

Development and Evaluation of Health Mixes to Improve Bone Health



Food Science

KEYWORDS: Food formulation, health mixes, acceptability tests, nutrient analysis, microbial analysis, shelf life.

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ABSTRACT

Development of food formulations using low cost, locally accessible indigenous foods is recognizable and is one of the strategies established to be effective in improving the health status of the community. Dietary supplements in different forms combined with normal food intake have shown earlier an improvement in bone health and the targeted nutrients are made available for body synthesis.

The present study found out that the developed basic health mix and combinations were highly acceptable and through analysis of various nutrients was found to be nutritious. The health mixes were found to be microbiologically safe. The cost of the health mixes were also found to be inexpensive and suitable for regular consumption.

Introduction

Supplementation of food formulation is one of the most effective ways of improving health status and also for combating malnutrition especially deficiency diseases of some or all the population. Supplementation of cereal based products with millets has become increasingly popular due to nutritional and economic advantages.

Formulation of supplementary foods based on low cost, locally available ingredients familiar to home makers is more promising. Complementary food supplements can be defined as food based mixes that can be consumed in addition to the diet to increase the nutritional value. Complementary food supplements are equivalent to food fortification in the sense that they increase the intake of essential nutrients from food (Nestel *et al.*, 2003).

Development of formulations using low cost, locally accessible foods recognizable to the community especially women, has been one of the strategies confirmed to be effective in improving the health status of the community (Sherleker and Udipi, 2006). Food mixes are developed with the idea to supply nutritionally high biological value protein and also to utilize as concentrated source of specific nutrients. Health mix prepared from millets is considered as a healthy food and compositionally it has immense protein, low fat and high fiber (Ramasri *et al.*, 2014).

Dietary supplements combined with normal food intake have shown improvement in bone health and they are prepared so that the targeted nutrients are made available for body synthesis. They are given in various forms like health mixes, drinks, capsules and recipes etc. The efficient distribution of diet supplement must be followed regularly. The nutrition policy must focus on improvements in usual diet and planning for nutritional supplements if required (Manders, 2006). The present study aimed at development and evaluation of suitable health mixes based on foods for supporting bone health.

Methodology

A. Formulation and Preparation of Health Mixes

An ultimate food for prevention and modification of nutritional inadequacies is supposed to be of high nutritive value, acceptable, readily available at low cost, familiar to the community and have better acceptance both in good health and illness (Swaminathan, 2005). In the present study a basic mix was formulated consisting of ragi flour, soya flour, wheat flour, milk powder, flax seeds and oats. The foods were selected to be rich in calcium,

protein and other components that helps in absorption of calcium.

The selected ingredients namely ragi flour, soya flour, wheat flour, sesame seeds, groundnuts, flax seeds and oats were purchased from local market, cleaned, dried, roasted and powdered separately. Finally all the ingredients were mixed with milk powder and blended well uniformly. Groundnuts and sesame seeds were the variable ingredients in the mixes.

The basic mix and combinations I, II, III and IV were prepared and acceptability tests were done. The composition of the selected ingredients in basic mix and health mix variations is presented in Table I.

TABLE I
COMPOSITION OF INGREDIENTS FOR HEALTH MIX VARIATIONS

Ingredients	Basic mix (90g)	HMC I (100g)	HMC II (100g)	HMC III (100g)	HMC IV (100g)
Ragi flour	50 g	50 g	40 g	50 g	40 g
Soya flour	10 g	10 g	20 g	10 g	20 g
Wheat flour	10 g	10 g	10 g	10 g	10 g
Milk powder	10 g	10 g	10 g	10 g	10 g
Sesame seeds	-	10g	10g	-	-
Oats	5 g	5 g	5 g	5 g	5 g
Flax seeds	5 g	5 g	5 g	5 g	5 g
Groundnuts	-	-	-	10 g	10g
Total	90 g	100 g	100 g	100 g	100 g

HMC - Health Mix Combination

B. Acceptability Testing

Sensory assessment is an essential and finest technique for evaluating novel products which offers quality measure and production control (Vidhya and Narain, 2010). The overall quality of foods may be packed up into uniqueness such as colour, appearance, flavor, taste and texture (Ranganna, 2004).

Accordingly the health mix variations were standardized and evaluated for acceptability using a 9 point hedonic scale by a panel of 20 members. The hedonic rating scale was used for the attributes like colour, appearance, texture, flavour and taste as 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) and Dislike extremely (1).

The most accepted combinations with highest scores were found to be health mix I and II which were selected for supplementation study.

C. Nutrient Analysis of the Health Mixes

The nutrient content of health mix I and II was analysed by standard procedures. Energy was determined by Pearson method (1991), Carbohydrate by AOAC method (2007) and fat and protein by AOAC method (2006). For determination of fiber, calcium, iron, phosphorus, moisture and ash by AOAC method (2005) were used. B vitamins were analysed by AOAC method (2008) and vitamin D by AOAC method (2007). Analysis were done in triplicates and the values were recorded.

D. Microbial Testing of the Health Mixes

Health mixes were evaluated for microbial counts like Total Bacterial Count (TBC) and Total Yeast and Mould Count. Storage was done at room temperature for a period of 3 months. The two health mixes were evaluated for bacterial, yeast and mould counts at the beginning and at the end of 3 months storage and the quality was evaluated.

E. Cost Computation of the health mixes

Cost calculation will help to assess the feasibility of the supplements for preparation at household and commercial level. The cost of the health mixes was computed as per the prevalent market prices of the ingredients at the time of preparation. For calculation of cost, aspects like ingredient cost, preparation, processing and packaging cost were included.

RESULTS AND DISCUSSION

1. Acceptability Scores of the Health Mixes

Costell *et al.*, (2009) stated that the method by which an individual allow or disallow a foodstuff is of multidimensional nature. In a multifaceted food matrix, it is not at all easy to create relationships between the individual chemical stimuli concentration, physiological observation and consumer reaction all the time.

Any food product is to be subjected to sensory evaluation for examining its quality either positively or negatively. The formulated basic health mix and combinations I, II, III and IV were subjected to organoleptic evaluation by a panel of members using the hedonic score card. The mean scores of the developed health mixes are presented in Table II.

TABLE II
MEAN ACCEPTABILITY SCORES OBTAINED BY THE DEVELOPED HEALTH MIXES (Max. Score = 45)

Criteria	Maximum Score	Basic Health Mix	HMC I	HMC II	HMC III	HMC IV
Colour	9	7.9	7.9	7.9	7.7	7.5
Appearance	9	7.7	7.5	7.3	7.0	6.8
Texture	9	8.1	7.2	7.3	7.0	7.0
Taste	9	7.3	7.9	7.7	7.5	7.7
Flavour	9	7.5	7.7	7.5	7.5	7.3
Total Score	45	38.5	38.2	37.7	36.7	36.3

HMC - Health Mix Combination

With regard to the color criteria the basic health mix and combinations I and II scored the maximum score of 7.9 out of 9, followed by health mix combination III and IV with a score of 7.7 and 7.5 respectively. It is observed that with regard to appearance, basic health mix scored the maximum of 7.7 followed by combinations I, II and III scoring 7.5, 7.3 and 7.0 respectively and least score of 6.8 was got by health mix combination IV.

For texture, a maximum score of 8.1 was obtained by basic health mix and a minimum of 7.0 was obtained by the two health mix combinations III and IV with groundnut. Health mix combination I and II with sesame seeds scored 7.2 and 7.3 for

texture and 7.9 and 7.7 for taste. The basic health mix scored only 7.3 and health mix III and IV scored 7.5 and 7.7 for the taste. With reference to flavor a maximum of 7.7 was scored by health mix I followed by basic health mix and combinations II and III with a score of 7.5. A least score of 7.3 was got by health mix IV for flavor. All the combinations and basic mix were good in terms of flavor.

In general, the overall scores of the developed basic and health mix combinations revealed that a maximum score of 38.5 was secured by basic health mix followed by combinations I and II with sesame seeds with a score of 38.2 and 37.7. A minimum score of 36.7 and 36.3 was obtained by combinations III and IV with groundnuts. All the developed health mixes were found to be acceptable based on scores.

2. Nutrient Content of the Health Mixes

Among the developed five health mixes, combinations I and II with sesame seeds were found to be highly suitable with good acceptability scores and hence they were subjected to nutrient analysis along with basic health mix. Table III presents the content of proximate principles in the developed health mixes.

TABLE III
PROXIMATE PRINCIPLES OF THE HEALTH MIXES (100 g)

Proximate Principles	Basic health mix	HMC I	HMC II
Energy (kcal)	336	400	420
Carbohydrate (g)	53	56	51
Protein (g)	13.45	15.00	18.88
Fat (g)	7.68	5.50	5.85
Fibre (g)	2.78	3.07	3.08
Moisture (g)	1.80	1.70	1.63
Ash (g)	3.70	3.96	3.80

HMC - Health Mix Combination

With regard to energy, a maximum of 420 kcal per 100 g was found in health mix combination II followed by health mix combination I with 400 kcal and basic health mix had 336 kcal per 100 g. A highest carbohydrate of 56 g per 100g was found in health mix combination I, followed by basic health mix with 53g and health mix combination II with 51 g per 100 g.

Among the health mixes, it is seen that a highest protein content was found in health mix combination II with 18.88 g and a minimum protein content of 13.45 g per 100 g in basic health mix. The fat content of the health mixes ranged from 5.5 g to 7.68 g per 100 g. With regard to fibre, a maximum of 3.08g and 3.07g per 100 g was found in health mix combinations II and I respectively and basic health mix with 2.78 g per 100 g. The moisture content of the health mixes ranged from 1.63 to 1.8g per 100g suitable for good storage.

With regard to ash content, it is observed that among the health mixes a maximum of 3.96 g of ash per 100 g was found in health mix combination I followed by health mix combination II with 3.80 g and basic health mix with 3.70g in 100g. In general all the three mixes were found to contain good amounts of proximate principles suitable for supplementation programmes.

The mineral and vitamin content of the developed health mixes are presented in Table IV.

TABLE IV
MINERAL AND VITAMIN CONTENT OF THE HEALTH MIXES (100 g)

Content	Basic health mix	HMC I	HMC II
Calcium (mg)	307	455	445
Iron (mg)	3.9	5.0	5.5
Phosphorus (mg)	356	350	330

Vitamin A (mg)	ND	ND	ND
Vitamin B1 (mg)	0.6mg	0.7mg	0.8mg
Vitamin B2 (mg)	0.3mg	0.25mg	0.25mg
Vitamin B3 (mg)	6.6mg	6.8mg	6.6mg
Vitamin B5 (mg)	1.2mg	1.1mg	1.0mg
Vitamin B6 (mg)	0.2mg	0.3mg	0.3mg
Vitamin B9 (mcg)	92mcg	98mcg	97mcg
Vitamin B12 (mg)	ND	ND	ND
Vitamin D (mg)	ND	ND	ND

HMC - Health Mix Combination ND – Not Detected

The minerals namely calcium, iron and phosphorus were analysed in the developed health mixes. With regard to calcium content, it is observed that among the health mixes a maximum of 455 mg of calcium per 100 g was found in health mix combination I followed by health mix combination II with 445 mg and a minimum of 307 mg per 100 g in basic health mix. A maximum iron content of 5.5 mg per 100g was found in health mix combination II, followed by health mix combination I and basic health mix with 5 mg and 3.9 mg per 100 g respectively. The phosphorus content of the health mixes ranged between 330 mg to 356 mg per 100 g with a minimum content in health mix combination II and maximum content in basic health mix.

It is observed that with regard to the vitamin content of the developed mixes, there was not much difference seen among the three mixes. Vitamins namely A, B12 and C were not in the detectable level in the health mixes.

With regard to B-complex vitamins content vitamin B1 (thiamin) ranged from 0.6 to 0.8 mg per cent. Vitamin B2 (riboflavin) content ranged from 0.25 to 0.3 mg per cent and vitamin B3 (niacin) content ranged from 6.6 to 6.8 mg per 100 g. Other vitamins like B5 ranged from 1.0 to 1.2 mg, B6 ranged from 0.2 to 0.3 mg and B9 ranged from 92 to 97mcg per 100 g among the health mixes.

Content of B-complex vitamins in the health mixes was found to be at a nominal level supporting the content of other nutrients in the mixes. In general the health mixes were found to contain good amounts of protein, calcium and phosphorus needed for bone health.

3. Shelf life Study of the Health Mixes

The health mixes were analysed for Total Bacterial Count (TBC), Total yeast and mould count and shelf life storage up to 90 days and the details are presented in Table V.

**TABLE V
MICROBIAL TESTING OF THE SELECTED HEALTH MIXES**

Criteria	Basic mix		HMC I		HMC II	
	Initial 0 day	After 90 days	Initial 0 day	After 90 days	Initial 0 day	After 90 days
Total Bacterial Count (cfu / g)	Abs	Abs	Abs	Abs	Abs	Abs
Yeast Count	Abs	Abs	Abs	Abs	Abs	Abs
Mould Count	Abs	Abs	Abs	Abs	Abs	Abs

HMC - Health Mix Combination Abs - Absent

From the table it is evident that total bacterial count, yeast and mould count of basic mix and health mix I and II at the beginning and over a period of three months were found to be nil highlighting the fact that these mixes were found to be safe for storage. The moisture content of these mixes was very low and hence better storage. Though they could be stored safely for 3 months, the health mixes were prepared once a week freshly and distributed to the osteopenic women.

4. Cost of the Health Mixes

For every food formulation the cost of the product should be considered as well as the nutrient composition.

The cost of the food supplement should be inexpensive and easily accessible to every individual. The cost of the health mixes is presented in Table VI.

**TABLE VI
COST OF THE HEALTH MIXES**

Particulars	Basic Health Mix (Rs.)	HMC I (Rs.)	HMC II (Rs.)
Raw materials	10.50	10.75	11.60
Processing cost	0.50	0.50	0.50
Packing cost	0.50	0.50	0.50
Cost per 100g	11.50	11.75	12.60

HMC - Health Mix Combination

It is found that the cost of all the health mixes including the raw materials, processing and packing charges ranged from Rs.11.50 to Rs.12.60 per 100g which is very reasonable. Among the health mixes, basic health mix priced the least of Rs.11.50 per 100g, followed by health mix combination I with Rs.11.75 per 100g and the maximum cost was for health mix combination II with Rs.12.60 per 100g. The cost of 50 g mix, which is one serving to the selected women ranged from Rs.5.87 to Rs.6.30 which is considered to be very reasonable and inexpensive. The cost of health mixes when compared with other health mixes was very economical and suitable for daily consumption.

CONCLUSION

The present study revealed that the developed basic health mix and combinations were highly acceptable. Basic mix and health mixes I and II with sesame seeds with high acceptability scores were analysed for various nutrients and found to be nutritious. The mixes contained adequate amounts of protein, calcium and phosphorus needed for bone health. The health mixes were analysed for Total Bacterial Count, Total yeast and mould count and found to be absent during the study period and could be stored safely for 3 months. Cost of the health mixes was reasonable and inexpensive compared to other health mixes and suitable for regular consumption.

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