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Formulation and Nutritional Evaluation of Ragi and Teff Based Instant Food Weaning Mixes

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ABSTRACT:

The present study focuses on the formulation of two types of weaning mixes incorporating Ragi and Teff as primary ingredients. Other ingredients such as green gram, dates, almonds and sugar were kept constant, resulting in eight different variations. The ratios of Ragi and green gram in Ragi-based weaning mixes were (20:40, 30:30, 40:20, and 50:10), while the ratios of Teff and green gram in the Teff-based weaning mixes were (20:40, 30:30, 40:20, and 50:10). Sensory evaluation of the developed mixes was done by semi-trained panellists. The results indicated that the composition of Ragi and Teff in the ratio of 50:10 was highly acceptable and was further evaluated for their proximate composition and shelf-life. The analysis revealed that the product was rich in Iron and Calcium (essential for infants in their growth and development). Shelf-life estimation demonstrated that these weaning mixes can be safely consumed for 30 days when stored properly in air-tight container. To provide consumers with essential information, comprehensive food labels were developed in accordance with the guidelines outlines by the FSSAI, 2020. These labels contain detailed information about the nutritive value, composition, ingredients, and storage instructions, ensuring that consumers have the necessary knowledge about the product.

Keywords: Ragi and Teff, Millet-based weaning mix, Malnutrition, Sensory evaluation, Proximate composition, Food label

INTRODUCTION

The development and well-being of infants beyond the breastfeeding period, typically up to six months, relies on the nourishing characteristics of the foods introduced during the weaning process (Heiru et al., 2019). In India, particularly in rural areas, breastfeeding is often practiced for duration of 1 to 3 years. There is a prevalent belief that exclusive breastfeeding alone is insufficient to sustain a suitable growth rate beyond 5 to 6 months. Consequently, the rate of growth slows down unless complementary foods are introduced through the process of weaning (Chuwa & Dhiman, 2021).

Weaning is most important for the period of infancy to childhood. Malnutrition is a significant global problem that leads to a higher infant mortality rate. This is primarily caused by inadequate access to nutritious foods and poor feeding practices, often due to various factors, particularly prevalent in rural areas. These factors result in an insufficient fulfilment of infant's nutrient requirements (Pandey & Singh, 2019). Therefore, nutritious supplementary foods are introduced to infants between the ages of 6 to 24 months. In the

process of weaning, the supplementary foods commonly utilized are derived from locally available cereals. These foods serve as the primary source of energy and nutrients for infants during this stage. Incorporating a combination of cereals and pulses has been found to create amino acid patterns that effectively support growth and development.

Traditional approaches involve the utilization of roasting, germination, and fermentation techniques for cereals and pulses. During the development of weaning food, these technologies are frequently employed either individually or in combination. High-quality weaning foods are characterized by their abundant calorie, protein, vitamin, and mineral content, as well as a soft texture. When mixed with warm or cold water, the weaning mixture should form smooth and consistent slurry, facilitating easy digestion and ensuring the absence of any anti-nutritional factors. Additionally, these foods should be free from contamination and retain their quality over an extended shelf life without being affected by external factors (Anandan et al., 2020).

Many mothers rely on rice and mashed fruits which do not supply all the required nutrition for the growing baby in the correct proportion (Gajra, 2021). So, it is wise to give the baby a specially prepared weaning mix which is a blend of cereals, pulses, nuts, fruits, and vegetables in order to meet the daily requirements of an infant. Therefore, various preparations based on cereal and combinations using processing methods like germinating, roasting, and grinding improve the protein quality of weaning food. Further addition of fruits, nuts, and sugar to the cereal-pulse combination improves the nutritive value and ensures adequate nutritive intake for infants.

OBJECTIVES OF THE STUDY

- To standardize and develop instant weaning mixes for infants.
- To assess the sensory characteristics of the developed weaning mixes.
- To analyze the proximate composition of the most acceptable weaning mixes.
- To calculate the nutritive value of the most acceptable weaning mixes.
- To analyze shelf-life of the most acceptable weaning mixes.
- To calculate the cost of the developed mixes.
- To design appropriate food labels for the developed mixes.

METHODOLOGY

Locale of the study

The study was conducted in the cookery lab at NIMS Institute of Nutrition and Public Health, Department of Nutrition and Dietetics at NIMS University, Jaipur, Rajasthan.

Procurement of raw ingredients

All the raw ingredients like Ragi, Green gram, Dates, Almonds, and Sugar were procured from the Achrol market, Jaipur. Teff grains were procured online from a renowned company called Lil'Goodness.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Processing of raw ingredients

All the raw ingredients were sorted to remove foreign impurities and washed thoroughly with fresh water. The cleaned ingredients were processed for further use as shown in the following flow charts depicted below (Figure 1 and 3).

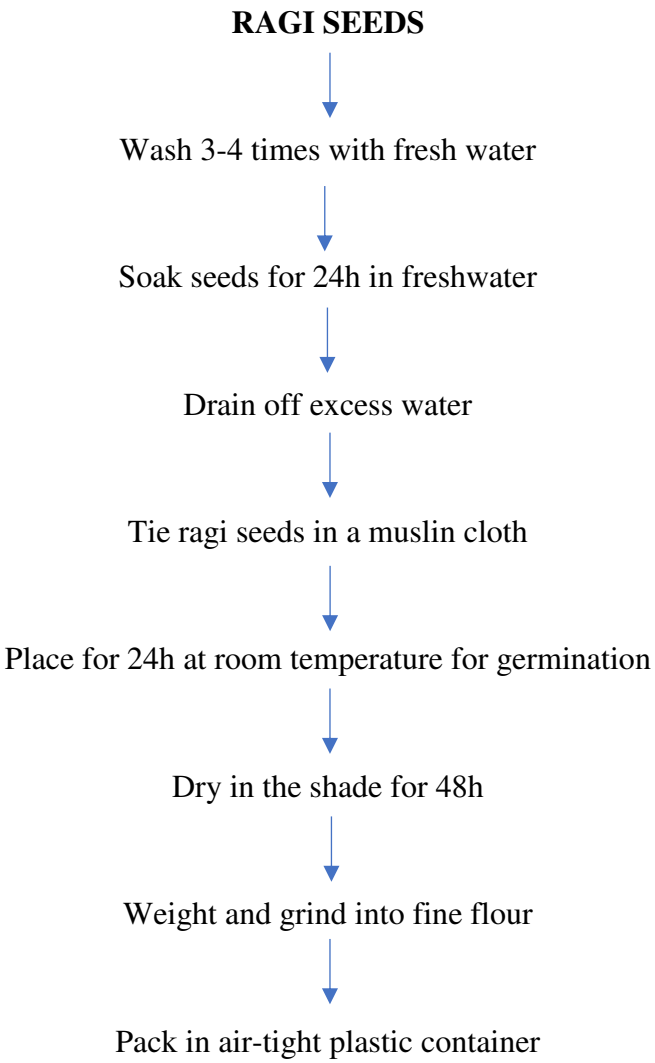

Figure 1 Processing of Ragi Seeds

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Figure 2 Ragi Seeds

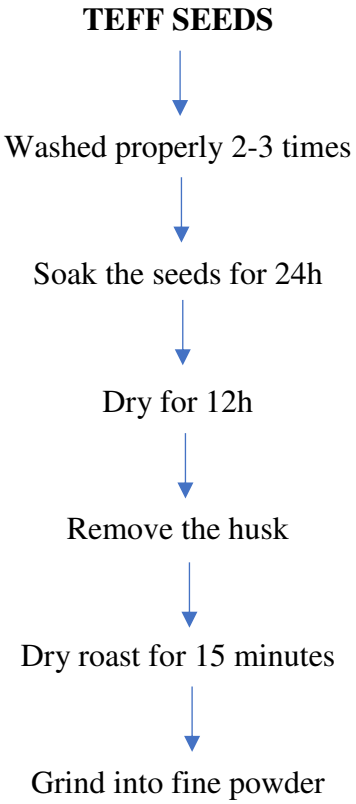

Figure 3 Processing of Teff Seeds

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Figure 4 Teff seeds

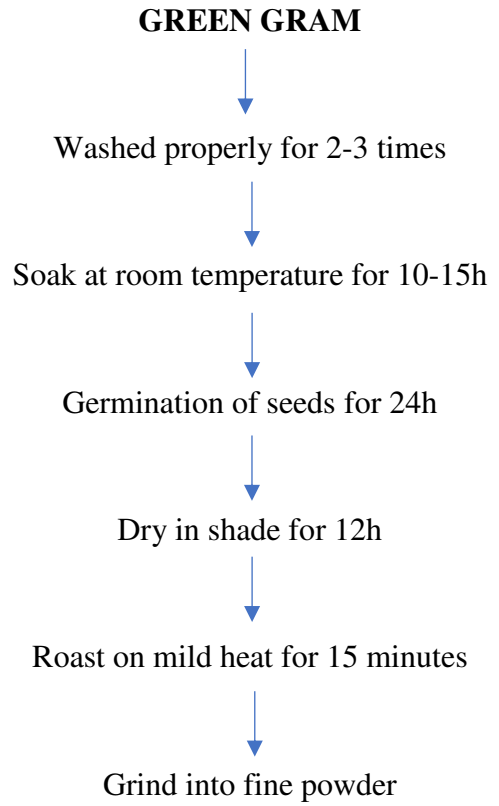

Figure 5 Processing of Green Gram Pulse

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Figure 6 (i) Raw Green Gram (ii) Sprouted Green Gram

Standardization and development of instant weaning mixes

Market survey

A market survey was conducted in nearby superstores and online, where weaning mixes of different brands like Cerelac, Slurrp, and Kellogg's were found to be convenient but were lacking in adequacy of nutrients and were loaded with preservatives and artificial flavors. The developed product majorly focused upon the incorporation of all five food groups including cereals, pulses, fruits, nuts, and milk which were added at the time of preparing the weaning mix.

Pilot study

Initially, formulations with green gram as the primary ingredient were developed, incorporating small amounts (5%) of ragi and teff. Feedback from panelists revealed an undesirable flavor caused by the high green gram content. Consequently, ragi and teff percentages were increased. Another pilot study, using 10% ragi and teff, received comments about the texture due to excessive green gram content. To address this, ragi and teff amounts were further raised and the final formulations were developed and are mentioned in Table no. 4 and 5 in the results and discussion section.

Sensory evaluation of the developed weaning mixes

A quantitative sensory analysis was conducted to evaluate the sensory characteristics like color, texture, taste, after-taste, and overall-acceptability, using 9-point hedonic rating scale. The evaluation was performed by 15 semi-trained panellists (selected through sensitivity threshold). Figure 7 depicts the panellists performing the sensitivity threshold test.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Figure 7 Panellists performing sensitivity threshold test

Proximate analysis of the most acceptable weaning mixes

Proximate analysis was conducted to evaluate the proximate composition of the two preferred weaning mixes, namely W4 for Ragi and W8 for Teff. The methodologies employed for proximate composition analysis are discussed in Table 1.

Table 1 Estimation of Nutrients and their methods

Proximate parameters	Methods
Moisture	AOAC, 2019
Ash	AOAC, 2019
Protein	AOAC, 2019
Fat	AOAC, 2019
Carbohydrate	AOAC, 2019
Energy	AOAC, 2019
Soluble fiber	AOAC, 2019
Insoluble fiber	AOAC, 2019
Iron	Wong's method (AOAC, 2019)
Calcium	Titration method (AOAC, 2019)

Moisture content

Method

- To determine the moisture content of the sample, around 10g of the sample was placed in a petri dish. The petri dish containing the sample was then dried in an oven at a temperature of 105˚C until a consistent weight was obtained. Before weighing, the petri dish was allowed to cool in a desiccator.

$$\text{Formula - Moisture content} = \frac{\text{Initial weight} - \text{Final weight} \times 100}{\text{weightofthe sample}}$$

Total ash content

Method

- To estimate the total ash content of the sample, approximately 5 grams of the sample were filled into a porcelain crucible that had been heated beforehand. The filled crucible

was then placed in a muffle furnace and heated at approximately 600ºC for 4 to 5 hours until the ash reached an almost white or greyish-white color.

- To ensure thorough ashing, the crucible was reheated in the muffle furnace for an extra hour, allowed to cool, and then weighed multiple times until two consecutive weights matched. This estimation process was conducted in triplicate to ensure precise and accurate results.

The ash content was expressed as grams of ash per 100 grams of the sample.

$$\text{Formula - Ash content} = \frac{\text{weightofthe ash} \times 100}{\text{weight of the sample}}$$

Protein content

Method

- The protein content of the dried samples was assessed using the Micro-Kjeldahl procedure, which enabled the measurement of the percentage of total nitrogen present. To obtain the protein percentage, the nitrogen percentage was multiplied by a conversion factor of 6.25.

$$\text{Formula - \% protein} = \frac{\text{titer value} \times \text{normality of Hcl} \times 14.001 \times 6.25 \times 100}{\text{sample weight(g)}}$$

Fat content

Method

- The fat content of the moisture-free sample was assessed by performing an extraction using the Gerhardt Soxtherm equipment.
- The sample was treated with ether, and the resulting mixture was subjected to evaporation. The remaining fat residue was carefully weighed to determine its quantity.

$$\text{Formula - Fat content} = \frac{\text{weight of the ether extract} \times 100}{\text{weight of sample taken}}$$

Fibre content

Method

- The determination of crude fiber content in the sample was carried out using a sample that had been previously freed from moisture and fat. The crude fiber content was then expressed as grams per 100 grams of the sample.
- The calculation of crude fibre content was based on the formula:

$$\text{Crude fiber} = \frac{100 - (\text{moisture} + \text{fat}) \times \text{We} - \text{Wa}}{\text{Weightof the sample taken (moisture and fat} - \text{free)}}$$

W_e- weight of the dish before ashing, W_a- weight of the dish after ashing.

Carbohydrate content

Method

- Using the differential approach, the sample's carbohydrate content was assessed. This involved estimating the individual content of protein, fat, fiber, ash, and moisture in the sample through established standard methods. The carbohydrate content was then calculated as the difference between 100% and the sum of these estimated components.

$$\text{Formula - Carbohydrate} = 100 - [\text{protein(g)} + \text{fat(g)} + \text{fibre(g)} + \text{ash(g)} + \text{Moisture(g)}]$$

Total Energy Content

Method

- The energy content of the sample was determined by utilizing a formula that accounts for the energy yield of each macronutrient:

$$\text{Formula - Energy} = [\text{Protein(g)} \times 4] + [\text{Carbohydrate (g)} \times 4] + [\text{Fat(g)} \times 9]$$

Calcium Content

Method

- To determine the sample's calcium concentration, a mineral solution was developed and then titrated against 0.01N EDTA (Ethylenediaminetetraacetic acid) in an alkaline environment.

$$\text{Formula - Calcium (\%)} = \frac{\text{Titer value for Ca} \times \text{N of EDTA} \times 0.02 \times \text{total volume of digested sample}}{\text{Aliquot taken} \times \text{weight of the sample}}$$

Here, "N" refers to the normality of EDTA.

Iron Content

Method

- An atomic absorption spectrophotometer was used to measure the sample's iron concentration, and the results were presented as milligrams per 100 grams of the sample.

$$\text{Formula - Iron content (ppm)} = \frac{\text{Graph ppm} \times \text{Volume made up}}{\text{weight of the sample}}$$

Shelf-life analysis of the most acceptable weaning mixes

The shelf-life of the developed product was assessed by evaluating the microbial activity through the total plate count, yeast and mould count. These techniques mentioned in table no. 2 are commonly employed to estimate the level of microbial contamination and the expected rate of shelf-life decline.

Table 2 Methods for the estimation of microbial activity

Methods	Reference
Total plate count	IS: 5402(P-1): 2021
Yeast and mould count	IS: 5403: 1999

Nutritive value of the most acceptable weaning mixes

The nutritive value of the Ragi-based weaning mix was determined by using the Indian Food Composition Tables (IFCT), 2017. On the other hand, the nutritive value for the Teff-based weaning mix was calculated by using standard values from USDA, 2018. These values provided insights into the macro and micronutrient composition of the food products, including information on proteins, carbohydrates, fats, vitamins, and minerals. The use of such standards helps ensure that the food products are nutritionally balanced and provide essential nutrients required for growth and development in infants.

Cost analysis of the most acceptable weaning mixes

The cost of the weaning mixes was determined by taking into account the current market prices of the raw ingredients, which are stated in Indian rupees per 100 grams. To determine the final cost, an overhead cost of 20% and a profit margin of 20% were added to the calculation.

Development of appropriate food labels

The food label for the developed product adheres to all the guidelines set by the FSSAI (Labelling and Display Guidelines), 2020. To create the label, the software Procreate was used, ensuring a professional and visually appealing design. Procreate offers a user-friendly interface with a wide range of customizable templates, fonts, and graphics, enabling the incorporation of essential label information such as ingredients, nutritional values, allergen declarations, and FSSAI license details. This process ensures that the label not only meets the mandatory requirements but also stands out with an attractive presentation, aiding in clear communication with consumers.

RESULTS AND DISCUSSION

Procurement and Processing of the ingredients

The ingredients used in the product were procured from both neighbourhood markets in Achrol, Jaipur, and online platforms (Lil'Goodness). Before utilization, a meticulous inspection was conducted to identify any extraneous materials, ensuring only high-quality ingredients were selected. Traditional methods were employed to clean and process the ingredients in accordance with the previously mentioned procedures. These traditional techniques involved thorough washing, sorting, and other processing techniques, that improve the nutritive value like soaking, germination, and other processes. By following these meticulous steps, the product's formulation was carefully prepared, upholding the commitment to quality and ensuring the safety of the final product.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Table 3 List of Ingredients

Ragi-based weaning mixes	Teff-based weaning mixes
Ragi	Teff
Green gram	Green gram
Dates	Dates
Almonds	Almonds
Sugar	Sugar

Standardization and formulation of the products

Ragi along with other ingredients were mixed in different amount to formulate four variations of ragi based weaning mixes, named as WM1, WM2, WM3, WM4. The composition of all variations is depicted in table 4 below. On the other side in the teff based weaning mixes, teff along with green gram, dated and almonds were used to formulate four different variations which were named as WM5, WM6, WM7 and WM8. The composition of the mix is depicted in table 5 below.

Table 4 Compositions of Ragi-based weaning mixes

Ingredients/ Weaning mixes	Ragi (g)	Green gram (g)	Dates (g)	Almonds (g)	Sugar (g)
WM 1	20	40	15	15	10
WM 2	30	30	15	15	10
WM 3	40	20	15	15	10
WM 4	50	10	15	15	10

Table 5 Compositions of Teff-based weaning mixes

Ingredients/ Weaning mixes	Teff (g)	Green gram (g)	Dates (g)	Almonds (g)	Sugar (g)
WM 5	20	40	15	15	10
WM 6	30	30	15	15	10
WM 7	40	20	15	15	10
WM 8	50	10	15	15	10

Sensory evaluation of the developed weaning mixes

Sensory evaluation was performed to assess the sensory characterstics, allowing panellists to rate various attributes of the weaning mixes such as colour, taste, texture, after-taste, and overall acceptability using 9-point hedonic rating scale. The evaluation aimed to gather valuable feedback on the sensory characteristics of the food product, which would be crucial for further refinement and development.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Figure 8 Panellists performing the sensory evaluation

Ragi-based weaning mix

The formulation of the Ragi-based weaning mix involved the utilization of ingredients, namely ragi, green gram, dates, almonds, and sugar, in varying proportions (20:40, 30:30, 40:20, and 50:10). A panel of 15 semi-trained individuals evaluated the sensory characteristics of the formulated weaning mixes. The mean scores provided by the panel members for these attributes are presented in Table 6.

Table 6 Mean scores of sensory characteristics of Ragi-based weaning mix

Parameters/ codes	Color	Taste	After Taste	Texture	Overall Acceptability
Control	6.33±1.17	6.80±0.94	6.60±1.12	6.60±0.91	6.93±0.88
W1	6.53±0.63	6.73±0.70	6.26±0.88	6.20±1.14	6.73±0.96
W2	6.93±1.03	7.20±1.20	6.40±0.98	6.33±0.89	7.00±1.06
W3	6.73±1.09	7.53±1.06	7.00±1.00	6.86±1.06	7.40±1.12
W4	6.867±1.06	7.40±1.12	7.13±0.83	7.00±0.92	7.53±1.12

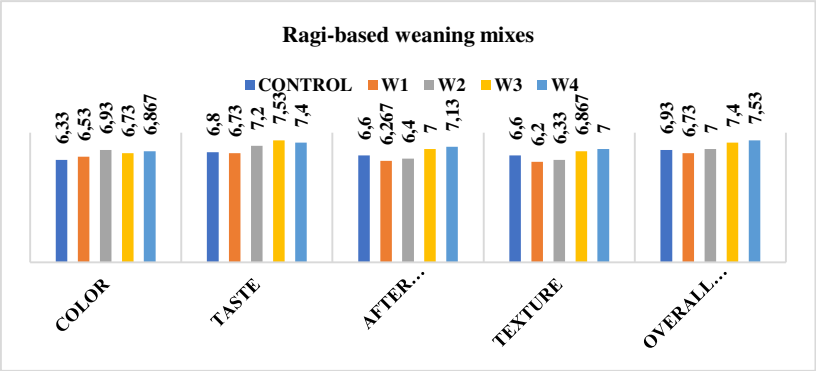

Figure 9 Graphical representation of the sensory scores of Ragi-based weaning mixes

Teff-based weaning mix

The formulation of the teff-based weaning mix involved the utilization of ingredients, namely teff, green gram, dates, almonds, and sugar, in varying proportions (20:40, 30:30, 40:20, and 50:10). A panel of 15 semi-trained individuals evaluated the sensory characteristics of the

formulated weaning mixes. The mean scores provided by the panel members for these attributes are presented in Table 7.

Table 7 Mean scores of sensory characteristics of Teff-based weaning mix

Parameters/ codes	Color	Taste	After Taste	Texture	Overall Acceptability
Control	5.93±0.88	6.00±0.75	5.93±0.79	6.13±0.83	6.20±0.77
W5	6.26±0.96	6.67±0.89	6.06±0.59	6.20±0.77	6.53±0.63
W6	6.20±0.94	6.26±1.03	6.46±0.91	6.13±0.83	6.46±0.99
W7	6.26±0.88	6.86±0.83	6.53±0.83	6.46±0.83	6.80±0.86
W8	6.53±1.12	7.40±0.63	6.67±1.11	6.80±1.08	7.13±0.99

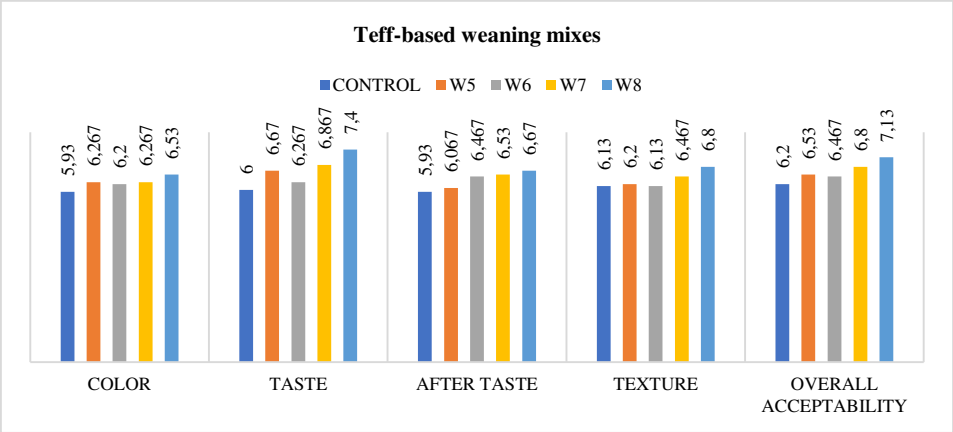

Figure 10 Graphical representation of the sensory scores of Teff-based weaning mixes

Proximate composition of the weaning mixes

Following the sensory evaluation, the most acceptable product was selected for further analysis of its proximate composition. The analysis was conducted according to the standard protocols. By following these established protocols, the nutritional composition of the most preferred product was accurately determined, providing valuable insights into its macronutrient composition, and aiding in the assessment of its overall nutritional quality. The results of the proximate composition of both weaning mixes are mentioned in table no. 8.

Table 8 Proximate composition of Ragi and Teff-based weaning mixes

Proximate parameters	RBWM	TBWM
Moisture (g/100g)	7.38	8.03
Total Ash (g/100g)	2.38	2.85
Energy (Kcal/100g)	406.21	400.33
Carbohydrates (g/100g)	70.12	69.13
Protein (g/100g)	11.07	11.22
Fat (g/100g)	9.05	8.77
Insoluble Dietary Fiber (g/100g)	14.78	18.22
Soluble Dietary Fiber (g/100g)	4.96	7.41
Calcium(mg/100g)	235.24	140.58

Iron (mg/100g)	4.56	6.48

*RBWM- Ragi-based weaning mix, TBWM- Teff-based weaning mix

Shelf-life analysis for developed weaning mixes

The microbiological quality of weaning mixes is an important parameter to ensure their safety for consumption, particularly for infants and young children who are more susceptible to infections. Weaning mixes were evaluated for two microbiological parameters: Total plate count (TPC), Yeast and mould count. Table no.9 provides information on the microbiological quality of two weaning mixes, Ragi and Teff-based weaning mixes, over a period of 30 days. The developed weaning mixes were found to be acceptable over a period of 30 days, this is because the ingredients were dry in nature.

Table 9 Yeast and mould count of weaning mixes at different intervals of storage

Weaning Mixes	Method	0 Day (cfu/g)	15th Day (cfu/g)	30th Day (cfu/g)
RBWM	Total plate count	3.72×10^4	3.78×10^4	3.83×10^4
	Yeast and mould count	140	180	230
TBWM	Total plate count	1.37×10^4	1.41×10^4	1.45×10^4
	Yeast and mould count	290	320	380

Nutritive value calculation of developed weaning mixes

Ragi-based weaning mix

The nutritive value of the ragi-based weaning mix was determined using the Indian Food Composition Tables (IFCT), 2017. This table provides comprehensive information on the nutritional content of various ingredients, enabling the calculation of the weaning mix's macro and micronutrient composition. This data helps assess the nutritional profile and value of the product, aiding in informed decision-making and ensuring its suitability for infant nutrition. The nutritive composition of the ragi-based weaning mix is mentioned in Table no. 10.

Table 10 Nutritive Composition of Ragi-Based Weaning Mix (g/100g)

Ingredients/ nutrients	Amount (g)	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fiber (g)	Iron (mg)	Calcium (mg)
Ragi	50	160.37	3.58	0.96	33.41	5.59	2.31	182.00
Green gram	10	29.37	2.25	0.11	4.61	1.70	0.49	9.24
Almonds	15	91.38	3.12	8.84	1.58	1.96	0.69	34.50
Dates	15	42.91	0.18	0.06	10.19	0.98	0.13	2.36
Sugar	10	40.00	-	-	-	-	-	-
TOTAL	100	364.03	9.13	9.97	49.79	10.23	3.62	228.10

Teff-based weaning mix

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

The nutritive value of the teff-based weaning mix was determined by utilizing the standard values mentioned in USDA, 2018. These reference values provide insights into the macronutrient and micronutrient composition of teff, which were then used to calculate the overall nutritional content of the weaning mix. This information helps assess the product's nutritional profile and suitability for infant nutrition based on established data. The nutritive composition of the teff-based weaning mix is mentioned in table no. 11.

Table 11 Nutritive Composition of Teff-Based Weaning Mixes

Nutrients/ Ingredients	Amount (g)	Energy (Kcal)	Protein (g)	Fat (g)	Carbohy-drate(g)	Fiber (g)	Iron (mg)	Calcium (mg)
Teff	50	183.50	6.65	1.19	36.55	-	3.81	90.00
Green gram	10	29.37	2.25	0.11	1.70	4.61	0.49	9.24
Almonds	15	91.38	3.12	8.84	1.96	1.58	0.69	34.50
Dates	15	42.91	0.18	0.06	0.98	10.19	0.13	2.36
Sugar	10	40.00	-	-	-	-	-	-
Total	100	387.16	12.20	10.20	41.19	16.38	5.12	136.10

COST ANALYSIS OF DEVELOPED PRODUCTS

Cost estimation of weaning mixes was done to determine the various costs associated with its production, packaging, and distribution. This analysis provided insights into the financial aspects of the product, including the impact of costs of ingredients, production, and other expenses. The estimated cost of the weaning mixes is mentioned in Table no. 12 and 13.

Table 12 Cost analysis of Ragi-based weaning mixes

S No:	Expenses	Amount (g)	RBWM Cost (Rs)
1.	**Ingredients**		
	Ragi	50	3.5
	Green gram	10	1.55
	Dates	15	4.2
	Almonds	15	11.47
	Sugar	10	0.51
	Total		**21.23**
2.	Overhead (includes labor, fuel, machinery, depreciation, taxes, etc.,)	20%	4.2
3.	Profit	20%	4.2
4.	**TOTAL**		**29.63**

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Table 13 Cost analysis of Teff-based weaning mixes

S No:	Expenses	Amount (g)	TBWM Cost (Rs)
1.	**Ingredients**		
	Teff	50	29.9
	Green gram	10	1.55
	Dates	15	4.2
	Almonds	15	11.47
	Sugar	10	0.51
	Total		**47.63**
2.	Overhead (includes labor, fuel, machinery, depreciation, taxes, etc.,)	20%	9.5
3.	Profit	20%	9.5
4.	**TOTAL**		**66.63**

DEVELOPMENT OF FOOD LABELS FOR WEANING MIXES

The food product labels for the ragi and teff-based weaning mixes were developed by following the guidelines set by the Food Safety and Standards Authority of India (FSSAI), 2020. These guidelines ensure that the labels accurately represent the ingredients, bar code, nutritional information, directions to use, storage instruction, and other essential details about the products, guaranteeing transparency and compliance with food safety standards.

Ragi-based weaning mix

Figure 11(i) Upper side of the food package for Ragi-based weaning mix

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

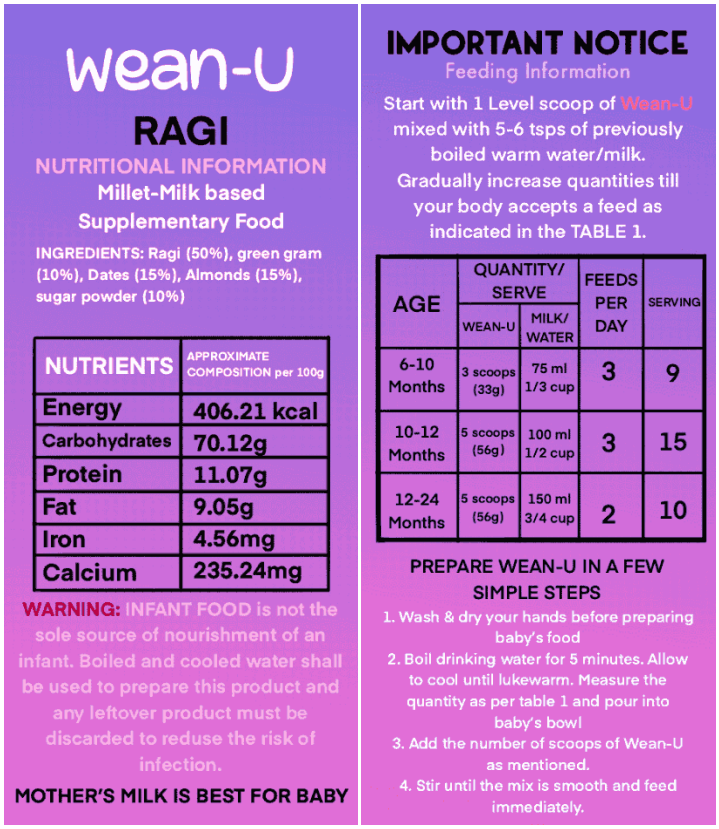

Figure 11(ii) Right side of the food package for Ragi-based weaning mix
(iii) left side of the food package for Ragi-based weaning mix

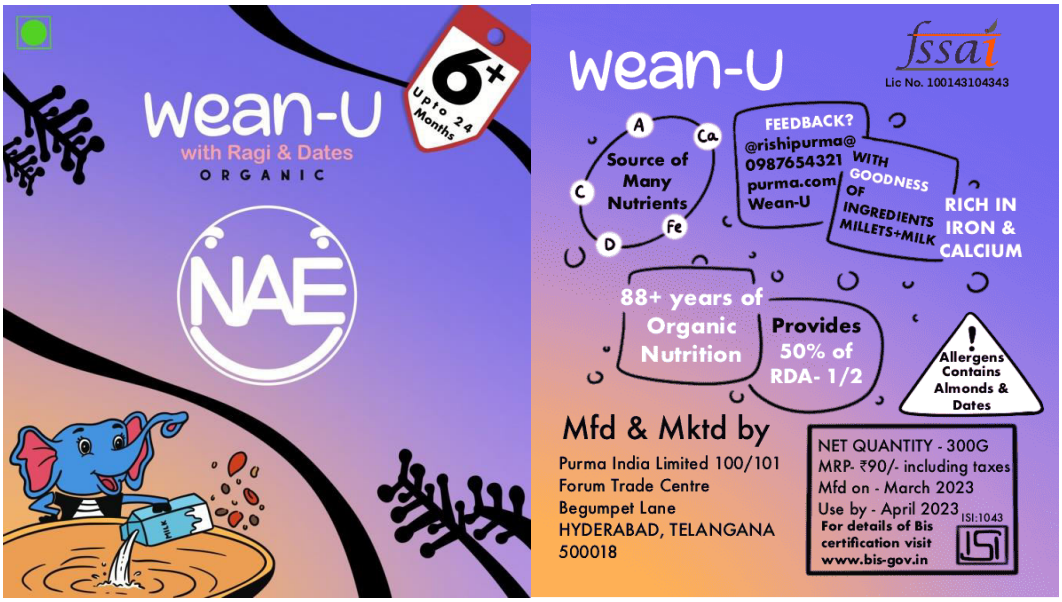

Figure 11(iv) Front side of the food package for Ragi-based weaning mix
(v) Back side of the food package for Ragi-based weaning mix

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

Teff-based weaning mix

Figure 12(i) Upper side of the food package for Teff-based weaning mix

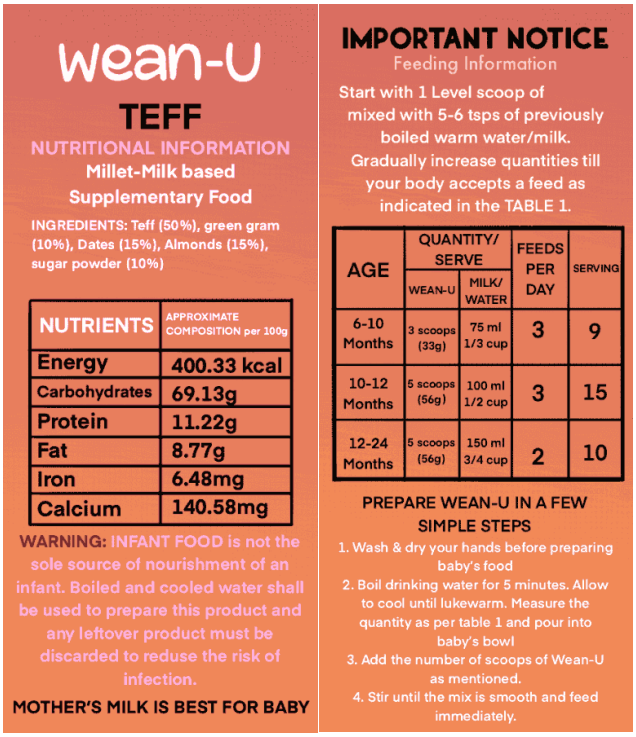

Figure 12(ii) Right side of the food package for Teff-based weaning mix
(iii) Left side of the food package for Teff-based weaning mix

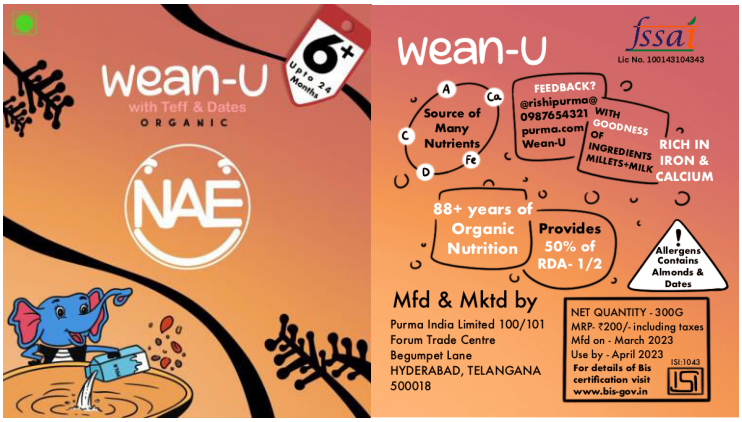

Figure 12(iv) Front side of the food package for Teff-based weaning mix
(v) Back side of the food package for Teff-based weaning mix

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DISCUSSION

Standardization and formulation of the products

After conducting the pilot study and formulating different compositions, eight different variations of weaning mixes were formulated using two fundamental ingredients, namely Ragi and Teff. Four of the mixes were formulated with Ragi as the primary ingredient, while the other four mixes were formulated with Teff as the primary ingredient. The remaining ingredients were kept constant throughout the study. The compositions are mentioned in the table no. 4 & 5.

Sensory evaluation of the developed weaning mixes

Ragi-based weaning mix

The results of sensory evaluation stated that W4 received the highest sensory scores for color (6.86 ± 1.06), taste (7.40 ± 1.12), aftertaste (7.13 ± 0.83), texture (7.00 ± 0.92), and overall acceptability (7.53 ± 1.12), indicating that it was the most preferred among the other ragi-based weaning mixes. The mean scores of the sensory evaluation for ragi-based weaning mixes are shown in Figure no. 9.

Teff-based weaning mix

Sensory evaluation for teff-based weaning mixes was conducted for sensory parameters for color, taste, aftertaste, texture, and overall acceptability, and the results stated that W8 received the highest rating for all parameters when compared to other mixes, with a rating of 6.53 ± 1.12 for color, 7.40 ± 0.63 for taste, 6.67 ± 1.11 for after taste, 6.80 ± 1.08 for texture, and 7.13 ± 0.99 for overall acceptability making it the most desired formulation among teff-based weaning mixes. The mean scores of the sensory evaluation for teff-based weaning mixes are shown in figure no. 10.

The two formulations which were obtained from the results of the sensory evaluation from ragi-based weaning mixes and teff-based weaning mixes were named RBWM and TBWM respectively and were further estimated for their proximate composition and shelf-life analysis.

Proximate composition of the weaning mixes

In terms of moisture content, the ragi-based weaning mix had a lower value of 7.38g per 100g compared to the teff-based weaning mix which was 8.03g per 100g, suggesting that ragi-based weaning mix has a longer shelf life and better stability which were similar to the moisture content founded ranging from 7.09 to 8.01 ±0.04 g per 100g in banana-based weaning mixes (Chitra, 2015) and roasted quinoa-based weaning mixes (Dong et al., 2021), respectively. The total ash content was higher in teff- based weaning mix at 2.85g per 100g compared to ragi based weaning mix which was 2.38gm per 100g which was similar to the ash content of complementary foods which was ranging between 3 to 3.4 g per 100g (Devi et al., 2014).

Both weaning mixtures provide similar amounts of energy, with teff- based weaning mix having 400.33 kcal per 100g and ragi based weaning mix having 406.21 kcal per 100g similar to the energy content of teff-based weaning mixes ranging from 391.63 ± 2.82 to 400.60 ± 3.49 kcal/100g (Tenagashaw et al., 2016), while roasted quinoa-based weaning mixes had an energy content of 404 ± 0.35 kcal/100g (Dong et al., 2021).

The carbohydrate content was slightly higher in teff- based weaning mix at 70.12g per 100g compared to the ragi-based weaning mix which was69.13g per 100g which are similar to the carbohydrate levels in millet-based weaning mixes ranged from 62.09±0.11 to 74.92±0.020 g per 100g (Prasanna et al., 2020), while Ready-To-Cook Porridge Mix had carbohydrate content ranging from 69.53±0.91 to 72.11±0.65 g per 100g (Chuwa and Dhiman, 2021).

The protein content was similar in both mixtures, with ragi based weaning mix having 11.07g per 100g and teff- based weaning mix having 11.22g per 100g which are similar to the protein levels in pumpkin-based weaning mix ranged from 11.26% to 12.57% (Dhiman et al., 2018), whereas rice and legume-based weaning mixes had protein levels ranging from 1.22 ± 0.15 to 10.70 ± 0.09 g per 100g (Tesby et al., 2019).

Fat content was slightly higher in the ragi-based weaning mix at 9.05g per 100g compared to the teff-based weaning mix which was 8.77g per 100g which were similar to the studies like Anandan et al. (2020) developed a low-cost weaning mix using germination technique and found a fat content of 8.09 g per 100g and Ali et al. (2016) developed an instant weaning mix with a fat content of 8.47 g per 100g.

Teff- based weaning mix has higher levels of both insoluble and soluble dietary fiber at 18.22g and 7.41g per 100g, respectively, compared to ragi based weaning mix which was 14.78g and 4.96 g per 100g, respectively which were similar to the weaning mixes developed by Chakravarthi and Kapoor (2015) using different proportions of wheat, sorghum, Bengal gram, and green gram had crude fiber values ranging from 3.089±0.09 to 3.69±0.14g per 100g.

Finally, calcium and iron content in the teff-based weaning mix was 140.58 mg and 6.48 mg per 100g, respectively, compared to ragi based weaning mix which was 235.24 mg and 4.96 mg per 100g, respectively which were similar to the calcium and iron contents spirulina incorporated millet-based weaning mix which were 150.7mg and 5.75mg per 100g, respectively (Kumar & Haripriya, 2021).

Shelf-life analysis for developed weaning mixes

As per the Food Safety and Standards Authority of India guidelines (FSSAI, 2021), the maximum permissible limit for total plate count in weaning mixes is 10^5cfu/g. In India, the acceptable range for yeast and mould count in weaning mixes is generally below 10^3cfu/g or below 10^4cfu/g. These limits are crucial for ensuring the safety and quality of weaning mixes, as they help control bacterial contamination and maintain product freshness. Adhering to these guidelines helps to meet regulatory standards and protect consumer health.

For Ragi-based weaning mix, the Total plate count was found to be 3.72 x 10^4cfu/g on the 0th day, which increased to 3.78 x 10^4cfu/g and 3.83x 10^4cfu/g on the 15th and 30th day

respectively. The yeast and mould count was 140 cfu/g on the 0th day, which increased to 180 cfu/g and 230 cfu/g on the 15th and 30th day respectively. This indicates an increase in the microbial load of the Ragi-based weaning mix over time.

For Teff-based weaning mix, the Total plate count was found to be 1.37 x 10^4cfu/g on the 0th day, which increased to 1.41x 10^4cfu/g and 1.45x 10^4cfu/g on the 15th and 30th day respectively. The yeast and mould count was 290 cfu/g on the 0th day, which increased to 320 cfu/g and 380 cfu/g on the 15th and 30th day respectively. Similar to Ragi-based weaning mix, the microbial load of the Teff-based weaning mix also increased over time.

CONCLUSION

The study successfully accomplished its objective of developing cost-effective weaning mixes using locally available ingredients to combat malnutrition. Ragi and teff-based weaning mixes were developed in variations formulations and found that higher proportions i.e. 50g of ragi and teff formulations were acceptable in all sensory parameters making them more preferable by consumers and were also found out they were fulfilling 1/2^{th} of RDA for infants. The weaning mixes were rich in iron and calcium making the mix more beneficial for infants for their growth and development. Additionally, the research demonstrated that the developed weaning mixes can remain acceptable for up to 30 days when stored in hygienic conditions. These findings underscore the viability of confidently commercializing the mixes while ensuring their desirable attributes are preserved through proper storage practices. The cost of the ragi-based weaning mix is priced at 90 Rs. while the teff-based weaning mix is priced at 200 Rs. for a 300g pack. These prices are significantly lower when compared to commercially available products in the market. As a result, these weaning mixes hold great potential for commercialization. Moreover, their competitive pricing, combined with their nutritional qualities, positions them as superior alternatives to existing weaning mixes currently in circulation.

REFERENCES

1. Ali, S., Singh, B., & Sharma, S. (2017). Development of high-quality weaning food based on maize and chickpea by twin-screw extrusion process for low-income populations. Journal of Food Process Engineering, 40(3), e12500.
2. Anandan, S., Nath, S. K. A., Sekar, K., & Reddy, M. (2020). Development of Low Cost Weaning Foods from Locally Available Grains. Journal of Human Ecology, 71(1-3), 154-160.
3. AOAC. 2019. Official Methods of Analysis, 21st Edition. Association of Official Agricultural Chemist. Washington. DC.
4. Chakravarthi, S., & Kapoor, R. (2003). Development of a nutritious low viscosity weaning mix using natural ingredients and microbial amylases. International journal of food sciences and nutrition, 54(5), 341-347.
5. Chitra, P. (2015). Development of banana-based weaning food mixes for infants and its nutritional quality evaluation. Reviews on Environmental Health, 30(2), 125-130.

6. Chuwa, C., & Dhiman, A. K. (2021). Development and nutritional evaluation of ready-to-cook porridge mix as a weaning food for infants. The Pharma Innovation Journal 2021; 10(12): 2259-2265.
7. Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2014). Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: a review. Journal of food science and technology, 51(6), 1021-1040.
8. Dhiman, A. K., Bavita, K., Attri, S., & Ramachandran, P. (2018). Preparation of pumpkin powder and pumpkin seed kernel powder for supplementation in weaning mix and cookies. International Journal of Chemical Studies, 6, 167-175.
9. Dong, G. M., Dong, J. L., Zhu, Y. Y., Shen, R. L., & Qu, L. B. (2021). Development of weaning food with prebiotic effects based on roasted or extruded quinoa and millet flour. Journal of Food Science, 86(3), 1089-1096.
10. Gajra, P., & Kashwan, M. (2020). Development of Nutritional Value Added Wheat Based Weaning Mixes, International Journal of Nutrition & Lifestyle, 1(2), 75-86.
11. Heiru, M., Bultosa, G., & Busa, N. (2019). Effect of grain teff, finger millet and peanut blending ratio and processing condition on weaning food quality. Cogent Food & Agriculture, 5(1), 1671116.
12. https://www.fssai.gov.in/upload/uploadfiles/files/Compendium_Labelling_Display_23_09_2021.pdf(FSSAI)
13. http://www.ifct2017.com/frame.php?page=home(ICMR)
14. https://fdc.nal.usda.gov/fdc-app.html#/food-details/169747/nutrients(USDA)
15. IS 5402: Part 1: 2021. Microbiology of the food chain - Horizontal method for the enumeration of microorganisms - Part 1: Colony count at 30°C by the pour plate technique. Bureau of Indian Standards.
16. IS 5403: 1999. Indian Standard method for yeast and mould count of foodstuffs and animal feeds (First Revision). Bureau of Indian Standards.
17. Kumar, A. S., & Haripriya, A. (2021). Formulation and evaluation of spirulina (Arthrospira platensis) incorporated millet based weaning food. International Journal of Academic Research and Development, 6(3), 62-65.
18. Pandy, L., & Singh, V. (2019). Development and Nutritional Evaluation of Weaning Foods to Prevent Protein Energy Malnutrition in Infants. International Journal of Chemical Studies, 7(1), 5-9.
19. Prasanna, M. S., Sowjanya, V. S., Jaya, E., &Rajender, G. (2020). Development of millet based instant weaning mix. Journal of Pharmacognosy and Phytochemistry, 9(4), 1908-1913.
20. Raghuramulu N, Nair MK, Kalyansundaram S. 2003. A Manual of Laboratory Techniques. National Institute of Nutrition, ICMR, Hyderabad, India.
21. Tenagashaw, M. W., Kenji, G. M., Melaku, E. T., Huyskens-Keil, S., &Kinyuru, J. N. (2016). Proximate composition and selected functional properties of complementary foods from teff fortified with soybean and orange-fleshed sweetpotato. RUFORUM Working Document Series (ISSN 1607-9345), 14(1), 953-965.
22. Tesby Mohamed, R. L., Asteer Victor, A. E., Zaki Mahfouz, M., & Khaled Shafik, A. (2019). Preparation and evaluation of some weaning foods made from rice and legumes. Alexandria Journal of Agricultural Sciences, 64(1), 1-9.