International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 611-614

Received: 09-01-2019
Accepted: 15-02-2019

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Development and quality evaluation of millet based weaning food

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Abstract
The Weaning food (RMS) was developed for infant using Ragi, Raigkeera, whole green gram, soybean, Sapota, sugar, cardamom and skim milk powder. The acceptability of developed RMS weaning food was studied using nine point hedonic scale. Nutrient content of highly accepted RMS weaning food was analyzed using standard methods. The acceptability of formulated weaning food by the infant and their mothers was also studied. The keeping quality of most accepted weaning food was studied by storing the weaning food at room and at refrigerator temperature for 90 days. Simultaneously the determination of colony count of bacteria present in stored sample was carried out by direct method of counting. The data generated was analyzed statistically. Results indicated that developed RMS weaning food contain more amount of energy (355 kcal), protein (20.33g), iron (9.5 mg) and calcium (448 mg) per 100 gm. Even after 90 days of storage found to have low microbial count. It was very well accepted by infants and their mothers and no digestive disorders were noticed after in infant feeding RMS mix. Hence, formulated weaning foods were nutritionally superior, functionally appropriate, microbiologically safe and organoleptically acceptable.

Keywords: Development, quality evaluation, millet, weaning food

Introduction
Breast milk satisfies the nutrient and energy requirements of the infant for the first 4- 6months; subsequently the nutritional composition of the breast milk increasingly becomes inadequate to meet the infant's requirement this gives room for the introduction of complementary food that can meet the nutritional requirements of the growing child. The introduction of supplementation in terms of weaning foods prepared from easily available and low cost ingredients is of vital importance to meet the requirements of the growing children (Saeeda *et al*., 2009). In most developing countries, commercial weaning foods of excellent quality either imported or locally produced are generally 10 to 15 times higher than the cost of the common staple foods due to sophisticated processing, expensive packing, extensive promotion and solid profit margins (Bahlol *et al*., 2007) [1].
Formulated weaning food must be soft, acceptable and must contain the essential nutrients in the correct proportion to supply the babies need for growth and development. During the weaning period, semi-solid andthe solid foods are introduced while breast feeding continues at lesser frequency. According to Mensah *et al*., (1995) [6], weaning food should be the same staple foods for adults, but made in smooth nourishing, appetizing and acceptable consistency suitable for baby. Commercial available weaning food are not with in the reach of common range. Even, FAO (1997) [3] has also recommended to use home based complementary food to stem the deleterious effect of malnutrition on infant and young children. This research work aimed to formulate weaning food from millet based and locally available food stuffs and easy to prepare.

Materials and Methods
The weaning food (RMS) was developed using ragi (*Eleusinecoracana*), raigkeera (*Amaranthus tricolor*), whole green gram (*Vigna radiate*), soybean (*Glycine max*), sapota (*Manilkarazapota*), sugar (*Saccharum officinarum*), cardamom (*Elettaria cardamomum*) and skim milk powder. Ragi, rajkeera, whole green gram and soybean were soaked for eight hours. Excess water was drained and tied in a muslin cloth and germinated at 28ºC for 48 hours and dried in sunlight for a day and grind into flour. While sapota were dried in mechanical drier in 46ºC temperature and grind in to fine powder.

All flours were sieved by 40 mesh sieve separately then mixed by addition of skim milk powder, sugar powder and cardamom powder and stored in air tight containers.

Different proportions of ingredients were used and four variations were formulated. Which were evaluated using nine point hedonic scale (BIS 1971) and the proportion found most acceptable was selected for further investigation. Moisture, fat and total minerals of the RMS weaning food were estimated by AOAC (2005) method. Calcium content was estimated by EDTA method. The carbohydrate content was calculated by difference method (Raghuramula *et al*., 2003). The energy value of the weaning food was calculated by using data of nutritive value of Indian foods. Protein content was estimated by micro kjeldhal method. Whereas, Magnesium, Zinc, Iron, Manganese and Copper content were analyzed by ICP-OES method.

The keeping quality of most accepted weaning food was studied by storing the weaning food at refrigerator temperature and at room temperature for 90 days. Microbial examination of the weaning food was perform to assess bacterial, yeast and mold load under laboratory condition. Physical and functional properties of WRG weaning Food was analyzed. Twenty five g of RM Sweaning food was mix with warm water or milk and fed to 10 infants continual for 10 days and acceptability of weaning food by the infant and their mother was studied. The results were analyzed statistically using analysis of variance and critical difference test (Panse and Sukhatme, 1985) [8].

Results and Discussion

RMS weaning food was developed using ingredients such as Ragi, raigkeera, whole green gram, soybean, sapota, sugar, cardamom and skim milk powder in different proportion (Table 1).

The organoleptic evaluation of developed weaning food is presented in Table 2.

Wide variations were noticed in the mean scores of all the organoleptic characteristics from 7.1 to 8.4colour, 7.1 to 8.6 texture, 7.2 to 8.8 taste, 7.2 to 8.6flavour and 7.3 to 8.4 in overall acceptability. The highest score was recorded for colour (8.4), texture (8.6), taste (8.8), flavor (8.6) and overall acceptability (8.4) by II variation of developed weaning food which was significant statistically. Results of organoleptic evaluation inferred that variation II of developed RMS weaning food was highly accepted as it scored significantly more score for all the organoleptic parameters.

Physical and Functional properties of RMS weaning food are presented in Table 3.

For preparation of RMS weaning food 40 mesh sieve was used. Bulk density of weaning food was 0.60g/ml, Water absorption capacity was 3.9 ml/g, Swelling capacity was 5 ml/g and viscosity was 3340- 590.

The nutrient content of developed weaning food is presented in Table 4.

Nutrient analysis indicated that RMS weaning food contains moisture (6.51 g%), protein (20.33g) energy (355 Kcal), carbohydrate (66.03g %), fat (5.33 g %) and ash (2.8 g). The micronutrient content of RMS weaning food exhibited higher values for iron (9.5 mg), calcium (448.6 mg), phosphorus (432.6 mg), manganese (140.3 mg), zinc (1.8mg), copper (1.35mg) and magnesium (2.12mg). The results of nutrient analysis inferred that developed RMS weaning food was rich in protein, iron and calcium. Similarly Barbar *et al.*, (2017) [2] reported that complementary food developed by them contain fat 7.83 per cent and protein 23.99 per cent.

The Mean scores for overall acceptability of developed RMS weaning food at room and at refrigerator temperature for varying periods are presented in Table 5.

Developed RMS weaning food was evaluated for their keeping quality, one sample was stored at room temperature and one sample stored at refrigerator temperature for 90 days. Organoleptic evaluation for both the treatment was carried out by trained panel members at initial, 15, 30, 45, 60, 75 and 90 days storage. The effect of storage and storage condition on keeping quality of RMS weaning food was studied from recorded scores for overall acceptability of developed RMS weaning food. Results indicated that the score obtained for overall acceptability of RMS weaning food was 8.4 at initial which was found to be reduced to 6.8 and 7.2 at room temperature and at refrigerator temperature after 90 days of storage period. It was found that as the storage period increases, the mean score of overall acceptability of both the sample decreases but it was not significant statistically. On the whole, RMS weaning food stored at refrigerator temperature was well accepted up to 90 days of period as compared to sample stored at room temperature.

The microbial load of developed RMS weaning food on storage is presented in Table 6. The microbial analysis was done for total bacterial count (TBC) and yeast and mould for developed RMS weaning food. The microbial population was analyzed at initial and 90 days interval over a period of three months. Initially the microbial population of developed RMS weaning food was found to be nil or below detectable level (BDL) but, it was increased up to 5×10^{-6}cfu/g at room temperature and 4×10-6 cfu/g at refrigerator temperature after 90days of storage period. In case of yeast and mould count of developed RMS weaning food initially it was found to be below detectable level which was increase to 0.4×10^{-1}cfu/g room temperature and 0.2×10^{-1} cfu/g refrigerator temperature at end of the storage period. Both the stored samples had low microbial population and hence, they were safe for consumption after storage.

The values for the acceptability of the developed RMS weaning food by infants and their mother are presented in Table 7. Infants were given 25g of weaning food per day. It was observed that the liking for the RMS weaning food was showed by all the infants(100%). All the mothers expressed that the formulation and blending of RMS weaning food was easy. Also after feeding of RMS weaning food to infant no digestive disorders were noticed.

Table 1: Composition of RMS weaning food per100 gm.

Ingredients (g)	Variations IIIIIIIV			
Ragi Malt flour	20	20	25	15
Rajkheera Malt flour	20	20	15	25
Green gram malt flour	20	15	20	15
Soybean flour	10	15	10	15
Sapota Powder	10	10	10	10
Skim milk Powder	10	10	10	10
Sugar Powder	9	9	9	9
Cardamom powder	1	1	1	1

Table 2: Mean scores of organoleptic characteristics of developed RMS weaning food

Variations	Mean value of organoleptic score of RMS weaning food				
	Colour	Texture	Taste	Flavour	Overall acceptability
I	8.0	8.1	8.0	7.8	7.7
II	8.4	8.6	8.8	8.6	8.4
III	7.6	7.6	7.4	7.5	7.5
IV	7.1	7.1	7.2	7.2	7.3
Mean	7.7	7.8	7.8	7.7	7.7
'F' Value	21.34**	29.88**	31.16**	22.27**	13.52**
S.E.	0.12	0.11	0.12	0.12	0.13
C.D.	8.0	8.1	8.0	7.8	7.7

**- significant at 1 % level

Table 3: Physical and Functional properties of RMS weaning Food

Parameters	Amount
Particle size	40 mesh
Bulk Density	0.60 (ml/g)
Water absorption capacity	3.9 (ml/g)
Swelling capacity	5(ml/g)
Viscosity	3340 – 590

Table 4: Nutrient Content of the highly accepted developed RMS weaning food (per 100 g)

S. No.	Nutrient	Mean + SD
1	Moisture (g)	6.51 + 0.28
2	Protein (g)	20.33 + 0.76
3	Energy (Kcal)*	355
4	Carbohydrate (g)*	66
5	Fat (g)	5.13 + 0.15
6	Ash (g)	2.8 + 0.3
7	Iron (mg)	9.5 + 0.4
8	Calcium (mg)	448.6 + 47.5
9	Phosphorus (mg)	432.6 + 17.78
10	Manganese (mg)	140.3 + 13.6
11	Zinc (mg)	1.8+ 0.15
12	Copper (mg)	0.52 + 0.02
13	Magnesium (mg)	2.12 + 0.15

* - Computed value

Table 5: Mean scores for overall acceptability of developed RMS weaning food at room temperature and at refrigerator temperature for varying periods

S. No.	Storage period	Mean scores of overall acceptability for developed RMS weaning food		't' value
		Room temperature Mean ± SD	Refrigerator temperature Mean ± SD	
1	Initial	8.4± 0.51	8.4± 0.51	0.3 ^{NS}
2	15 days	8.1 ± 0.75	8.3 ± 0.47	0.5 ^{NS}
3	30 days	8.0 ± 0.72	8.0 ± 0.64	0.2 ^{NS}
4	45 days	7.7 ± 0.63	7.9 ± 0.71	0.3 ^{NS}
5	60 days	7.3 ± 0.58	7.7 ± 0.73	0.2 ^{NS}
6	75 days	7.1 ± 0.87	7.5 ± 0.60	1.1 ^{NS}
7	90 days	6.8 ± 0.58	7.2 ± 0.78	1.4^{NS}

NS- non significant

't' values for room temperature		't' values for refrigerator temperature	
I vs. II	1.7 ^{NS}	I vs. II	0.9 ^{NS}
II vs. III	0.4 ^{NS}	II vs. III	1.6 ^{NS}
III vs. IV	1.1 ^{NS}	III vs. IV	0.4 ^{NS}
IV vs. V	2.0 ^{NS}	IV vs. V	0.8 ^{NS}
V vs. VI	0.8 ^{NS}	V vs. VI	0.9 ^{NS}
VI vs. VII	1.2 ^{NS}	VI vs.VII	1.1 ^{NS}
VII vs. I	10.8**	VII vs. I	5.75**

NS- non significant, **- significant at 1 % level

Table 6: Microbial count of RMS weaning food

Period	Room temperature		Refrigerator temperature	
	Total plate count	Yeast and mould	Total plate count	Yeast and mould count
Initial (1st day)	BDL	BDL	BDL	BDL
After (90th day)	5X 10^{-2}	0.4X 10^{-1}	0.2 X 10^{-1}	5X 10^{-2}

Table 7: Acceptability of RMS weaning food by the infants and their mothers

Name of the weaning food	Amount of weaning food consumed (g)	General acceptability Like Dislike	Blending of weaning food Easy Difficult	Method of formulation Easy Difficult	Digestive Disorder reported
RMS	25 g/day	100% --	100% --	100% --	--

Conclusion

Developed RMS weaning food from millets, pulses, oilseed and vegetables applying malting processing technique found to have good acceptability and it contain more amount of energy, protein, iron and calcium. Even after 90 days of storage found to have low microbial count there for, it can be consider as microbial safe for consumption. It was also very well accepted by infants and their mothers. Beside this no digestive disorders were noticed after feeding RMS weaning food to the infants. In conclusion developed nutritious RMS weaning food will prove to be of immense benefit for infants in developing countries, because it is prepared from locally available, low cost food stuffs and ease of preparation.

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