground in an electric mixer

Pearl Millet
↓
Cleaning
↓
Roasting
↓
Grinding
↓
Pearl Millet Flour
↓
Storage (air tight container)

Source: Srivastava and Kumar (2007) [15]

Fig 1: Flow Chart showing preparation of Pearl Millet flour

b. Preparation of green whole mung dal flour (100gm)

Green Whole moong dal was cleaned, dried separately and then roasted and ground in an electric mixer

Green Whole mung dal
↓
Cleaning (removing foreign material and washing)
↓
Soaking (6-8 hours)
↓
Sprouting
↓
Drying
↓
Grinding
↓
Mung dal flour
↓
Storage (air tight container)

Source: Srivastava and Kumar (2007) [15]

Fig 2: Flow Chart showing preparation of & Whole mung dal flour

c. Preparation of carrot flour (100 gm)

Carrot was washed, cleaned and cut into thin slices and blanched in 2% salt solution. Then it was spread on flat trays and dehydrated, sweated and ground in an electric grinder and obtained in powder form.

Carrot
↓
Washing and cleaning
↓
Cutting (Thin slices)
↓
Blanching (2% salt solution)
↓
Spreading on Flat trays
↓
Drying (Hot air oven)
↓
Grinding
↓
Carrot Flour
↓
Packing
↓
Storage (air tight container)

Source: Srivastava and Kumar (2009) [14]

Fig 3: Flow Chart showing preparation of carrot flour

d. Preparation of sesame seed flour (100gm)

Sesame seeds
↓
Cleaning
↓
Roasting
↓
Grinding
↓
Sesame Seeds Flour
↓
Storage (air tight container)

Source: Srivastava and Kumar (2007) [15]

Fig 4: Flow Chart showing preparation of Sesame Seeds flour

e. Preparation of fox nut flour (100 gm)

Preparation of fox nuts flour:- Fox nut was Cleaned, after that Sun drying was done for one day, then fox nut was Ground, then Fox nut flour was Packed (Airtight tin containers or polythene bags) and Storage (At ambient temperature in dry place).

Fox nuts
↓
Cleaning
↓
Roasting
↓
Milling
↓
Cooling at room temperature
↓
Grinding
↓
Ready to mix powder

Source: Srivastava and Kumar (2007) [15]

Fig 5: Flow Chart showing preparation of fox- nuts flour

Development of food product

Weaning products was developed by incorporating the selected flours at different levels. The products were prepared using standard recipes.

Details of treatment and replications of prepared products: For the preparation of the weaning food four treatments i.e. incorporation of flours at different levels T_1, T_2, T_3 and T_4 was referred respectively.

Ingredient Treatment	Pearl Millet flour (%)	Moong Dal Flour (%)	Carrot Flour (%)	Sesame seed flour (%)	Foxnut flour (%)	Sugar Powder (%)
T_1	35	30	15	5	5	10
T_2	35	25	20	5	5	10
T_3	35	20	25	5	5	10
T_4	35	15	30	5	5	10

According to a study by Ghosh *et al*. (2019) [11], fortified complementary foods developed in India have significantly improved the protein, fat, and micronutrient content. To bridge the gap between traditional weaning foods and the RDA, several interventions have been introduced. Fortified weaning foods, such as those enriched with micronutrients, have shown promising results.

Determination of the nutritional value/proximate analysis:

The nutritional value of the prepared weaning powder was determined using various standardized methods. Moisture content was assessed using the hot-air oven method, while protein was measured by Lowry's method. Crude fat and fiber were analyzed using the Soxhlet and AOAC methods, respectively. Carbohydrates were determined by the difference method, and β-carotene was measured following Ranganna's technique. Calcium was analyzed according to AOAC guidelines, and iron content was determined using an Atomic Absorption Spectrophotometer. These methods provided accurate and reliable results, offering a comprehensive understanding of the weaning powder's nutritional profile.

Storage trials were conducted to analyze the stability of the weaning food product at 0, 7, and 14-day intervals at room

temperature. One hundred grams of the ready-to-eat mix was packed in airtight containers, and samples were drawn at each interval for analysis. The product was evaluated for moisture content, peroxide value, and bacterial contamination, including mold count. Century acceptability was also assessed at these intervals to ensure the product's quality and safety over time. These analyses were conducted in accordance with the standards set by the Prevention of Food Adulteration (PFA) Act and the Food Safety and Standards Authority of India (FSSAI). This ensured that the weaning food product met the necessary quality and safety regulations throughout the storage trials.

Cost of the prepared product

Costing plays a pivotal role in attaining financial success. It empowers individuals, regardless of their income and expense scales, to make informed decisions about money allocation. By using the current market prices of the ingredients in product preparation, we were able to accurately calculate its true cost.

A. Organoleptic acceptability of developed weaning food

Sensory characteristics of the prepared weaning food with milk at Zero day

Table 1.1: the average sensory scores of prepared weaning food with milk at zero day

Parameters / Treatments	Colour and appearance	Consistency	Taste and flavor	Overall acceptability
T1	6.8±0.0621	7.4±0.285	6.4±0.453	6.6±0.288
T2	7±0.0621	7.4±0.285	6.4 ±0.453	6.6 ±0.288
T3	7±0.0621	7.6±0.285	8.2 ±0.453	8 ±0.288
T4	6.8±0.0621	7±0.285	6 ±0.453	6.2 ±0.288
F%	139.65 (S)	5.69 (NS)	20.67 (S)	10.4 (S)
CD	0.1517	_	1.108	0.704

S=Significant, NS-Non-Significant, ± =S.E Colour and appearance

The Table 1.1 shows the mean scores of weaning food in relation to colour and appearance which indicates that T3 and T2 (7) had the highest score followed by T1 and T4 (6.8) respectively. Scoring shows that the treatment T3 and T2 was liked very much while T1 and T4; were moderately liked by the panel of judges.

The ANOVA table (appendix A, table1) indicates that the calculated value of F due to treatment is greater than its table value of F on 3 and 6 degree of freedom at 5% (8.94) probability level so the null hypothesis for treatment will be rejected; concluding thereby significant difference between four treatments. Since ANOVA table shows the significant result due to treatment, so the value of critical differences was also calculated which is equal to CD (5%) = 0.94. Since the average value of treatments T3 and T2 are highest, so these two treatments can be regarded as best treatments in regards to colour of the product. On the above comparison table, significant difference was observed between the treatments (T1, T3) and (T1, T2); where as non significant difference was found between (T3, T4) (T1, T4) and (T2, T3).

Consistency

The Table 4.1 and Fig. 4.1 shows the mean scores of weaning food in relation to consistency which indicates that the treatment T3 (7.6) had the highest score for the consistency of weaning food followed by T1 and T2 (7.4), T4 (7) respectively.

The above ANOVA table (Appendix F, table 2) reveals that the calculated value of F is smaller that its table values of F at 5% (8.94) level of significance and on 3 and 6 degrees of Freedom, so the null hypothesis due to the treatments will be accepted, concluding thereby non-significant difference between four treatments, that is all the four treatments are equally effective as regards to consistency of the product. It shows that the Incorporation of Pearl Millet flour, Green Mung Dal flour, Carrot flour, Sesame Seed Powder, and Fox nut powder affects the consistency of the prepared weaning food and it becomes thinner and less viscous as the amount of Green Mung Dal flour decreases till a certain limit.

Taste and flavour

On the above comparison table significance difference was observed between the treatments (T3, T4) (T1, T2) and (T2, T3); whereas non significance difference was found between (T2, T4), (T1, T4) and (T1, T2); since the average value of the treatment T3 is highest and it differs significant from the other treatments T1, T2 and T4, so this could be regarded as the best treatment in terms of taste and flavor of the prepared product.

Overall acceptability

The calculated value of F due to treatment is greater than the table value of F at 5% (8.94) level of significance and on three and 6 degrees of freedom, so the null hypothesis for the treatments will be rejected, concluding there by significant effect of four treatments as regard to overall acceptability on zero days. Since the ANOVA table provides significant results so to compare all possible combination of two treatments at a time the value of CD is also needed, so it is obtained as CD 5%= 0.704. On the above comparison table significant difference was observed between the treatments (T3, T4); (T1, T3); (T2, T3) where as non significant difference was obtained between (T2, T4); (T1, T2) and (T1, T4).

Table 1.2: The average sensory scores of prepared weaning food with milk at 15th day

Parameters / Treatments	Colour and Appearance	Consistency	Taste and Flavor	Overall Acceptability
T1	6 ± 0.274	6.2 ± 0.438	6.2 ± 0.256	6.1 ± 0.148
T2	6.4 ± 0.274	6.2 ± 0.438	6.2 ± 0.256	6.2 ± 0.148
T3	7 ± 0.274	7.5 ± 0.438	7.5 ± 0.256	7.6 ± 0.148
T4	6 ± 0.274	6 ± 0.438	5.9 ± 0.256	5.7 ± 0.148
F%	4.033 (NS)	16.74 (S)	10.96 (S)	67.5 (HS)
CD	_	1.071	0.626	0.362

S=Significant, NS-Non-Significant, ± = S.E Colour and appearance

The above ANOVA table shows that the calculated value of F due to treatment is smaller than the table value of F at 5% (8.94) probability level and on 3 and 6 degrees of freedom, so that the null hypothesis will be accepted. Therefore there is no significant difference between four treatments in terms of colour and appearance, that is to say all the four treatments are at par.

Consistency
Since the calculated value of F is greater than the table value of F at 5% (8.94) level of significance and on 3 and 6 degrees of freedom, so the null hypothesis for treatment will be rejected; therefore there is significant difference between four treatments as regards to consistency on 15 days. Since the significant result is obtained so, critical difference was also computed as CD (5%) = 1.071. hence the following comparison table is prepared on comparing the difference between the two treatments was observed between the pairs of treatments (T3, T4); (T1, T4); (T2; T3), and non significant was obtained between the treatments (T1, T4); (T1, T2) and (T2, T4). Since the average score of treatment T 3 was found to be the highest (T3=7.5), so, it can be regarded as the best treatment. [T¯4<T¯<1 T¯2< T¯3]

Taste and flavor
Since the calculated value of F due to treatments is greater than the table value of F on 3, 6 degrees of freedom and at 5% (8.94) level of significance, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is significant difference between the four treatments. The above ANOVA table provides significant results for treatments, so the critical difference is also computed as CD (5%) = 0.626, which will be used for comparing two treatments at a time. From the above comparison table significant difference was observed between (T3, T4); (T1, T3) and between (T2, T3); whereas non-significant difference was obtained between (T1, T4); (T2, T4), (T1, T2). Since the average value of the treatment (T3 = 7.5) is highest amongst the other treatments, so T3 will be regarded as the best treatment. [T¯4<T 1= T 2<T 3¯].

Overall acceptability
Since the calculated value of F due to treatments is greater than the table value of F on 3, 6 degrees of freedom and at 5% (8.94) as well as 1% (27.91) probability level, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is high significant difference between the four treatments. The above ANOVA table provides significant results for treatments, so the critical difference at 5% is also computed as CD (5%) = 0.362 from the above comparison table significant difference was observed between (T3, T4); (T2, T3); (T1, T3); (T1, T4) and (T2, T4). Whereas non-significant difference was recorded only between (T1, T2). Since the average value of the treatment (T3 = 7.6) is highest compared to the average value of treatments T 1, T2, and T 4. [T 1<T 4<T 2<T 3¯].

Table 1.3: The average sensory scores of prepared weaning food with milk at 30th day

Parameters / Treatments	Colour and Appearance	Consistency	Taste and Flavor	Overall Acceptability
T1	6.9 ± 0.282	6.8 ± 0.214	6.6 ± 0.178	6.8 ± 0.1
T2	7.4 ± 0.282	7.6 ± 0.214	6.9 ± 0.178	7 ± 0.1
T3	8.4 ± 0.282	8.2 ± 0.214	8 ± 0.178	8.4 ± 0.1
T4	7.5 ± 0.282	6.8 ± 0.214	7.2 ± 0.178	6.8 ± 0.1
F%	13.66 (S)	29.85 (HS)	33.061 (HS)	92 (HS)
CD	0.690	0.523	0.435	0.244

S=Significant, NS-Non-Significant, ± =S.E Colour and appearance

The Table shows the mean scores of weaning food in relation to colour and appearance which indicates that T3 (8.4) had the highest score followed by T4 (7.5) and T2 (7.4) respectively. Scoring shows that the treatment T3 and T4 was liked very much while T2 and T1; were moderately liked by the panel of judges.
The ANOVA table indicates that the calculated value of F due to treatment is greater than its table value of F on 3 and 6 degree of freedom at 5% (8.94) and on 1% (27.91) probability level, so the null hypothesis for treatment will be rejected; concluding thereby high significant difference between four treatments. Since ANOVA table shows the significant result due to treatment, so the value of critical differences was also calculated which is equal to CD (5%) = 0.690. Since the average value of treatments T3 and T4 are highest, so these two treatments can be regarded as best treatments in regards to colour of the product. On the above comparison table, significant difference was observed between the treatments (T1, T3) and (T2, T3) and (T3, T4); where as non significant difference was found between (T1, T4) (T2, T4) and (T1, T2). [T¯1<T¯2<T¯4<T¯3]

Consistency
Since the calculated value of F is greater than the table value of F at 5% (8.94) and 1% (27.91) level of significance and on 3 and 6 degrees of freedom, so the null hypothesis for treatment will be rejected; therefore showing high significant difference between four treatments as regards to consistency on 30 days. Since high significant result is obtained so, critical difference was also computed as CD (5%)=0.523. hence the following comparison table is prepared on comparing the difference between the two treatments was observed between the pairs of treatments (T1, T3); (T3, T4); (T2; T3), (T1, T2) and (T2, T4), and non- significant difference was obtained between the treatments (T1, T4). Since the average score of treatment T 3 was found to be the highest (T3=8.2), so, it can be regarded as the best treatment in terms of consistency. [T¯4<T¯<1 T¯2<T¯3]

Taste and flavor
Since the calculated value of F (33.061) due to treatments is greater than the table value of F on 3, 6 degrees of freedom and at 5% (8.94) and 1% (27.91) level of significance, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is high significant difference between the four treatments in terms of Taste and Flavor. The above ANOVA table provides high significant results for treatments, so the critical difference is also computed as CD (5%) = 0.435, which will be used for comparing two treatments at a time. From the above comparison table high significant difference was observed between (T1, T3); (T2, T3); (T3, T4) and between (T1, T4); whereas non-significant difference was obtained between (T2, T4), (T1, T2). Since the average value of the treatment (T3 = 8) is highest amongst the other treatments, so T 3 will be regarded as the best treatment. [T¯1>T¯2>T¯4>T¯3]

Overall acceptability
Since the calculated value of F due to treatments is greater than the table value of F on 3, 6 degrees of freedom and at 5% (8.94) as well as 1% (27.91) probability level, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is high significant difference

between the four treatments. The above ANOVA table provides significant results for treatments, so the critical difference at 5% is also computed as CD (5%) = 0.244 from the above comparison table significant difference was observed between (T1, T3); (T3, T4) and (T2, T3); whereas non-significant difference was recorded between (T1, T2), (T1, T4) and (T2, T4). Since the average value of the treatment (T3 = 8.4) is highest compared to the average value of treatments T 1, T2, and T4. [T¯1=T¯4>T¯2>T¯3].

Table 1.4: The average sensory scores of prepared weaning food with milk at 45th day

Parameters / Treatments	Colour and Appearance	Consistency	Taste and Flavor	Overall Acceptability
T1	6 ± 0.270	5.6 ± 0.181	6 ± 0.30	5.6 ± 0.216
T2	6.1 ± 0.270	6.2 ± 0.181	6 ± 0.30	6 ± 0.216
T3	7.6 ± 0.270	7.3 ± 0.181	7.6 ± 0.30	8.2 ± 0.216
T4	6 ± 0.270	6 ± 0.181	5.8 ± 0.30	6 ± 0.216
F%	17.36 (S)	35.4 (HS)	10.14 (S)	59.15 (HS)
CD	0.660	0.44	0.734	0.528

S=Significant, NS-Non-Significant, ±=S.E Colour and appearance

The Table 1.4 shows the mean scores of weaning food in relation to colour and appearance which indicates that T3 (7.6) had the highest score followed by T2 (6.1); T1, T4 (6) respectively. Scoring shows that the treatment T3 was liked very much while T2, T1 and T4; were moderately liked by the panel of judges.

The ANOVA table (appendix A, table4) indicates that the calculated value of F due to treatment is greater than its table value of F on 3 and 6 degree of freedom at 5% (8.94) probability level, so the null hypothesis for treatment will be rejected; concluding thereby high significant difference between four treatments. Since ANOVA table shows the significant result due to treatment, so the value of critical differences was also calculated which is equal to CD (5%) = 0.660. Since the average value of treatments T3 is highest, so this treatment can be regarded as best treatment in regards to colour of the prepared product. On the above comparison table, significant difference was observed between the treatments (T1, T3) and (T2, T3) and (T3, T4); where as non significant difference was found between (T1, T4) (T2, T4) and (T1, T2). [T¯1=T¯4>T¯2>T¯3]

Consistency

Since the calculated value of F is greater than the table value of F at 5% (8.94) and 1% (27.91) level of significance and on 3 and 6 degrees of freedom, so the null hypothesis for treatment will be rejected; therefore showing high significant difference between four treatments as regards to consistency on 45 days. Since high significant result is obtained so, critical difference was also computed as CD (5%) = 0.44. hence the following comparison table is prepared on comparing the difference between the two treatments was observed between the pairs of treatments (T1, T3); (T3, T4); (T2; T3); (T1, T2) and non- significant difference was obtained between the treatments (T2, T4) and (T1, T4). Since the average score of treatment T 3 was found to be the highest (T3=7.3), so, it can be regarded as the best treatment in terms of consistency. [T¯1<T¯4<T¯2<T¯3]

Taste and flavor

Since the calculated value of F (10.14) due to treatments is greater than the table value of F (8.94) on 3, 6 degrees of freedom and at 5% level of significance, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is significant difference between the four treatments in terms of Taste and Flavor. The above ANOVA table provides high significant results for treatments, so the critical difference is also computed as CD (5%) = 0.734, which will be used for comparing two treatments at a time. From the above comparison table high significant difference was observed between (T1, T3); (T2, T3) and (T3, T4); whereas non-significant difference was obtained between (T1, T4); (T2, T4), (T1, T2). Since the average value of the treatment (T3 = 7.6) is highest amongst the other treatments, so T3 will be regarded as the best treatment. [T¯4<T¯1=T¯2<T¯3]

Overall acceptability

Since the calculated value of F (59.15) due to treatments is greater than the table value of F on 3, 6 degrees of freedom and at 5% (8.94) as well as 1% (27.91) probability level, so the null hypothesis for the treatment will be rejected, thereby it can be concluded that there is high significant difference between the four treatments. The above ANOVA table provides significant results for treatments, so the critical difference at 5% is also computed as CD (5%) = 0.528 from the above comparison table significant difference was observed between (T1, T3); (T3, T4) and (T2, T3); whereas non-significant difference was recorded between (T1, T2), (T1, T4) and (T2, T4). Since the average value of the treatment (T3 = 8.2) is highest compared to the average value of treatments T 1, T2, and T4. [T¯1<T¯2=T¯4<T¯3]

B. Nutrient content analysis of the prepared weaning powder

Table 1.5: The proximate analysis values of different nutrients of prepared weaning food

S.NO.	Nutrients	Parameter
1.	Fat	1.05%
2.	Protein	15.96%
3.	Carbohydrate	76.71%
4.	Fiber	2.25%
5.	Beta Carotene	3.97mg/100gm
6.	Calcium	210mg/100gm
7.	Iron	5.18mg/100gm

Table 1.5 presents the proximate values obtained from the analysis of different nutrients. These results shed light on the nutrient composition and are benchmarked against the Indian Council of Medical Research (ICMR) standards for children below two years of age. The comparison helps identify whether the nutrient content of the foods analyzed meets the recommended levels.

Table 1.6: Peroxide value (m. eq.) of weaning food during storage

Test Parameter	T3	PFA Standard Value, (2004)
Zero day	0.51 meqO2/kg	< 10 m. eq.
15th day	1.23 meqO2/kg	
30th day	1.79 meqO2/kg	
60th day	2.28 meqO2/kg	

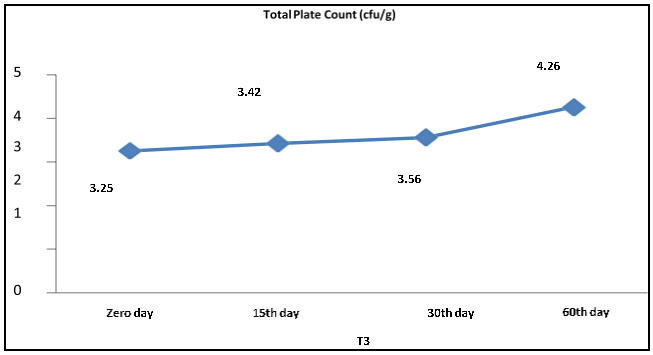

Fig 1: Peroxide value (m. eq.) of weaning food

The table 1.1 the analysis of the weaning food revealed a clear pattern: the peroxide value steadily increased over time, peaking on the 60th day. Yet, even at its highest point of 2.28 m.eq./kg, it remained well within the safe threshold—far below the PFA standard of <10 m.eq./kg (2004). On day zero, the peroxide value was at its lowest, 0.51, gradually rising to 1.23 on the 15th day, and 1.79 on the 30th day. These values remained comfortably within the safe limit, a reassuring indicator that, despite natural changes over time, the weaning food maintained its safety and quality throughout the storage period.

Table 1.7: Total Plate Count of selected treatment as compared to FSSAI standards

Test Parameter	T3	FSSAI Standard Value, (2022)
Zero day	3.25 ×10²cfu/gm	1 × 10³/g (m)
15th day	3.42 ×10²cfu/gm	
30th day	3.56 ×10²cfu/gm	1 × 10⁴/g (M)
60th day	4.26 ×10²cfu/gm	

Table 1.7 presents the Total Plate Count of the organoleptically superior treatment during storage, compared to the FSSAI standards. The findings indicate that while microbial growth increases over time, it remains within the acceptable limits for T3. However, the high moisture content of the weaning food poses a potential risk to storage stability. Elevated moisture levels in foods are known to foster microbial growth, as highlighted by Temple *et al*. (1996) [17]. This underlines the critical need for moisture control in preserving the quality and safety of such food products.

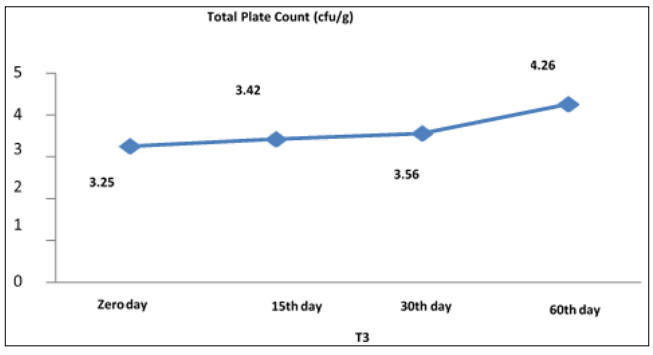

Fig 2: Total Plate Count of selected treatment

Table 1.8: Yeast and mould count of organoleptically best treatment (T3)

Days	Treatment	Yeast and mould count (cfu /g)	FSSAI Standard Value, (2022)
Zero day	T3	Absent	<10 cfu /g
15th day	T3	Absent	
30th day	T3	Absent	
60th day	T3	Absent	

Table 1.8 showed that the yeast and mould count in the best treatment at zero day, 15th day, 30th day, and 60th day was consistently absent, indicating that the mix was safe to use. This meant that even two months after opening the pack, the mix remained free from fungal contamination, ensuring its quality and safety for storage. The absence of yeast and mould was crucial in preventing spoilage and maintaining the product's freshness. Studies had demonstrated that foods with low moisture content, when properly packaged and stored, were less likely to support fungal growth (Hocking, 2006) [6]. Additionally, research highlighted that reducing oxygen and moisture inside the packaging helped prevent microbial growth, allowing foods to remain safe for longer periods (Jay, 2000) [7]. This underscored the importance of proper packaging and moisture control in extending the shelf life of products like weaning food.

Table 1.9: Coliform count of selected treatment (T3)) as compared to FSSAI 2022

Days	Treatment	Coliform Count (cfu/g)	FSSAI Standard Value, (2022)
Zero day	T3	Absent	<10 cfu /g
15th day	T3	Absent	
30th day	T3	Absent	
60th day	T3	Absent	

The coliform count results were impressive. Over 60th days—on the 0, 15th, 30th, and 45th days— there was no sign of microbial growth. Even when compared to the FSSAI standard, the treatment remained completely safe, showing its good quality and freshness.According to Sihag *et al*. (2015) [12], both coliform count and yeast and mold count remained absent throughout the six-month storage period, regardless of whether the product was stored in vacuum or ordinary packaging. This indicates that strict hygiene practices were maintained during product development. The rise in microbial load observed in ordinary packaging during storage was likely due to an increase in moisture content in the cereal-based weaning food. The findings suggest that while the product can be safely stored for six months in either packaging, vacuum packaging proved to be more effective.

c. Cost of prepared weaning food

Table 1.10: Cost of the prepared weaning food per kg

Ingredients	Rate /Kg. (Rs.)	Treatment			
		T_1	T2	T3	T4
Pearl Millet	36	1.26	1.26	1.26	
Green Moong dal	140	4.2	3.5	2.8	1.26
Carrot	60	0.9	1.2	1.5	2.1
Sesame seeds	100	0.5	0.5	0.5	1.8
Fox nut	1100	5.5	5.5	5.5	0.5
Sugar	44	0.44	0.44	0.44	5.5
Total		12.80	12.40	12	11.60

When evaluating the cost-effectiveness of prepared weaning foods, a detailed analysis of the raw ingredients reveals a compelling picture. As shown in Table 4.13, the most economical option emerges as T_4, priced at just Rs. 11.6 per 100 grams. This is closely followed by T_2, T_3, and T_1, priced at Rs. 12, Rs. 12.4, and Rs. 12.8, respectively. The significant cost advantage of these homemade weaning foods over their market counterparts can be attributed to the use of locally sourced ingredients, making them not only budget-friendly but also convenient for home preparation. This approach not only supports local agriculture but also empowers families to provide nutritious meals for their children without straining their finances.

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