



DEVELOPMENT OF NUTRIENT DENSE READY TO COOK CEREAL MIXES FOR CHILDREN BETWEEN 6 MONTHS TO 2 YEARS

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Abstract

Introduction: Appropriate complementary feeding is crucial for preventing malnutrition and its effects in the early years of life. Most of the feeding mixes available or developed, lack dietary diversity and fail to provide all nutrients to children. It is necessary to provide complementary foods that fill in the gaps between child's daily nutritional needs and the amount gained from breastfeeding.

Methods: Present study dealt with development of nutrient dense ready to cook (RTC) cereal mixes for children below 2 years. Market survey was conducted to gain information regarding locally available foods. Several combinations were worked upon using cereals, millets, pulses, fruits, vegetables, nuts and oilseeds for meeting nutrient requirements along with dietary diversity. Four mixes were finally developed and tested for nutrient composition, organoleptic attributes and shelf life. Since the requirements at 6-8 months, 9-12 months and 12-23 months differ therefore, separate recipes were developed for these groups.

Results: Overall acceptability reported by semi trained panellists were between 6.66 and 6.83 for all the mixes. Nutrient composition analysis revealed that RTCs met more than 75% requirement for fibre and calcium and almost 100% for energy, protein, fat, carbohydrates and iron. Shelf-life studies were conducted at 1 month, 2.5 months and 3 months duration which revealed that acid value ($<11\text{mg NaOH/gm}$) and peroxide values ($<4\text{ mEq/1000gm}$) were well within acceptable limits. Manual and videos were developed on complementary feeding as well as on steps to prepare recipes using mixes. Present study clearly showed that important aspects of complementary feeding like adequacy and safety can be met cost effectively with these RTC cereal mixes.

Conclusion: Thus, development of these innovative nutrient dense mixes on a large scale using more sustainable options can be the key to reducing malnutrition amongst these children.

IndexTerms - Nutrient dense mix, complementary feeding, Ready to cook, undernutrition

INTRODUCTION

Malnutrition remains at unacceptably high levels on a global scale, according to the Global Nutrition Report 2020. Despite some progress in certain nutrition indicators, progress is insufficient to meet the global nutrition targets for 2025. Following the same pattern, GNR 2021 reveals a similar level of malnutrition. According to the most recent data, malnutrition continues to affect an unacceptable number of people. Nearly 22% of all children are stunted while 6.7% and 5.7% of all children are wasted and overweight respectively (1).

Only 54 countries are on course to meet stunting targets by 2030 while 102 countries are either off course or have shown no change (1). India showed a reverse trend for all indicators of malnutrition amongst children under 5 years except wasting which has gone down to 25.1% from 26.4% between NFHS 4 and 5. Underweight, stunting and overweight increased from 39.3%, 38.5% and 1.9% to 39.7%, 39.0% and 3.9% respectively between NFHS 4 and 5. Anemia prevalence amongst these children increased by 9% between NFHS 4 and 5. The trend clearly indicates that indicates a strong need to address the issue of triple burden of malnutrition amongst these children (2,3).

The triple threats of undernutrition (stunting and wasting), micronutrient deficiencies, and overweight and obesity are occurring within the same country, city, community, household and child. According to the Lancet conceptual framework, some of the immediate determinants of malnutrition are adequate food and nutrient intake, feeding, caregiving, and parenting practices. Adequate IYCF practices are critical to children's healthy development (4).

Far too many children aren't fed at the right times, with the right consistency, or with the dietary diversity they need to attain their full potential. Sadly, the nutritional quality of young children's diets has been consistently low over the last decade (5). To combat malnutrition and its related consequences during the early stages of life, complementary feeding is essential. Moreover, developing complementary foods that address the gaps between the daily energy and nutrient requirement of infants and young

children and the amount obtained from breastfeeding should be designed. These complementary foods should aim at providing adequate calories and protein along with dietary diversity.

AIMS/OBJECTIVES

Thus, the present study was planned with objective of developing ready to cook cereal mixes and assessing its nutrient composition along with organoleptic attributes and shelf life for children between 6 months to 2 years.

RELEVANCE OF THE STUDY

CNNS survey data clearly showed that prevalence of all forms of malnutrition was highest in children after 2 years of life indicating a strong need to strengthen the complementary feeding practices. Previous studies have revealed that usually complementary feeds fail to meet the nutrient gap between daily requirements and the amount obtained from breastfeeding after 6 months of age. A review of the complementary mixes developed showed that most of these lacked micronutrients as these were predominantly developed using cereals, pulses, nuts and oilseeds with sugar or jaggery (6,7). Thus, there is a strong need to develop ready to cook cereal mixes taking into consideration not only nutrient requirements but also considering minimum dietary diversity, gastric capacity and other aspects like breastfeeding.

METHODOLOGY

A market survey was conducted to get an idea about locally available food items. To meet dietary diversity wide range of foods were selected. Various combinations of RTC mixes were developed considering dietary diversity, nutrient requirements, average breastmilk intake and minimum meal frequency. Simultaneously, calculations were also done for non-breastfed children. In all, four mixes were developed with the following combinations:

- RTC 1 (6-11 months): Puffed rice, sago, apple, sapota, spinach, sesame seeds, jaggery, dates, green gram, scarlet beans
- RTC 2 (6-11 months): Jowar, Bengal gram, Sweet potato, Banana, Moringa, Dates, Cluster beans, Sesame seeds
- RTC 3 (12-23 months): sweet potato, amaranth seeds, bengal gram, sago, coconut, lotus stem, drumstick leaves, spinach, sesame, flaxseed, apple and jaggery were used.
- RTC 4 (12-23 months): Arrowroot, Jowar, Dates, Jaggery, Fenugreek leaves, Walnut, pineapple, grapes and Horsegram were selected.

Methodology for development of RTC mixes is shown in Figure 1.

Further nutrient analysis was conducted for determination of moisture, ash, protein, fats, carbohydrates, calcium, iron and dietary fibre using standard methods. A panel of semi trained panellists were selected for conducting organoleptic evaluation of the mixes based on composite and hedonic rating scales. To assess the keeping quality (shelf life) of the mixes peroxide value and acid value tests were performed at first, second and third month.

RESULTS

Ready to cook cereal mixes (RTC) were formulated and values were calculated based on IFCT, 2017. Infants between 6-11 months were divided into two sub groups i.e. 6-8 months and 9-11 months. For breastfed infants, nutrient requirements were met by 20g serving of mix with feeding frequency of 3 and 4 for age group 6-8 months and 9-11 months respectively. For non-breastfed infants, nutritional requirements were met by 25g serving of the mix with feeding frequency of 5 and 6 for age group 6-8 months and 9-11 months, respectively.

The serving size for children between 12-23 months for one feed was 65gm and 3 feeds were suggested for a breastfed child while 4 feeds for a non-breastfed child as per the guidelines. The serving size was derived as 20 gm/65gm keeping in consideration the gastric capacity of the child and focusing on the indicator- minimum meal frequency (6,8).



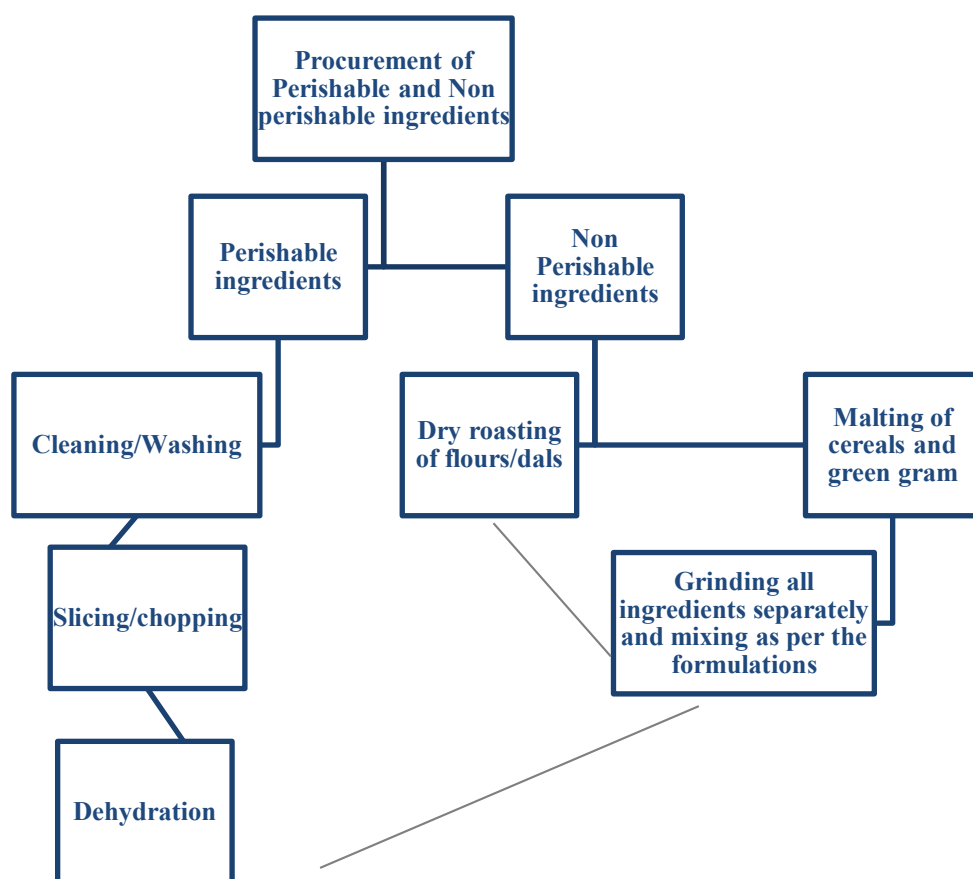


Figure 1: Methodology for Development of RTC mixes

Post nutrient composition analysis, calculations were done based on the requirements of children and a comparison with recommended dietary allowances was performed. Results showed that most of the requirements were met for breastfed children with respect to RTC 1 while for non-breastfed children fat requirement and to some extent calcium requirement was not being met. For this reason, it was suggested that RTC 1 can be mixed with 1 tsp of ghee/ whole fat milk before serving to meet the requirements for fat and calcium amongst NBF children. Similar findings were also observed for RTC 2 (Table 1 and 2) As shown in Table 3 and 4, most of the requirements for children between 12-23 months was met by RTC3 and RTC4.

Organoleptic evaluation

A semi trained panel of 40 panellists was selected to conduct organoleptic evaluation of the developed RTC mixes. Mean overall acceptability scores for RTC mixes 1-4 were 6.9, 6.7, 6.65 and 6.95 respectively. RTC 1 was the most liked flavour followed by RTC 3, 4 and 2. As per the guidelines no salt or sugar was added to these meals (Table 5).

Composite rating results as shown in Figure 2 revealed that the most liked RTC was RTC 1. Around 15% of the panellists did not like RTC 1 and 3 which was the highest number. However, as high as 82 % panellist reported to like RTC 4 and 1.

Panellists reported that the scores were a little lower because a common perception about these mixes is that it should be sweet. Natural sweetening foods were used in the mixes and therefore it did not have a strong sweet taste as expected. A few of them stated that if such foods are provided to children during early years, then children can develop healthy eating habits of consuming low fat, salt and sugar which can be very helpful in the long run.

Shelf Life of RTC mixes

Since several nuts and oilseeds were used in development of RTC mixes, therefore, shelf-life studies mainly pertaining to development of rancidity were conducted. It was observed that Acid values for RTC 1-4 was well within the acceptable range of <11mg NaOH/gm. Thus, it indicated that the RTC mixes were not rancid by the end of three months period (Table 6).

A separate analysis was done for peroxide value of the RTC mixes and the results revealed that the peroxide values were well within acceptable limits of <4 mEq/1000gm as shown in Table 7. If stored properly these mixes can easily last upto 3 months

without getting rancid. Thus, these mixes can provide for nutrient dense meals for children without the mothers worrying to cook fresh foods every time.

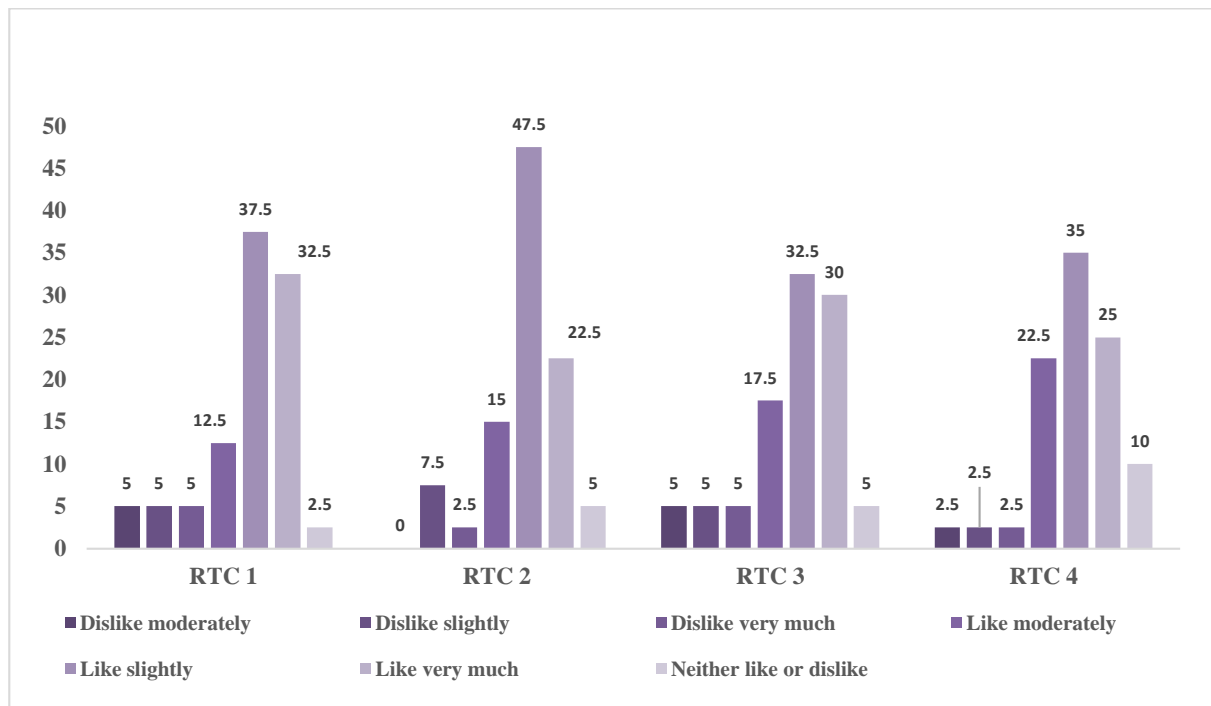


Figure 2: Composite rating for RTC mixes

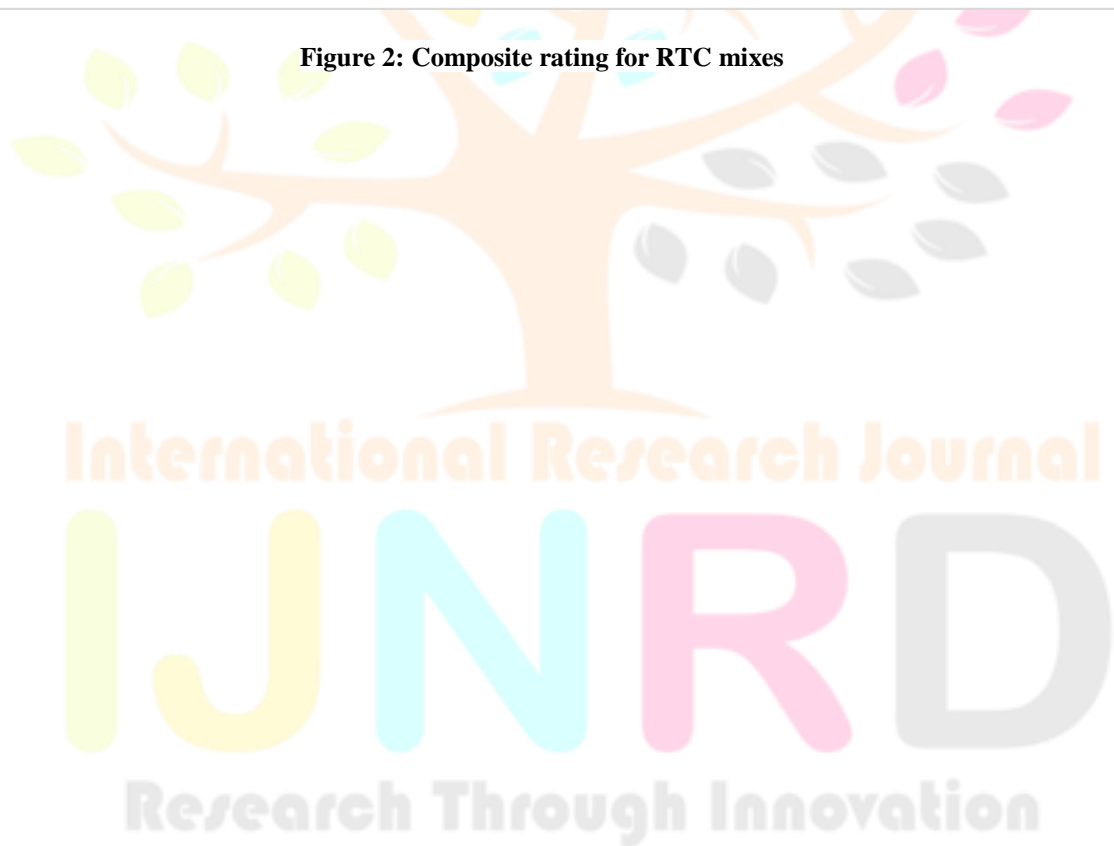


Table 1: Nutritive value as % of RDA met (Breastfed (BF) and Non-Breastfed (NBF)- RTC 1

RTC 1	Nutrients provided 6-8 months (BF)	%RDA met at 6-8 months	Nutrients provided at 9 months (BF)	%RDA met at 9-11 months	Nutrients provided 6-8 months (NBF)	%RDA met at 6-8 months	Nutrients provided at 9 months ((NBF)	%RDA met at 9-11 months
Energy(kcal)	237.6	118.8	316.8	105.6	495	82.5	594	84.9
Carbs (g)	48.1	95	61.4	126.7	100.2	105.5	120.2	126.6
Protein(g)	5.5	141.1	7.3	188.1	11.5	109.2	13.8	131
Fat(g)	2.6	112.2	3.4	149.6	5.4	23.7	6.5	28.4
D.Fibre(g)	5.4	50.7	7.2	67.5	11.2	105.5	13.4	126.7
Calcium(mg)	73.2	55.5	97.6	73.9	152.5	50.8	183	61
Iron(g)	1.5	51.2	2	68.3	3.2	106.7	3.8	128

Table2: Nutritive value as % of RDA met (Breastfed (BF) and Non-Breastfed (NBF)- RTC 2

RTC 2	Nutrients provided 6-8 months (BF)	%RDA met at 6-8 months	Nutrients provided at 9 months (BF)	%RDA met at 9-11 months	Nutrients provided 6-8 months (NBF)	%RDA met at 6-8 months	Nutrients provided at 9 months (NBF)	%RDA met at 9-11 months
Energy(kcal)	230.5	115.2	307.3	102.4	480.1	80	576.2	82.3
Carbs (g)	48.8	96.4	65	128.6	101.6	107	122	128.4
Protein(g)	4.2	108.5	5.6	144.6	8.8	83.9	10.6	100.7
Fat(g)	2	88.4	2.7	117.9	4.2	18.7	5.1	22.4
D.Fibre(g)	6.1	57.3	8.1	76.4	12.7	119.3	15.2	143.2
Calcium(mg)	82.2	62.3	109.6	83	171.3	57.1	205.5	68.5
Iron(g)	2.8	92.8	3.7	123.7	5.8	193.3	7	232

Table 3: Nutritive value as % of RDA met (Breastfed (BF) and Non-Breastfed (NBF)- RTC 3

RTC 3	Nutrients provided 12-23 months (BF)	%RDA	Nutrients provided 12-23 months (NBF)	%RDA
Energy(kcal)	836.67	111.18	1115.56	100.50
Carbs (g)	155	119.23	206.67	158.98
Protein(g)	10.73	85.84	14.3	114.4
Fat(g)	19.3	105.46	25.73	69.54
D.Fibre(g)	13.43	89.53	17.91	119.4
Calcium(mg)	312	90.17	416	83.2
Iron(g)	7.58	94.75	10.11	126.37

Table 4: Nutritive value as % of RDA met (Breastfed (BF) and Non-Breastfed (NBF)- RTC 4

RTC 4	Nutrients provided 12-23 months (BF)	%RDA	Nutrients provided 12-23 months (NBF)	%RDA
Energy(kcal)	790.12	105	1053.493	94.91
Carbs (g)	154.79	173.34	206.3867	158.76
Protein(g)	10.31	159.84	13.74667	109.97
Fat(g)	14.41	78.74	19.21333	51.93
D.Fibre(g)	13.51	90.07	18.01333	120.09
Calcium(mg)	310.05	89.61	413.4	82.68
Iron(g)	5.16	64.5	6.88	86

Table 5: Hedonic rating scores for RTC 1-4

RTC	Colour and appearance	Aroma	Texture	Taste	After-taste	Mouthfeel	Overall acceptability
RTC 1	7.15 ± 1.06	6.9 ± 1.20	6.7 ± 1.20	6.8 ± 1.15	6.6 ± 1.06	6.7 ± 1.25	6.95 ± 1.82
RTC 2	7.05 ± 1.76	6.45 ± 1.98	7.05 ± 1.62	6.67 ± 1.97	6.3 ± 1.25	6.43 ± 1.85	6.65 ± 1.95
RTC 3	6.7 ± 2.11	6.3 ± 2.05	6.9 ± 2.13	6.7 ± 1.80	6.6 ± 1.92	6.9 ± 2.14	6.9 ± 1.92
RTC 4	6.8 ± 2.29	6.4 ± 2.02	7 ± 1.76	6.5 ± 1.89	6.6 ± 1.94	6.7 ± 1.90	6.7 ± 1.86

Table 6: Acid Value of RCT 1-4 between 1-3 months

Sample	Acid value (mg NaOH/gm) 1 st month	Acid value (mg NaOH/gm) 2 nd month	Acid value (mg NaOH/gm) 3 rd month
RTC 1	0.63	1.42	2.34
RTC 2	0.82	1.27	2.13
RTC 3	0.79	1.67	2.73
RTC 4	1.23	3.15	4.35

Table 7: Peroxide value of RTC 1-4

Sample	PEROXIDE mEq/1000g
RTC1	3.02
RTC 2	2.02
RTC 3	1.62
RTC 4	2.03

Cost comparison

On calculating the cost of RTC mixes fulfilling a day's requirement it was found out that the cost for RTC 1-4 was between INR 28.3 to INR 42.7 per day for breastfed and non-breastfed infants.

Development of manual and videos

Development of manual and videos was carried out in order to explain mothers about complementary feeding and also how to use RTC mixes.

Summary and conclusion

These RTC mixes provide a sustainable option to meet dietary diversity along with nutrient requirements of children aged 6-23 months using locally-available foods and thus is a cost-effective sustainable approach. Scaling up of these mixes can be carried out under incubation centres for providing environment friendly sustainable nutrition to children in order to eradicate malnutrition amongst them.

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