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Lavanya Nallasamy
Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Usha Singh
Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Correspondence
Lavanya Nallasamy
Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Development and evaluation of ready to use instant food mixes for infants and young children

Lavanya Nallasamy and Usha Singh

Abstract
To meet out the nutritional requirement of infants and young children and to get rid of malnutrition ready to use instant food mixes were developed by using locally available food materials like peanut, ragi, wheat, rice, maize, sugar, milk powder and ghee. The ingredients were processed by appropriate methods like cleaning, germinating, drying, roasting and grinding. The proximate composition of the developed ready to use instant food mixes has been found in the range of 1.43 to 1.68% moisture, 24.50 to 26.55% fat, 2.12 to 2.412% ash, 0.82 to 1.06% fibre, 10.20 to 10.28% protein and 57.50 to 59.00% carbohydrate. Zinc and iron content ranges from 2-4mg and 0.2-4mg per 100g respectively. It was found in all four treatments after 6 months of storage in the range of $1\text{-}2\times10^3$ cfu/ml. All the different combinations of food were extremely liked with overall acceptability score of 7-9 and 3-5.

Keywords: Ready to use instant food mixes infants and young children proximate composition zinc and iron storage and acceptability

Introduction

Nutrition is a science of foods, nutrients and other substances, their action, interaction and balance in relation to health and disease. Malnutrition is an impairment of health due to deficiency, excess or imbalance of nutrients. A state of poor nutrition can be result from insufficient or excessive or unbalanced diet or from inability to absorb nutrients. In India, Uttar Pradesh is the densest state by population. Most of the children are under the age of 5 years are stunted due to malnutrition. In Tamil Nadu, despite high education, the state has a prominent child malnutrition problem. A National Family and Health Survey reveal that, 23 per cent of children show moderately stunted growth. Madhya Pradesh has India's highest number of malnourished children that is 74 per cent of children under the age of 6 years suffer from anaemia whereas 60 per cent children suffer from one or other cause of malnutrition. Next to this, Jharkhand has India's second highest number of malnourished children (56.5 %), followed by Bihar where the prevalence of malnutrition among children is 55.9 per cent (World Bank data, 2015).

The significant risk factors for Moderate Acute Malnutrition (MAM) and Severe Acute Malnutrition (SAM) are inadequate dietary intake, inappropriate feeding, fetal growth restriction, inadequate sanitation, lack of parental education, family size, incomplete vaccination, poverty, economic, political and environmental instability, and emergency situations. (Lenters *et al.*, 2016) [7] Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) are significant public health concerns and disproportionately affect the population in low- and middle- income countries (LMICs). Moderate Acute Malnutrition (MAM) affects 32.8 million children worldwide, 31.8 million of whom reside in LMICs. Severe Acute Malnutrition (SAM) affects 18.7 million children worldwide; 18.5 million of those children reside in LMICs (Black *et al.*, 2013) [3].

To meet out the nutritional requirement and to get rid of different forms of malnutrition, complementary foods need to be included in the diet of infants and young children. Complementary feeding is defined as the provision of food or fluids to infants in addition to breast-milk. Timely introduction of appropriate complementary foods are important to meet the full nutritional and psychological needs of infants and young children. Home prepared foods usually provide a sound foundation for complementary feeding. Hence, the use of such food is encouraged. A good start to complementary feeding is to use a mixture of family foods, with the staple food (rice, wheat, legumes, etc.) as a base. A wide variety of household food can be used (Brown, 1998) [4].

The major cereals and millets consumed in India are rice, wheat, jowar, bajra, and ragi. These grains are the main source of energy in Indian diets as they contribute 70-80 % of daily intake of the majority of Indians. Peanut (*Arachis hypogaea*) is a legume widely grown in India. It contains 26 per cent of protein, 49.5 per cent of lipids, and about 16 per cent of carbohydrates of which 9 per cent is dietary fiber (Khalil & Chunghtai, 1983) [5]. Therefore, peanut is a good source of protein and energy. Peanut protein contains all the essential amino acids that are indispensable for health maintenance, although methionine, lysine, and tryptophan are in a relatively low amount (Kholief, 1987) [6].

Materials and methods

Procurement of food materials

Since ragi, wheat, parboiled rice and maize are the most common cereals and millets in consumption as food by the people in Bihar, the ready to use food mix for the infants and young children had been developed based on these food materials. An amount of 2 kg each from all four cereals/ millets (Ragi, wheat, parboiled rice and maize) had been procured from the local market of Pusa (Samastipur district). First of all, these food materials had been cleaned. After cleaning, a lot of 500 g each from cereals and millet had been kept in triplicate for processing for the development of food products. Hence, there had been a total of 12 lots of 500 g from each of cereals/ millet (Rice, wheat, maize and ragi).

Peanut commonly known as groundnut or *mungphali* had been procured from local Pusa market in the amount of 10 kg and left for cleaning. After cleaning a portions of 800 g were made and kept in 12 lots for its use for the development of cereal/ millet based food product.

Eight kilogram of milk powder, 10 kg of sugar and k kg of ghee had been procured from the local Pusa market and kept at cool and dry place for the preparation of the product.

Processing of food materials

The food materials after getting cleaned have undergone for different processing methods as described in Fig. 1.

Development of ready to use food mixes

The ready to use food mixes were prepared with various combinations using different ingredients. For the development of food products, a standard combination of peanut, sugar, milk powder and ghee had been made in the ratio of 2:3:2.5:1. The food mixes from cereals/

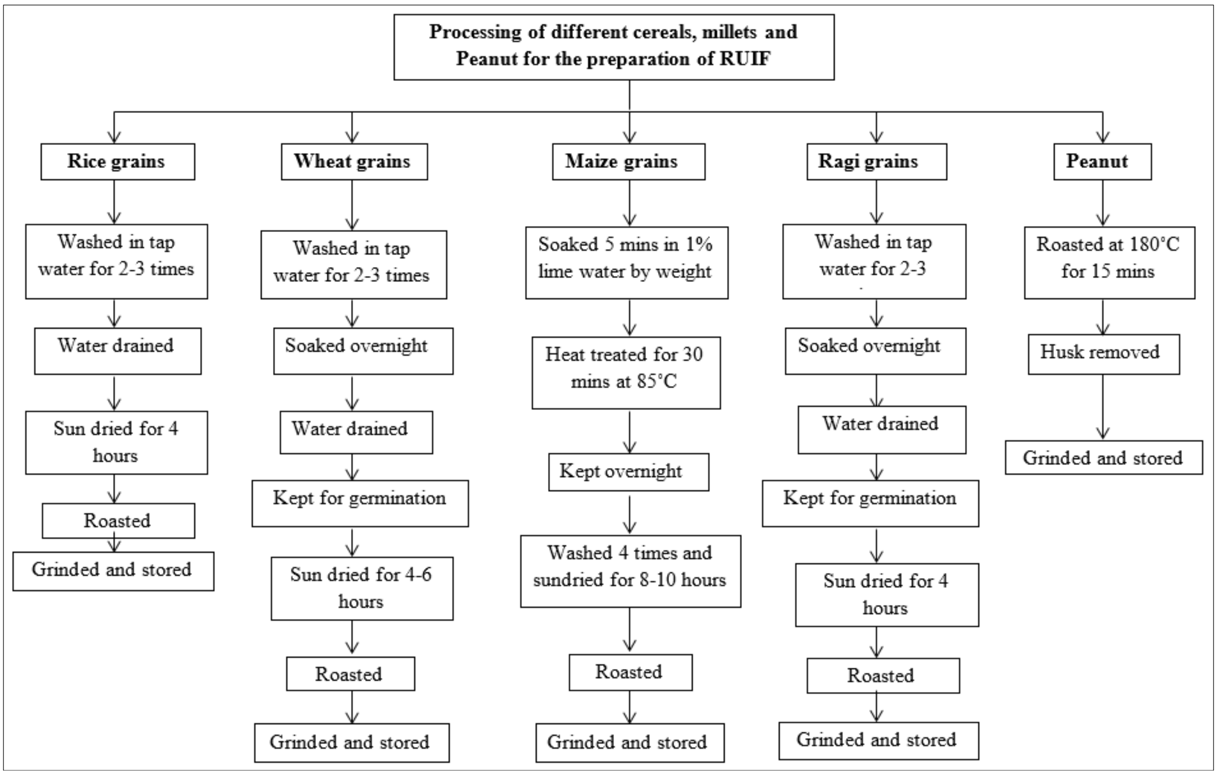

Fig 1: Processing of different cereals, millets and peanut

millets had been developed by taking the standard combination and processed cereals/ millets powder in the ratio of 85:15. The food materials had been properly mixed and kept in triplicate for determination of quality parameters. The prepared food mixes were named as T_1, T_2, T_3 and T_4 for ragi based, wheat based, rice based and maize based food mixes respectively.

Chemical composition

The ready to use instant food mixes have been analysed for bulk density and other parameters such as moisture, ash, fat, fibre and carbohydrate by AOAC method (2000) [2]; Protein content was analysed by Lowry's method; Zinc and iron content was analysed by the method described by Lindsay and Norvell (1978) [8]. As well, the microbial load of the products has been assessed at different period of storage. The products were further evaluated for organoleptic quality for wider acceptability.

Results and discussion

Physico-chemical properties

The bulk density of the developed ready to use instant food mixes has been presented in Table 1. The maize based instant food mix had been found to be highest in bulk density (0.619±0.01), followed by rice based instant food mix (0.590±0.00), ragi based instant food mix (0.583±0.02) and wheat based instant food mix (0.560±0.02). The statistical analysis shows that the difference in bulk density of T_1 & T_2 ('t' value: 1.211), T_1 & T_3 ('t' value: 0.733) and T_2 & T_3 ('t' value: 2.729) were not significant. Whereas rest of the pairs like T_1 & T_4 ('t' value: 3.099) and T_3 & T_4 ('t' value: 3.859) were significant at 1 per cent level of probability, followed by T_2 & T_4 ('t' value: 4.613) which was significant at 5 per cent level of probability.

Table 1: Bulk density of the ready to use instant food mixes

Instant food mixes	Treatments	Bulk density (g/cc) Mean±SD
Ragi based food	T_1	0.583±0.02
Wheat based food	T_2	0.560±0.02
Rice based food	T_3	0.590±0.00
Maize based food	T_4	0.619±0.01
"t" value among different treatments		
T_1 * T_2		1.211^{NS}
T_1 * T_3		0.733^{NS}
T_1 * T_4		3.099*
T_2 * T_3		2.729^{NS}
T_2 * T_4		4.613**
T_3 * T_4		3.859*

Each value is the mean of six observations
^{NS}Not significant
*Significant at 5% level of probability
**Significant at 1% level of probability

It can be concluded that bulk density of maize based infant food mix shows significant difference with other treatments

Chemical composition

Table 2 shows the proximate composition (moisture, fat, protein, ash, carbohydrate and fiber) and micro-nutrient contents (Zinc and iron) of the developed ready to use instant food mixes which reveals that the moisture content of rice based food (1.72±0.023) was higher than ragi based food (1.68±0.089), maize based food (1.44±0.085) and wheat based food (1.43±0.044). When compared statistically, significant difference was found with T_2 ('t' value: 7.600) and T_4 ('t' value: 4.538) at 5 per cent level of probability. This is in line with the study conducted by Sabanis and Tzia (2007) [11] in which the moisture content of wheat flour was higher while compared to other flour like soy flour, corn flour and rice flour due to their moisture content was significantly lower than wheat flour.

Table 2: Proximate composition and micro-nutrient contents of ready to use instant food mixes

		Parameters (g/100g)						Parameters (mg/100g)	
Ready to Use Food	Treatments	Moisture Mean±SD	Fat Mean±SD	Ash Mean±SD	Fibre Mean±SD	Protein Mean±SD	Carbohydrate Mean±SD	Zinc Mean±SD	Iron Mean±SD
Ragi based food	T_1	1.68±0.089	24.50±0.683	2.42±0.125	1.06±0.035	11.80±0.396	58.50±0.872	3.84±0.145	2.90±0.070
Wheat based food	T_2	1.43±0.044	26.55±0.541	2.23±0.057	0.96±0.020	11.33±0.085	57.50±0.872	3.56±0.148	3.65±0.174
Rice based food	T_3	1.72±0.023	26.28±0.464	2.12±0.100	0.96±0.025	10.20±0.225	59.00±0.520	3.30±0.126	0.20±0.012
Maize based food	T_4	1.44±0.085	25.48±0.730	2.24±0.055	0.82±0.021	12.28±0.374	57.50±0.769	2.20±0.117	1.90±0.067
"t" value among different treatments									
T_1 * T_2		3.670^{NS}	7.715*	3.970^{NS}	3.250^{NS}	2.536^{NS}	1.146^{NS}	4.924*	5.369*
T_1* T_3		0.911^{NS}	3.026^{NS}	2.340^{NS}	3.273^{NS}	16.000**	1.055^{NS}	3.473^{NS}	70.149**
T_1 * T_4		2.622^{NS}	1.548^{NS}	1.721^{NS}	7.856*	1.146^{NS}	1.226^{NS}	68.089**	14.320**
T_2* T_3		7.660*	0.473^{NS}	1.361^{NS}	0.277^{NS}	13.000**	3.328^{NS}	1.786^{NS}	32.814**
T_2* T_4		0.335^{NS}	3.061^{NS}	0.171^{NS}	15.497**	3.585^{NS}	0.000^{NS}	35.291**	17.721**
T_3* T_4		4.538*	1.987^{NS}	4.536*	7.000*	6.313*	3.616^{NS}	7.888*	48.407**

Each value is the mean of six observations
^{NS} Not significant
* Significant at 5% level of probability
** Significant at 1% level of probability

Fat content has been found highest in wheat based food (26.55±0.541) when compared to rice based food (26.28±0.464), maize based food (25.48±0.730) and ragi based food (24.50±0.683). But the significant difference was observed only between T_1 & T_2 ('t' value: 7.715) at 5 per cent level of probability. The highest ash content among four treatments has been found in ragi based food (2.42±0.125), which was higher than maize based food (2.24±0.055), wheat based food (2.23±0.057) and rice based food (2.12±0.100). But the difference was not statistically significant with each other except T_3 & T_4 ('t' value: 4.536) which was significant at 5 per cent level of probability. It is in line with the study conducted by Sabanis and Tzia (2007) [11] in which the ash content of the blends like wheat flour with rice flour or corn flour or soy flour was increased due to the significantly higher mineral content of all the non-wheat flours compared to bread wheat flour and durum wheat flour.

In case of fibre, it was has been found higher in ragi based food (1.06±0.035) than wheat based food (0.96±0.020), rice based food (0.96±0.025) and maize based food (0.82±0.021). The fibre content of ragi was found highest due to the coarse grain nature. However maize is also belonged to coarse grain but which shows lower fibre content, it may be because of removal of outer layer after roasting by rubbing between hands. The Statistical analysis also shows that T_1 and T_4 have been significant ('t' value: 7.856) at 5 per cent level of probability, T_2 & T_4 have been significant ('t' value: 15.497) at 1 per cent level of probability and T_3 & T_4 has been significant ('t' value: 7.000) at 5 per cent level of probability. Other combinations were not statistically significant with each other. Protein content has been found more in maize based food (12.28±0.374) when compared to ragi based food (11.80±0.396), wheat based food (11.33±0.085) and rice based food (10.20±0.225). The statistical analysis also shows that the difference in protein content of T_1 & T_3 has been found significant ('t' value: 16.000) at 1 per cent level of probability, T_2 & T_3 also shows significance ('t' value: 13.000) at 1 per cent level of probability. And T_3 & T_4 has been found significant ('t' value: 6.313) at 5 per cent level of probability while T_1 with T_2 and T_4 has been found not statistically significant and T_2 & T_4 also not statistically significant. In case of carbohydrate content the highest amount has been found in rice based food (59.00±0.520) while compared to ragi based food (58.50±0.872), wheat based food (57.50±0.872) and maize based food (57.50±0.769). But the statistical analysis shows that difference has been not statistically significant between each other. In case of zinc content, it has been found highest in ragi based food (3.84±0.145), followed by wheat based food (3.56±0.148), rice based food (3.30±0.126) and maize based food (2.20±0.117). When analysed statistically, significant difference has been found between T_1 & T_4 ('t' value: 68.089) and T_2 & T_4 ('t' value: 35.291) at 1 per cent level of probability. A statistically significant difference was observed between T_1 & T_2 ('t' value: 4.924) and T_3 & T_4 ('t' value: 7.888) at 5 per cent level of probability. The difference was not statistically significant between T_1 & T_3 and T_2 & T_3.

The iron and zinc content of the developed ready to use infant food has been presented in Table 2. The iron content has been found highest in wheat based food (3.65±0.174), followed by ragi based food (2.90±0.070), maize based food (1.90±0.067) and rice based food (0.20±0.012). The statistical analysis also shows that the difference between iron content of each treatment was statistically significant at 1 per cent level of probability except T_1 & T_2 which was found significant ('t' value: 5.369) at 5 per cent level of probability.

From the above findings it can be concluded that rice based food has been found highest in carbohydrate and moisture content, while wheat based food was highest in fat and iron content, ragi based food was highest in ash, fibre and zinc content and maize based food was highest in protein content.

Energy content of the developed product:

The energy content of the developed ready to use instant food has been presented in Table 3. It is evident from Table 3 that energy content of wheat based food shows highest kcal (514.27 kcal/100g) as compared to rice based food (513.32 kcal/100g), maize based food (508.44 kcal/100g) and ragi based food (501.70 kcal/100g). However the energy content of all four treatments was more than 500 kcal/100g, which was found to be highly significant to meet the energy needs of the infants and young children.

Table 3: Energy content of ready to use instant food mixes

Ready to Use Food		Treatments	Energy content(kcal)
A.	Ragi based food	T_1	501.70
B.	Wheat based food	T_2	514.27
C.	Rice based food	T_3	513.32
D.	Maize based food	T_4	508.44

Note: The Atwater General Factor System (Protein – 4.0 kcal/g, Carbohydrate – 4.0 kcal/g, Fat – 9.0 kcal/g)

Determination of storability

The developed food has been found safe for consumption till five months from the date of production. The amount of different microbial load has been found NIL in all samples upto fifth month. At 6 months, in some samples, appearance of fungi was observed. It was found in all four treatments after 6 months of storage with T_1 (1×10^3 cfu/ml), T_2 (2×10^3 cfu/ml), T_3 (2×10^3 cfu/ml) and T_4 (1×10^3 cfu/ml).

Organoleptic quality of the developed product

The organoleptic scores of Ready to Use Infant Food (9 point hedonic rating scale) has been presented in Table 5.

Perusal of the Table 5 reveals that, all the different combinations of food was extremely liked with 8.81±0.162, 8.74±0.185 and 8.40±0.163 wise wheat based, maize based and rice based food except ragi based food which was liked very much with overall acceptability score of 7.81±0.244 in hedonic 9-point rating scale.

Table 5: Organoleptic scores of ready to use instant food mixes (9 point hedonic rating scale)

Parameters		T1 Mean±SD	T2 Mean±SD	T3 Mean±SD	T4 Mean±SD
A.	Colour	7.95±0.649	8.92±0.279	8.50±0.504	8.82±0.390
B.	Appearance	7.88±0.524	8.82±0.390	8.10±0.303	8.77±0.427
C.	Flavour	7.56±0.537	8.88±0.324	8.92±0.279	8.78±0.415
D.	Texture	7.63±0.486	8.68±0.469	8.17±0.376	8.65±0.481
E.	Taste	8.05±0.649	8.75±0.437	8.33±0.475	8.68±0.469
F.	Overall acceptability	7.81±0.244	8.81±0.162	8.40±0.163	8.74±0.185

Acceptability of the developed product among infants and young children

Table 6 shows the acceptability quality of Ready to Use Infant Food among infants and young children (The incredible 5 point facial expression scale).

It can be observed in Table 6, it has been found that all the different combinations of developed ready to use infant foods were accepted by the infants and young children. Wheat based and maize based foods have been extremely liked by the respondents with the scores of4.77±0.424 and 4.58±0.497 respectively, while rice based and ragi based food were moderately accepted with scores of 4.23±0.427 and 3.80±0.576 respectively.

Table 6: Acceptability quality of ready to use instant food mixes among infants and young children (The incredible 5 point facial expression scale)

Parameters		T_1	T_2	T_3	T_4
A.	Score	3.80±0.576	4.77±0.427	4.23±0.427	4.58±0.497
B.	Facial expression				

Conclusion

No doubt, the liking of wheat based instant food mixes was very high. But all other food combinations were liked very much. Hence all of these four combinations are recommended to be used by the infants and young children developing on the availability and food habits of other members in the family.

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