Storage Evaluation of Nutritionally Enriched Weaning Food for Infants

M. R. Roshana* and T. Mahendran

Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University, Sri Lanka
mrroshana30@gmail.com

Abstract - Complementary weaning foods play an important role on child growth and development. Therefore, breast milk alone is no longer sufficient for infants. A study was carried out to develop incorporated unpolished parboiled red rice, germinated green gram and carrot flour complementary weaning food mixture and to assess the quality of complementary weaning food during storage. The complementary weaning food mixtures were prepared from unpolished parboiled red rice, germinated green gram and carrot flour in the ratios of 100:00:00 (T1), 80:10:10 (T2), 70:20:10 (T3), 60:30:10 (T4), 50:40:10 (T5) and 40:50:10 (T6) respectively. These complementary weaning food mixtures were packed in aluminium laminated foil. Selected treatments such as T3, T4 and T5 along with control were stored under ambient conditions of average temperature of 30±1°C and relative humidity of 75-80% for evaluation of the shelf life. Complementary weaning food mixtures were subjected to quality assessments at two weeks interval for the entire storage period of 14th weeks. The results of storage studies showed the declining trends in ash, protein, fiber, fat and β-carotene and an increasing trend in moisture of the complementary weaning food mixtures. Among the treatments, the complementary weaning food formulated with 30% of germinated green gram flour has acceptable range of nutritional characteristics during entire storage period. The sensory evaluation was carried out to assess the quality attributes such as colour, texture, taste and overall acceptability by a semi-trained panel of consisting 30 members using a seven-point hedonic scale. The ratings of the samples are ranged from 1 (dislike very much) to 7 (like very much). From the results of quality assessments, T4 complementary weaning food mixture could be stored at above mentioned temperature and relative humidity for a minimum period of 14 weeks without any significant changes in the quality attributes.

Key words: Carrot flour, germinated green gram, nutritional enrichment, parboiled red rice.

I. INTRODUCTION

Complementary feeding is that introduction of foods other than milk to an infant's diet during the period of weaning. It is a major step in the development of food behaviour, it represents a critical stage from both nutritional and behavioral standpoints, likely to affect the infant's growth and health [1]. Adoption of recommended breast feeding and complementary feeding practices and access to the appropriate quality and quantity of foods are essential components of optimal nutrition for infants and young children [2].

Rice (Oryza sativa L) is a major source of nutrients in many parts of the world. Consumers prefer to eat unpolished rice because of the nutrient value in the bran. Therefore, demands for red rice and parboiled rice are increasing because of their high value in nutrition and health importance associated with eating this type of rice.

Green gram (Vigna radiata) is an excellent source of protein (25%), high in dietary fiber, rich source of vitamins and minerals. Several studies found that germination can increase protein content and dietary fiber; reduce tannin and phytic acid content and increase mineral bioavailability [3]. Germination improves calcium, copper, manganese, zinc, riboflavin, niacin and ascorbic acid content.

Carrot (Daucus carota L.) is a very popular vegetable for its nutritive value and pleasing taste. The carotenoids are in the group of bioactive compounds that are believed to play a significant role for the health-promoting properties of carrots [4]. Carotenoids are the precursor of vitamin A which is an essential component of the visual pigments in the retina and their deficiency leads to xeropthalmia and night blindness in human beings.

Therefore, there is a need to study means and ways of developing inexpensive, but equally nutritious weaning mixes from available food materials using simple technology as an intervention to childhood malnutrition and micro nutrient deficiency. In this present study, efforts have been made to incorporate unpolished parboiled red rice flour with germinated green gram flour and carrot flour to develop the complementary food mixture for infants. This complementary weaning food mixture can be used as a low cost nutritious food for babies, especially among the low income families.

II. MATERIALS AND METHODS

1. Preparation of Raw Materials for the Formulation of Complementary Weaning Food Mixture

The rice grains were cleaned, air dried for 48 hours at 30±1°C, roasted, ground and screened through 1mm sieve to obtain flour. Green grams were soaked in water for 8 hours, allowed to germinate for 3 days, air dried for 48 hours at 30±1°C, the testa and roots were removed, roasted, ground and sieved through 1mm sieve to obtain flour. Carrots were washed, peeled and sliced into 1mm

thickness. They were dipped into sodium metabisulphite (100ppm) for 3 minutes. Later, the carrot slices were air dried at room temperature of 30±1°C for 3 days and ground and sieved through 1mm sieve to get uniform size flour.

2. Preparation of Instant Weaning Food Mixtures

The complementary weaning food was prepared by using unpolished parboiled red rice flour, germinated green gram flour and carrot flour in different combinations. In the formulation, the total amount of unpolished parboiled red rice flour and germinated green gram flour were kept at 90% and amount of carrot flour was maintained at 10% constant level. All the formulations were prepared within the range of Recommended Daily Allowance for infants up to 2 years.

3. Combination of Ingredients for Different Treatments

Combination of Ingredients for Different Treatments are shown in Table 1:

Table 1: Combination of Ingredients for Different Treatments

Ingredients	Treatment					
	T_1 (C)	T_2	T_3	T_4	T_5	T_6
% of Unpolished Parboiled Red Rice Flour (UPRF)	100	80	70	60	50	40
% of Germinated Green Gram Flour (GGF)	0	10	20	30	40	50
% of Carrot Flour (CF)	0	10	10	10	10	10

4. Package, Storage and Shelf life Evaluation of Complementary Weaning Foods

Based on the nutritional and sensory evaluation, the most preferred and nutritionally valuable complementary weaning foods were selected for the storage studies, such as T3, T4 and T5 along with control. They were packed using aluminium laminated packaging material for storage studies. The selected packs were stored under ambient conditions of average temperature of 30±1°C and relative humidity 75-80% for 3 months. The nutritional characteristics of moisture, ash, fat, fiber and protein content were determined in every 2 weeks interval using recommended AOAC [5] methods and β-carotene content was measured in one month interval during the 14 weeks of storage period.

III. RESULTS AND DISCUSSION

1. Nutritional Characteristics of Unpolished Parboiled Red Rice Flour, Germinated Green Gram Flour and Carrot Flour

Nutritional analysis were performed for the unpolished parboiled red rice flour, germinated green gram flour and carrot flour to develop the complementary weaning food mixture. The results are shown in the Table 2.

Table 2: Nutritional Characteristics of Unpolished Parboiled Red Rice Flour, Germinated Green Gram Flour and Carrot Flour

Composition	UPRF	GGF	CF
Moisture (%)	5.72±0.04	7.50±0.03	6.56±0.33
Ash (%)	1.15±0.03	3.93±0.09	2.82±0.03
Protein (%)	8.54±0.06	23.2±0.19	7.13±0.08
Fat (%)	2.87±0.02	1.18±0.02	1.55±0.02
Fiber (%)	0.53±0.05	3.20±0.05	5.45±0.05
β-Carotene (mg/kg)	9.07±0.09	3.71±0.04	236.33±4.41

Values are means of triplicates ± standard error

2. Shelf life Evaluation of Formulated Weaning Food Mixtures

Based on the nutritional and sensory analysis of freshly made complementary food mixtures, the most preferred complementary food mixtures with control were selected for storage studies (Table 3).

Ingredients	Treatments			
	T_1 (C)	T_3	T_4	T_5
% of Unpolished Parboiled Red Rice Flour	100	70	60	50
% of Germinated Green Gram Flour	0	20	30	40
% of Carrot Flour	10	10	10	10

Table 3: The Most Preferred Treatments for Storage Studies

3. Changes Nutritional Qualities of Weaning Food Mixtures during Storage

3.1 Moisture Content

Moisture is an index of the shelf life of any food. Moisture content of less than 10% has been reported to be responsible for the state of non-deterioration in foods. Dry foods are very hygroscopic in nature. Therefore, most cases they must be protected from moisture pickup from atmosphere for long term storage. The changes in moisture content of the complementary food mixture during storage are shown in Figure 1.

According to the DMRT, moisture content increased significantly ($p<0.05$) throughout the storage period. The gradual uptake of moisture by all the complementary food mixtures throughout the storage period agreed with other workers finding in respect of soybean based complementary food formulation [6]. There were no significant differences in moisture content of T_3 and T_4 from 2nd week up to 10th week.

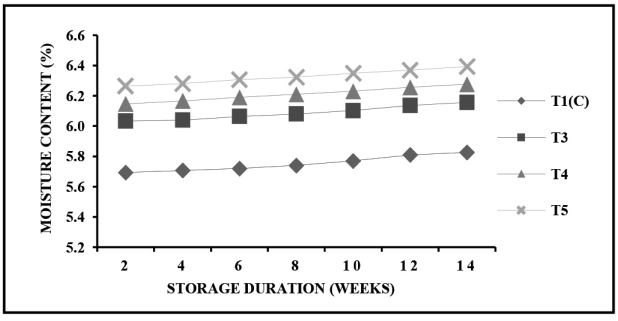


Figure 1: Changes in Moisture Content of Weaning Food Mixture during Storage

3.2 Ash Content

According to the DMRT, ash content decreased significantly ($p<0.05$) throughout the storage period. Treatments T_3 and T4 have the slow rate of decreasing trend than T_5 and T_1. But there were no significant differences in ash content of T_4 throughout the storage period.

3.3 Protein Content

During the processing and storage of foods, non-enzymatic browning may cause deterioration and reduce the shelf life [7]. The changes in protein content of the complementary food mixture during storage are shown in Figure 2. According to the DMRT, protein content decreased significantly ($p<0.05$) throughout the storage period. This is due to the interaction between reducing sugars and amino acids. This is called non-enzymatic browning and this reaction impairs protein nutritional value [8]. Treatments T_3 and T_4 have the slow rate of decreasing trend than T_1 and T_5. But there were no significant differences in protein content of T4 throughout the storage period.

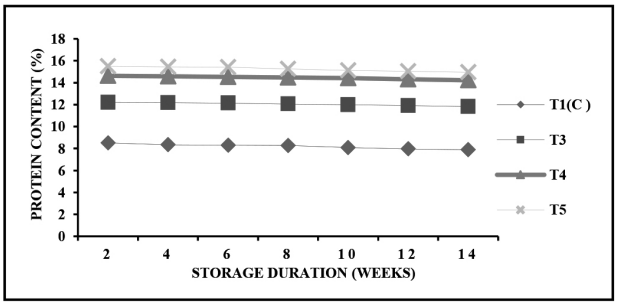


Figure 2: Changes in Protein Content of Weaning Food Mixture during Storage

3.4 Fat Content

The changes in fat content of the weaning food mixture during storage are shown in Figure 3. According to the DMRT, fat content decreased significantly ($p<0.05$) throughout the storage period. This decrease in fat content might be associated with the activity of lipase and thus, splits up fat into free fatty acids and glycerol resulting in reduction in total fat content of the product [9]. T4 has the slow rate of decreasing trend than all other treatments and also there were no significant differences in fat content of T4 from 2nd week up to 12th week.

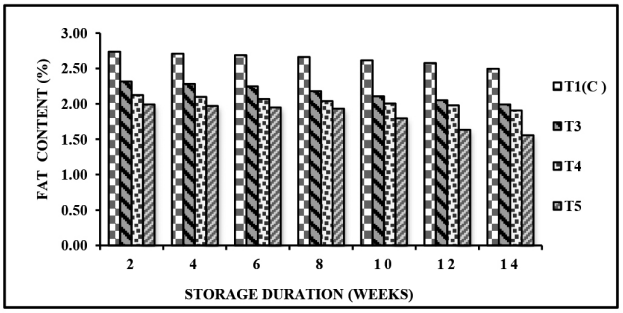


Figure 3: Changes in Fat Content of Weaning Food Mixture during Storage

3.5 Fiber Content

The low fiber content would enable children to consume food that is more nutrient dense and help to meet their daily energy and other vital nutrients requirements [10]. The changes in fiber content of the complementary food mixture during storage are shown in Figure 4. According to the DMRT, fiber content decreased significantly ($p<0.05$) throughout the storage period. T4 and T5 have the slow rate of decreasing trend than T3 and T1. But there were no significant differences in fiber content of throughout the storage period.

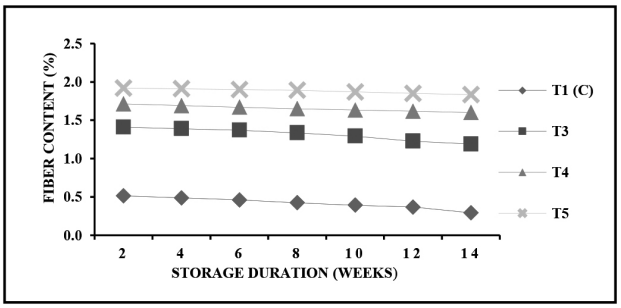
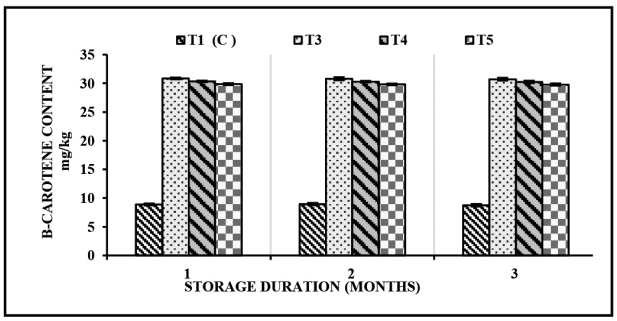


Figure 4: Changes in Fiber Content of Weaning Food Mixture during Storage

3.6 β-Carotene Content

Dehydrated products are considered more likely to undergo carotenoid degradation during storage because of the increase in surface area and porosity via the storage conditions and the packaging material permeability to oxygen and moisture [11]. The changes in β-carotene content of the complementary food mixture during storage are shown in Figure 5. According to the DMRT, β-carotene content decreased significantly ($p<0.05$) throughout the storage period. Treatments T4 and T5 had the slow rate of decreasing trend than T1 and T3. There were no significant differences in all the treatments throughout the storage period.



The values are means of triplicates
The vertical bars indicate the standard errors

Figure 5: Changes in β-Carotene Content of Weaning Food Mixture during Storage

4. Organoleptic Evaluation of Weaning Food Mixture during Storage

Sensory evaluation was made for complementary weaning food mixtures after 14 weeks of storage period through a semi-

trained panel of consisting 30 members using a seven-point hedonic scale. Organoleptic characters of complementary food mixtures stored at ambient temperature were changed during the storage period (Table 4). Due to maillard reaction, lipid oxidization [12], moisture uptake and other chemical reaction may change the sensory qualities of the complementary food mixtures during the storage period.

Table 4: Sensory Characteristics of Weaning Food Mixtures Following 14 Weeks at Ambient Temperature

Treatment	Colour	Texture	Taste	Overall acceptability
T_1 (C)	3.53±0.16^c	3.27±0.18^c	2.30±0.17^d	3.27±0.17^c
T_3	4.80±0.15^b	4.93±0.16^a	5.07±0.14^b	4.93±0.14^b
T_4	5.33±0.12^a	5.37±0.15^a	5.63±0.13^a	5.63±0.13^a
T_5	4.47±0.15^b	4.33±0.17^b	4.50±0.17^c	4.37±0.19^b

From the overall acceptance rating, 30% germinated green gram added complementary food mixture has the highest mean value and no remarkable changes in organoleptic characters were observed up to 14th weeks of storage.

IV. CONCLUSIONS

This study was carried out by incorporating the unpolished parboiled red rice flour with germinated green gram flour and carrot flour as a source of protein and carotenoids respectively which could help in alleviating protein-energy malnutrition and vitamin A deficiency (VAD) amongst the children. Germination significantly improves the nutritional value of the complementary food formulations by improving their protein content. Carrot is a rich source of β-carotene and contains other vitamins like thiamine, riboflavin, vitamin B-complex and minerals. The finding of the storage study revealed that, 60% unpolished parboiled red rice flour, 30% germinated green gram flour and 10% carrot flour added complementary weaning food mixture is the best combination in the nutritional and organoleptic qualities compared to other tested combinations at the temperature of 30±1°C and the RH of 75-80% for the storage period of 14 weeks. It is recommended that the infants fed on this weaning food be breastfed for at least 2 years, as the formulation is intended to act as supplement to breast milk and a transition meal from breast milk to solid family diets and not a substitute to breast milk. Fortification of the formulation with minerals is also recommended.

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