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Formulation and Preparation of Nutrifuse Supplement for Mother and Child

Research Article

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Abstract

Supplementary foods are special formulations in ready-to-eat or milled form, beyond normal ration of home diets with modified energy, protein, fat or micronutrient content. It helps to improve nutritional status or prevent nutritional detoriation of the food insecure vulnerable population, people suffering from diseases, cope up with long and short term food shortage, improve school performance etc. Integrated Child Development Services Scheme among multidimensional services provide supplementary foods with an aim to meet the gap of 1/3rd of total calories as well as ½ of the protein requirements for children below 6 years, pregnant, lactating women and adolescent girls. The study was focused with interest to prepare suitable Nutrifuse supplement powders of low and moderate cost i.e two gluten based and two gluten free (gluten sensitivity) for pregnant, lactating women, children up to 6 years of age in the weaker sections of the society ranging from Rs 14.92 to Rs29.3 /100g. The supplements developed were good source of protein (10.42 g to 13.96 g), fat (11.32to 20.44 g) and calcium (3.32 to 6 g) per 100g with overall acceptability score between 6.9 to 7.4.Thus the 4 formulations of Nutrifuse supplement can be given as supplementary foods and can be used in future product development process.

Keywords: Almonds; Bengal gram; Groundnuts; Nutrifuse supplements; Ragi; Semolina; Soyabean

Introduction

Industrialization, urbanization and rapid rise in number of working women in recent years has led to a drastic change in the growth of the convenience foods in terms of quality and quantity, products available in the market, the packaging and the processing technologies involved. Convenience foods in the market vary from ready-to-eat dry products, frozen foods, various mixes, snacks [1]. Nutrimix powder is an instant type of food that helps to achieve recommended nutrient requirement of the people with busy lifestyle in diverse age groups. Nutrimix is a complete energy, protein, mineral, vitamin and fibre rich supplement that can properly balance the nutrient levels thereby helping to support normal blood composition, immune function and overall performance [2]. Government of India has launched and implemented various schemes to combat malnutrition but India being a developing country, malnutrition pose serious problems among pregnant women, lactating women, children and adolescents. Illiteracy, low socio economic status in addition to multiple child births, early marriage combined with adolescent pregnancy, reluctance for IFA tablets, deworming tablets, lack of kitchen garden practices, depriving the infants from colostrum, poor complementary feeding practices, poor hygiene practices, are responsible for under nutrition of the above-mentioned age groups specially stunting, followed by underweight and wasting in children. Nutrimix yields 16.66% of Protein, 11.70% of Fibre, 13.13% of Fat, 63.71% of Carbohydrates and 6.99% of Moisture [2]. Proximate analysis of Sarbottam pitho showed that the content of protein, fat, carbohydrate, crude fiber and total ash were 12.73%, 9.30%, 69.23%, 2.61% and 2.89% respectively [3]. Calcium-rich Nutrimix flour has Moisture (7.7±0.2%), Calcium (398.2±0.89 mg), Iron (4.8±0.14 mg), Protein (16.4±0.99%), Carbohydrates (65.6±0.22 g), Energy Value (389.29±1.24 Kcal), Crude Fat (6.80±36%) and Crude fibre (2.04±0.30%) [4]. Pearl millet based weaning foods contains moisture of 3.73±0.02%, protein, fat, carbohydrate, ash and crude fiber of 15.32±0.06%, 1.96±0.07%, 79.58±0.06 %, 2.02±0.02 % and 1.12±0.10% and iron, vitamin A and ß-Carotene content of the final

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product are 15mg, 393μg and 30.62µg per 100g respectively [5]. Nutrimix supplement has protein content 28%, fibre 14%, fat 3%, starch 43% and moisture 12% [6]. The Nutri- mix supplementation for 90 days has helped to improve wasting status of children of 9-36 months of age [7].

The study was aimed with interest to prepare supplementary food for socioeconomically underprivileged community. Proximal and sensory characteristics evaluation was also the focus of the present study.

Materials & Methods

Sample collection and formula development

Raw ingredients were purchased from Ballygunj market of Kolkata, India and 4 different types of formula were developed by roasting depending on allergic sensitivity (gluten sensitivity) to different foods and for better nutrition and affordability of the target audience.

Name of formula	Cereals and millets		Pulse		Nuts and oilseeds	
	Name	Amount (g)	Name	Amount (g)	Name	Amount (g)
Formula 1	Semolina	25	Bengal gram whole roasted and dehulled	45	Groundnuts	30
Formula 2	Whole wheat	30	Bengal gram whole roasted and dehulled	40	Flax seeds (roasted)	10
					Pumpkin seeds	20
Formula 3	Rice parboiled	35	Green gram whole	25	Groundnuts	10
			Soyabean	30		
Formula 4	Ragi	15	Bengalgram whole roasted and dehulled	20	Almonds	10
	Rice Parboiled	25	Soyabean	30		

- Formula 1- Low Cost Gluten Based Formula
- Formula 2 - Moderate Cost Gluten Based Formula
- Formula 3- Low Cost Gluten Free Formula
- Formula 4 - Moderate Cost Gluten Free Formula

Proximate analysis

Determination of Moisture Content

10g of sample was used for determination of moisture content. Oven drying method was used for this purpose [8].

Moisture (%) = Weight of sample – (Weight of petridish after drying - Weight of petri dish)/Weight of sample X 100

Determination of Ash Content

5 g of sample was used for determination of ash content. Muffle furnace was used for ashing the samples [8].

% Ash (Dry basis) = Weight after ashing/ Weight before ashing X 100

Determination of Carbohydrate Content

Total carbohydrate content of the samples was measured by Anthrone method [9]. During sample preparation, the supernatant of the sample solutions after centrifugation at 3000 rpm were 40 times serial diluted and from it 0.5ml and 1 ml collected and distilled water was added for volume make up to 1ml and this aliquot was used for the analysis.

Determination of Total Protein Content

Total protein content of the samples was measured using Kjeldahl method [10]. For this purpose 50 g of the 4 sample mixes were weighed and sent for laboratory testing.

Determination of Total Fat Content

Total fat content of the moisture free samples were estimated using Soxhlet extraction method [11].

Determination of Micronutrient Content

Determination of Vitamin C Content

Estimation of Vitamin C was done by 2,6 Dichlorophenol indophenols (DCIP) dye titration method [12]. 5g sample dissolved in 50ml (3% Metaphosphoric acid) and the solution filtered in a conical flask through funnel with the help of muslin cloth. 10ml filtrate transferred to 100 ml conical flask. To it equal volume of distilled water added, titration done with dyestuff until pink colour appeared which was stable for 15 seconds.

Determination of Total Carotenoids

Total carotenoids measured by spectrophotometry [13,14]. Homogenized sample after centrifugation were collected in volumetric flask after being filtered through funnel whose mouth was covered with glass wool.

Chlorophyll a = 11.75 X A_{662} - 2.35 X A_{645}

Chlorophyll b = 18.61 X A_{645} - 3.96 X A_{662}

Total Carotenoids (ug/ml) = 1000 X A_{470} - 2.27 X Chlorophyll a – 81.4 X Chlorophyll b/ 227

Determination of Calcium Content

Calcium content of the samples was measured using EDTA Titrimetric method [15].

Determination of Iron Content

Iron was estimated by Thiocyanate method [16].

Sensory analysis

Sensory evaluation was done using 9 point Hedonic scale. Formula 1, Formula 2, Formula 3, Formula 4 (Marked with random alphabets (A,B,C,D). Samples introduced once in front of 10 sensory panel members and were asked to give scores to each sample on the basis of colour, smell, texture, taste, after taste, overall quality. There was intake of drinking water between 2 consecutive samples.

9 Point Hedonic scale	Points
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

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Product development

Using the best formula two sweet items was prepared. Required amount of formula mix was added to 2 tablespoon of oil and stirred till a baking flavor developed. To this equal quantity of sugar/ jaggery was added and mixed properly. Milk powder and powdered coconut were added to enhance the taste. Water was added further and a thick consistency was prepared. Appropriate shapes were made which were suitable for preparing laddus and barfis. For laddu preparation sugar was used and for barfi jaggery was used.

Results & Discussion

Proximate Analysis

Moisture Content

High moisture content of Formula 2 revealed that it had the least shelf life among the others. Moisture content of Formula 4 was almost similar to that of nutrimix powder with oats flour, soybean powder, ragi, chia seeds, jaggery. It is 6.99±4.27% [2]. Nutrimix with Finger Millet, Semolina, Green Gram, Amaranth Seeds and Gingelly Seeds has greater moisture content 7.7±0.2% in comparison to Formula 1 [4]. Total bacterial and fungal count of the formulas were within the safer limits for at least 30 days as they were kept in airtight packages and were stored properly.

Name Of Nutrifuse Formula	Moisture Content %
Formula 1	5.2
Formula 2	8
Formula 3	6.65
Formula 4	6.74

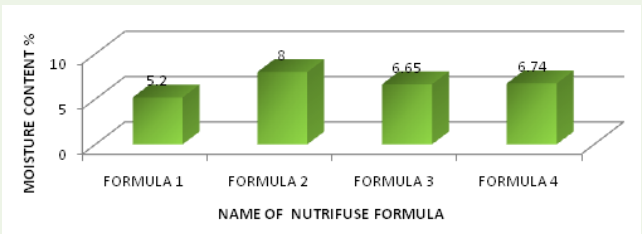

Figure 1: Moisture Content of the Nutrifuse Supplements

Ash Content

Ash content of the formulas indicated the concentration of minerals present in them. Ash content of formula 4 was almost similar to nutrimix powder made from finger millet, green gram, bengal gram, groundnuts which is 2.85 + 0.05 g [17]. Nutrimix with Finger Millet, Semolina, Green Gram, Amaranth Seeds and Gingelly Seeds has lesser Ash content 2.4±0.34% than that of Formula1[4].

Name Of Nutrifuse Formula	Ash Content %
Formula 1	2.6
Formula 2	3.9
Formula 3	3
Formula 4	2.98

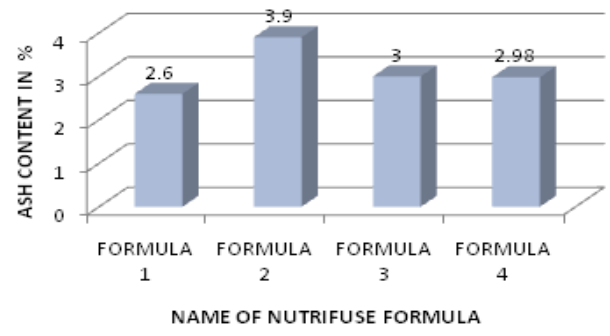

Figure 2: Ash Content of the Nutrifuse Supplements.

Carbohydrate content

Carbohydrate content of Formula 3 was highest followed by Formula 4 while the lower carbohydrate content of the other two formulas might be due to manual error in the experiment. Carbohydrate content of Formula 4 was much less than carbohydrate content of nutrimix powder with oats flour, soybean powder, ragi and chia seeds, jaggery which is 63.71±27.53% [2]. Carbohydrate content of Formula 1 was much lesser than nutrimix powder from finger millet, green gram, bengal gram , groundnuts which is 69.82 + 2.29g [17].

Name of Sample Nutrifuse Formula	Carbohydrate Content %
Formula 1	2.8
Formula 2	9.6
Formula 3	43.2
Formula 4	18

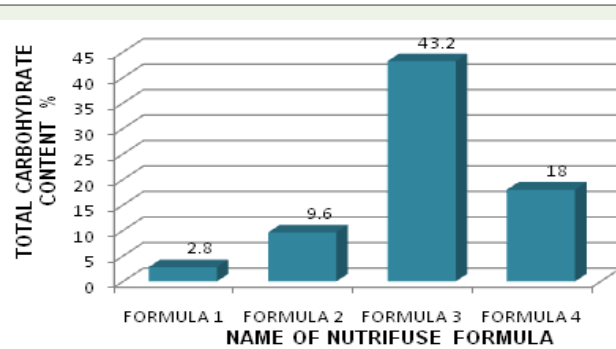

Figure 3: Total Carbohydrate Content of the Nutrifuse Supplements.

Total Protein Content

Formula 1 had the highest protein content among the 4 formulas, was slightly lesser than Protein of Nutrimix with Finger Millet, Semolin, Green Gram, Amaranth Seeds and Gingelly Seeds which is16.4±0.99% [4]. Formula 4 had the least protein content but the

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quality of protein was better due to presence of well balanced amino acids in ragi and soyabean. It was lesser than nutrimix powder made from finger millet, green gram, bengal gram, groundnuts which is 15.03 + 1.40 g [17].

Name of Nutrifuse Formula	Protein Content %
Formula 1	13.96
Formula 2	13.87
Formula 3	12.32
Formula 4	10.42

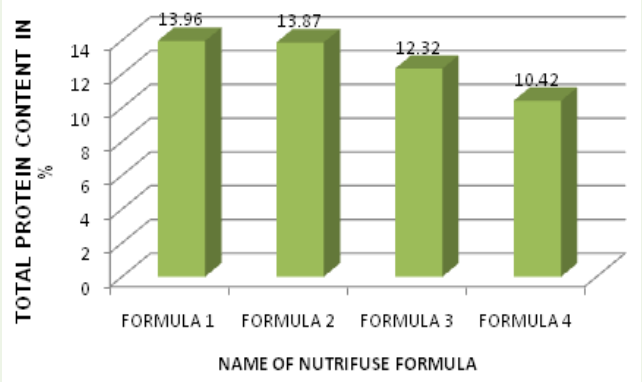

Figure 4: Total Protein Content of the Nutrifuse Supplements.

Total fat content

Total fat content of Formula 4 was highest due to presence of almonds. Fat content of Formula 4 was greater than Fat of nutrimix powder with oats flour, soybean powder, ragi and chia seeds, jaggery which is 13.13% [2]. Formula 1 had higher fat content than nutrimix made from finger millet, green gram, bengal gram, groundnuts which is3.68 + 0.25g [17].

Name of Nutrifuse Formula	Total Fat Content %
Formula 1	11.32
Formula 2	16.21
Formula3	17
Formula 4	20.44

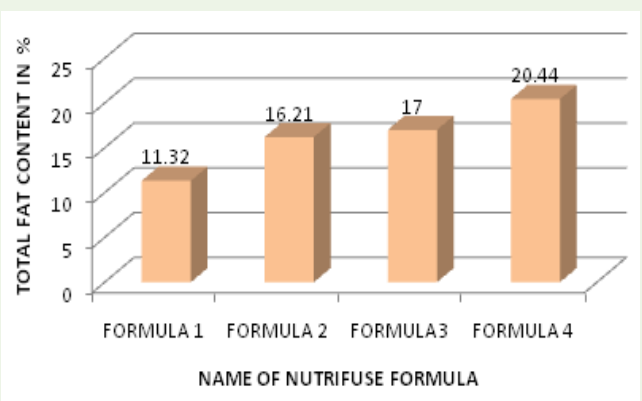

Figure 5: Total Fat Content of the Nutrifuse Supplements.

Determination of Micronutrient Content

Vitamin content

Vitamin C content of the samples depends upon the rate of oxidation of Vitamin C present in the samples. Vitamin C content of the Formula 1 was the highest among the others.

Name of Nutrifuse Formula	Vitamin Content mg/100 g
Formula1	0.012
Formula 2	0.01
Formula 3	0.009
Formula 4	0.008

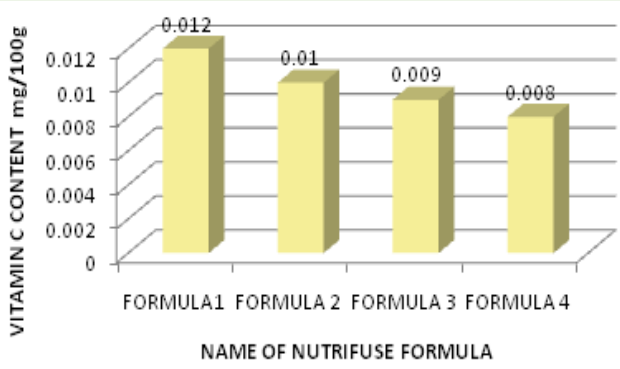

Figure 6: Vitamin C Content of the Nutrifuse Supplements.

Total carotenoids

Total Carotenoids content of Formula 1 and Formula 4 were higher than Vitamin A content of nutrimix powder made from finger millet, green gram, bengal gram, groundnuts which is15.82 ± 0.59

Name of Nutrifuse Formula	Total Carotenoid Content ug/100 g
Formula 1	288
Formula 2	0
Formula 3	220
Formula 4	275

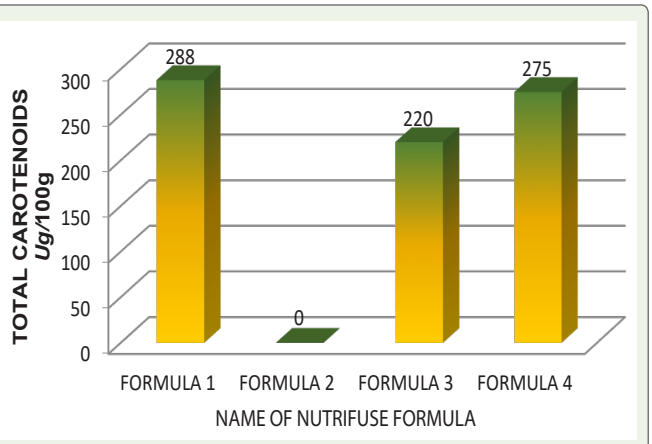

Figure 7: Total Carotenoids Content of the Nutrifuse Supplements.

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(μg) [17].

Calcium content

Calcium content of Formula 4 was higher than of nutrimix powder made from finger millet, green gram, bengal gram, groundnuts which is 284.78 ± 2.20 mg [17]. Calcium content of Formula 1 was higher than Nutrimix with Finger Millet, Semolina, Green Gram, Amaranth Seeds and Gingelly Seeds which is 398.2±0.89 mg [4].

Name of Nutrifuse Formula	Calcium Content %
Formula1	3.32
Formula 2	6
Formula 3	3.6
Formula 4	3.62

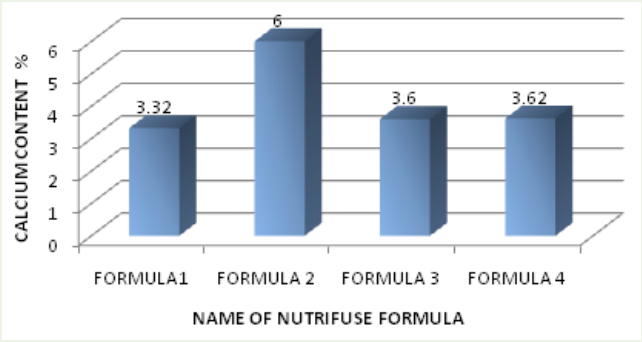

Figure 8: Calcium Content of the Nutrifuse Supplements.

Iron content

Iron content of the samples was much below than the expected level. It might be due to presence of interfering factors which gave false results during the experiment. Iron content of nutrimix powder 4.8±0.14 mg with Finger Millet, Semolina, Green Gram, Amaranth Seeds and Gingelly Seeds is higher than that of Formula 1 [4]. Likewise iron content of nutrimix powder made from finger millet, green gram, bengal gram, groundnuts has iron content of 4.39 ± 0.43 mg much higher than Formula 4 [17].

Name of Nutrifuse Formula	Iron Content mg/100g
Formula1	0.004
Formula 2	0.006
Formula 3	0.01
Formula 4	0.007

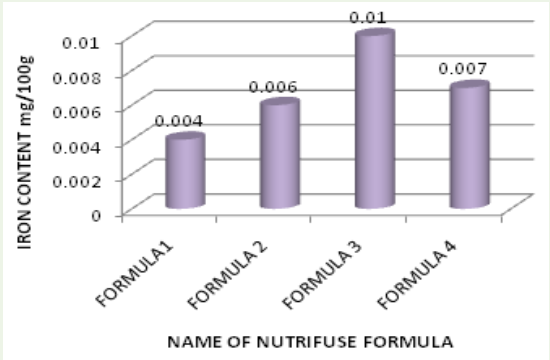

Figure 9: Iron Content of the Nutrifuse Supplements.

Sensory characteristics

Among the 4 formulas mean scores of sensory attributes were obtained from average scores given by 10 panelists. Colour score of Formula 1 was highest followed by Formula 3,2 and 4. Scores regarding Smell of Formula 4 was highest followed by Formula 1, Formula 2 whereas Formula 3 scored the least. Score regarding Texture of Formula 1 was highest followed by Formula 4, 3 and Formula 2 scored the least. Scores of Taste of Formula 4 highest followed by Formula 1 and equal score of Formula 2 and 3. Scores of after taste of Formula 4 was highest followed by followed by equal score of Formula 1 and 2 whereas Formula 3 scored the least. In overall quality Formula 4 ranked the highest followed by Formula 1, 3 whereas the score for Formula 2 was the least.

Sensory Attributes	MEAN SCORE OF SENSORY ATTRIBUTES			
	SAMPLE-A	SAMPLE-B	SAMPLE-C	SAMPLE-D
Colour	8.2	7.6	7.8	7.3
Smell	7.2	6.9	6.8	7.4
Texture	7.6	6.4	6.7	7.2
Taste	6.8	6.2	6.2	7.4
After taste	6	6	5.9	6.8
Overall quality	7.2	6.9	7.1	7.4

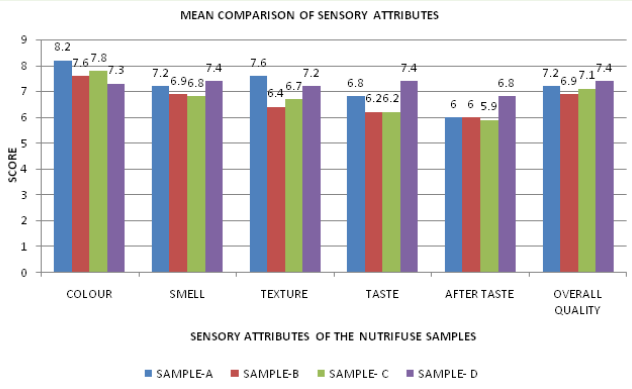

Figure 10: Sensory Attributes of the Nutrifuse Supplements.
Sample A = Formula 1
Sample B = Formula 2
Sample C = Formula 3
Sample D = Formula 4

Thus the best formula among the 4wasFormula 4 or moderate cost gluten free formula due to greater score in overall quality. Formula 1 or low cost gluten based formula was ranked after it.

Cost Analysis

The cost of the formulas was calculated according to the quantity of ingredients used in 100 g mixture for the specific formulas. Cost effectiveness of Formula 3 or low cost gluten free formula is greater (Rs 14.92/100 g) than Formula 1or low cost gluten based formula (Rs16.1/100g). Similarly cost effectiveness of Formula 4 or moderate cost gluten free formula is greater (Rs23.59/100g) than that of

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Formula 2 (Rs29.3/100 g) or moderate cost gluten based formula.

Developed product

The sweets like laddus and barfis developed from the best formula or formula 4 had good colour, shape, texture and were appealing to the eyes. The taste of the developed products was accepted by pregnant, lactating women as well as children. The products developed had a good after taste. So the products were nutritious as well as palatable and they gained psychological acceptance. Apart from that addition of jaggery to the barfis had enhanced the energy as well as iron content of the diet.

Discussion

Complementary foods are unique preparations in ready-to-eat or milled form that go beyond and beyond the typical home diets' serving sizes and have altered calorie, protein, fat, and micronutrient contents. Socioeconomically underprivileged community was targeted for better nutrition. Nutritionally, Formula 4 consists of Parboiled rice, Ragi, Soya bean, Bengal gram, Almonds. On the other hand, Formula 1 was prepared using different components from the food group composed of Semolina, Bengal gram and Groundnuts. From the view point of macronutrient content, it is slightly lower in quantity but the quality is better due to presence of well-balanced polysaccharides and amino acids required for the growth. Micronutrient content especially iron and calcium of the prepared Formula indicates that it will be a good source for bone and brain development of the target group. Due to the presence of groundnut in Formula 1, it could be a good source for Zinc supplementation required for brain development of preschool and school going children. Both the formulae could be a good source for Vitamin A supplement as the presence of Total Carotenoids is higher than the products that are available in the market. The shelf life of both the Formulae is better than that of other supplementary powders available in the market due to their less moisture content.

Conclusion

The best formula mix is Moderate cost gluten free formula. It includes parboiled rice which is a good source of energy, carbohydrate, B vitamins. The protein in ragi is well balanced, and content of lysine, methionine, threonine, and valine is more. Soya bean and Bengal gram are good source of essential nutrients especially protein, dietary fiber, iron, manganese, phosphorus and several B vitamins, including folate. Almond is nutrient dense with rich source of vitaminE, calcium, copper, iron, magnesium, manganese, phosphorus, and zinc, moderate source of B vitamins thiamine, vitamin B_6, and folate, choline, and potassium, substantial dietary fiber, the monounsaturated fat, oleic acid, and the polyunsaturated fat, linoleic acid. Although the gluten free formulas are meant for people with gluten sensitivity it is not suitable for people having allergy to soy protein, Almonds, Groundnuts. Thus, soyabean can be replaced with Bengal gram, green gram or a mixture in suitable ratios. Groundnuts and almonds can be replaced with sesame seeds and flax seeds. Although Formula 4 is the most suitable formula but the cost of preparing the mix is much higher. Thus Formula 1 or Low-costgluten-based formula consisting of semolina, bengal gram, groundnuts are also source of ample quality of nutrients and thus also can serve as suitable supplement powder keeping in mind for the affordability of the target audience.

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