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Formulation and Evaluation of Functional Food Mixes As A Nutritional Approach For Chronic Diseases

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Abstract: ***Increasing awareness among consumers to know which specific molecules present in their food possess disease preventive or curative properties has led to the concept of functional foods. This study was planned to formulate and evaluate health mixes based on functional foods, study the acceptability, nutrient content, anti nutritional factors, shelf life and cost to know their economic viability. Foods like Bengal gram dhal, black gram, carrot, tomato and cauliflower leaves were selected for the formulation of health mixes. Pepper, cumin seeds and red chillies were added to improve the taste and acceptability of food mixes. Basic Health Mix and variation 1 (Amla) was formulated and developed by using the above functional foods. Amla is highly nutritious and is one of the richest sources of vitamin-C, amino acids and minerals suitable for Diabetic patients. Functional food mixes can be effective for treating patients with chronic diseases like, hypertension, diabetes mellitus, arthritis and cardiovascular disease etc.***

Keywords: Functional foods, Health mixes, amla, Vitamin-C

1. Introduction

Functional food is a Natural or processed food that contains known biologically-active compounds which in quantitative and qualitative amounts provides a clinically proven and documented health benefit and thus an important source in the prevention, management and treatment of chronic diseases of the modern age (Danik, 2011). Functional food is any fresh or processed food claimed to have a health-promoting or disease-preventing property beyond the basic function of supply of nutrients. Functional foods offer potential health benefits that could enhance the well-being of consumers and reduce the economic and social costs of treating non-communicable diseases (Das *et al*, 2010). Functional foods include amla, carrot, oats, fatty fish, soy, tomatoes, nuts, grape juice, greens, milk, almond, walnuts, blue berries etc.

Food supplementation is one of the effective ways of improving the health status of adults by means of regulating the blood pressure. Keeping all these points in mind the investigator selected low cost, locally available ingredients and foods familiar to the community to formulate food supplements to manage the disease Diabetes mellitus. Considering all the health benefits of functional food ingredients bengal gram, black gram, carrot, tomato, cauliflower leaves, amla, cumin seeds, pepper and coriander seeds were selected for the development of health mixes.

The present study was carried out with the following objectives

- Formulation and preparation of functional food mixes based on functional foods
- Evaluation of the acceptability, nutrient content and anti nutritional factors of functional food mixes
- Determination of the shelf life and cost of health mixes

2. Materials and Methods

Selection of Functional foods for the development of Functional Food mixes: Bengal gram (channa) dhal is a very important pulse crop that grows as a seed of a plant Cicer Crietinu in the leguminosae family. Channa dhal is good for diabetics because it has low glycemic index which regulates the blood glucose level. Whole black gram is a rich source of protein, fiber, several vitamins and essential minerals such as calcium and iron. Black gram consist of polyphenols and carotenoids which are effective in the prevention of cardiovascular disease, cancer and diabetes (Scalbert *et al.*, 2005). Studies show that diets high in carotenoids are associated with a lower risk of heart disease and regular consumption of carrots reduces LDL cholesterol levels. Soluble fiber in carrots can help lower blood cholesterol levels by binding with and removing bile acids (Hezy, 2010). In fact, epidemiological studies have shown that consumption of raw tomato and its tomato based products is associated with a reduced risk of cancer and cardiovascular diseases (Giovannucci *et al.*, 2002).

Cauliflower leaves are a good source of minerals such as calcium, copper, iron, manganese and potassium. Manganese is used as co-factor for the antioxidant enzyme superoxide dismutase in the body. Potassium is an important intracellular electrolyte which helps to counter the hypertensive effects of sodium (Bhuvaneswari and Ramya, 2014).

Amla fruit has been said to be useful against many diseases, including cancer, diabetes, hepatic disorders and heart diseases. Research has been done with amla for its role as an antioxidant, in ulcer prevention, for people with diabetes, for mental and memory effects and its anti-inflammatory benefits. Amla extract supplements not only retain the lost body energy and vigor but also helpful in those undergoing radiation therapy. Amla Tonic has a hematinic and lipolytic function useful in scurvy and jaundice (Dasaroju and

Gottumukkala, 2014). Cumin is a good source of manganese, iron, vitamins and minerals. The antioxidant content of cumin seeds is more effective (Kalaivani *et al*, 2013). Pepper controls blood cholesterol and suppress bad cholesterol thereby decreasing the risk of cardiovascular disease (www.king-of-spices-10-black-pepper-health-benefits). Coriandrum sativum (coriander) has been reported to have a number of possible medicinal attributes including antispasmodic, carminative and stomachic properties (Dhanapakiam, *et al.,* 2008). Additionally, coriander has been advocated as an anti-diabetic remedy. Considering the beneficial effects of functional foods bengal gram dhal, black gram dhal, carrot, tomato, cauliflower leaves, pepper, coriander seeds, cumin seeds and amla were selected for the study.

Formulation and Preparation of Functional Food mixes based on Functional Foods: For the formulation of Basic health mix, bengal gram dhal, black gram dhal, cumin seeds, pepper, coriander seeds and chilli powder were procured from departmental stores. Carrot, tomato, cauliflower leaves were purchased from the local vegetable market. Amla was ordered in advance and obtained from departmental stores located at Coimbatore.

Bengal gram dhal and black gram dhal were roasted and powdered separately. Carrots and tomatoes were chopped into fine pieces. Cauliflower leaves were cleaned free from foreign matters and thick stems. All the vegetables were sun dried on a clean plastic sheet till the moisture content significantly reduced to safe levels. Then the ingredients were milled using a pulveriser to obtain the respective powders. All the spices were roasted and powdered using a pulveriser. Various proportions of ingredients were tried out and acceptability tests were done to find out the best proportion.

For the Basic health mix 30g bengal gram dhal flour, 15g black gram dhal flour and 5g each of all the spices and 5g each of all the vegetable powders were blended homogenously to obtain 80g of mix which had a good acceptability. Fifteen g each of Amla powder was added to 80g of Basic health mix to get variation 1 respectively. Variation 1 can be given as a supplement to adults with diabetes mellitus. Figure 1 shows the steps involved in the preparation of the heath mixes.

Acceptability Testing and Nutrient Analysis of Functional Food Mixes: Acceptability testing through sensory evaluation was done for the Basic health mix and variation 1. A panel of 25 semi-trained members were requested to evaluate different proportions of the Basic health mix and the variation organoleptically using a five point scale. The best proportions of the selected health mixes according to the panel members, revealed that all the mixes scored more than 19 out of 25 highlighting the good acceptability of health mixes.

The Basic health mix and the variation 1 were analysed for their nutrient content. The proximate principles like energy and carbohydrate were analysed using NIN (2004) procedures and protein, fat, moisture, crude fiber, dietary fiber and ash were analysed using the AOAC (2000) procedures. Minerals like calcium, phosphorus, sodium, potassium, iron, magnesium and vitamins such as vitamin A, C and E were analysed using the ISI (2004) procedures.

Anti nutritional factors of Functional Food Mixes

Anti nutritional factors in foods may inhibit the utilization of nutrients in our body. Hence the important anti nutritional factors like oxalate, phytate, tannin and alkaloid were estimated for the two health mixes. The modified methods of the Ukpabi and Ejidoh (1989) were used for the determination of oxalate content of the samples. The phytate of each of the samples was determined through phytic acid determination using the procedure described by Lucas and Markaka (1975). Estimation of tannin was done by adopting the method of Sujata Wangkheirakpam and Warjeet, *et al.,* (2012). The alkaloid content was determined gravimetrically (Haborne, 1973).

Shelf life of Health Mixes: Both the food mixes were examined initially and after a storage period of three months for the microbial content (bacteria, yeast and mould) to evaluate the shelf life of the health mixes. Microbial content was found out by standard plate count, yeast and mould count and the results were compared with the permissible limits.

Computation of Cost of Health Mixes: The total cost incurred in the preparation of the health mixes based on the market prices prevalent during the specific time, was computed. The cost of unit weight of food mixes was calculated and the economic feasibility was assessed.

3. Results and Discussion:

1. Nutrient analysis of the Functional Food mixes

Table I depicts the analysed values of proximate principles present in the formulated functional food mixes. Among the food mixes developed, Basic health mix and variation 1 provided 384 and 333 Kcal of energy per 100g respectively. The total carbohydrate content of basic health mix and variation 1 was 69.10 and 59.81g per 100g respectively. Protein content of health mixes ranged from 12.8 to 15.75g per 100g with a maximum content in variation 1 might be due to the incorporation of amla in this mixes. With regard to total fat content, variation 1 possessed the maximum of 3.41g per 100g due to the incorporation of amla in this mix. Basic health mix contained 3.0g of fat per 100g.

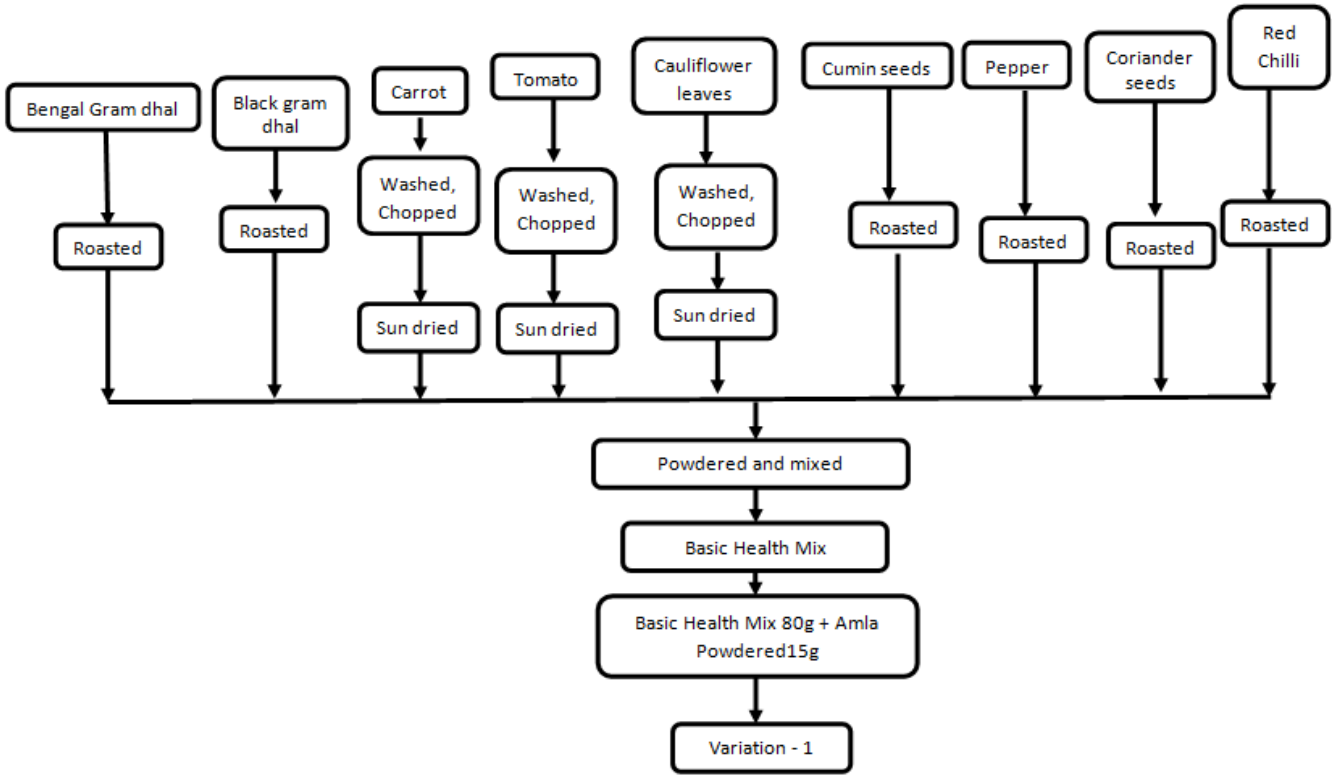

Figure 1: Steps in the Preparation of Functional Food Mixe

Table 1: Proximate Principles of the Developed Functional Food Mixes (In 100g)

Proximate Principles	*Basic Health Mix*	*Variation- 1(Amla)*
Energy (Kcal)	384	333
Carbohydrate (g)	69.10	59.81
Protein (g)	12.80	15.75
Fat (g)	3.00	3.41
Moisture (g)	3.07	3.43
Ash (g)	8.00	9.44
Crude fibre (g)	6.00	8.30
Dietary fibre (g)	8.00	8.16

Basic health mix had maximum moisture content of 3.07g whereas variation 1 had a minimum moisture content of 3.43g per 100g respectively. These levels are found to be minimum and safe for good storage. Dietary fiber content of variation 1 was the maximum with 8.16g per 100g followed by basic health mix which had 8.0g per 100g.
The mineral content of the developed functional food mixes is presented in Table II

Table 2: Mineral Content of the Developed Functional Food Mixes (In 100g)

Minerals	*Basic Health Mix*	*Variation- 1(Amla)*
Calcium (mg)	180	419
Potassium (mg)	12.1	13.0
Sodium (mg)	6.0	7.2
Iron (mg)	2.0	3.9
Magnesium (mg)	110	163
Phosphorus (mg)	68.0	72.0

Among the minerals, variation 1 contained a higher amount of calcium 419mg per 100g followed by basic health mix which had only180mg of calcium per 100g. With regard to potassium content, variation 1 had 13.0mg per 100g slightly higher than Basic mix which had 12.1mg per 100g. Sodium content of basic health mix was found to be the maximum with 6.0mg per 100g. Whereas variation 1had a higher amount of 7.2mg per 100g. Iron content in Basic health mix was only 2.0 mg whereas variation 1 had 3.9mg per 100g. Magnesium content was found to be more in variation 1 with 163mg. Basic health mix had less magnesium of 110 mg per cent only. With regard to phosphorus, the content was more in variation 1 with 72mg per cent followed by basic health mix with 68mg respectively. In general, all the functional food variations had more mineral content than the Basic health mix which might be due to the incorporation of specific functional food namely amla in variation 1.
Table III presents the vitamin content of the developed functional food mixes

Table 3: Vitamin Content of the Developed Functional Food Mixes (In 100g)

Vitamins	Basic Health Mix	Variation- 1(Amla)
Total carotenoids (µg)	1020	1420
β- carotene (µg)	420	460
Vitamin – C (mg)	17.28	23.85
Vitamin – E (µg)	0.20	0.28

Total carotenoids content of functional food mixes ranged from 1020 to 1420µg per 100g with a maximum content in variation 1 with amla based mix. Beta carotene content also ranged from 420 to 460µg per 100g with a maximum in variation 1 with 460 µg per cent. Vitamin C content ranged from 17.28 to 23.85mg per 100g with a maximum content in basic health mix. Vitamin E content of the mixes ranged from 0.20 to 0.28 µg per 100g with basic health mix and amla incorporated mix had a maximum of 0.28µg per 100g.
The anti nutritional factors of the developed functional food mixes is given in table V

Table 4: Anti Nutritional Factors of the Developed Functional Food Mixes (In 100g)

S.No	Functional food Mixes	Basic Health Mix	Variation-1 (Amla)
1.	Oxalate (mg)	146.08	407.02
2.	Phytate (g)	0.51	0.53
3.	Tannin (µg)	53	256
4.	Alkaloids (mg)	73.90	85.01

Among the four samples basic health mix had the highest oxalate content of 146.08mg per 100g followed by variation 1 which had 407.68mg per100g. Reports have shown that the lethal dose of oxalate is between 200 and 500mg/100g (Pearson, 1976). Noonan and Savage (1999) noted that the intake of 4 to 5 g of oxalate is the minimum dose that can result in death in an adult human. The amounts of oxalate reported in the present study are safe and within permissible levels. With regard to phytate content both the basic health mix 0.51g and variation 1 had 0.53g respectively. Large amounts of phytic acids have been reported to be present in fiber-rich foods. Such food, however, are pharmacologically recommended because they protect human from cardiovascular diseases and some forms of cancer (Norhaizan and Nor-Faizadatul, 2009). Inspite of this advantage, phytic acid reduce bioavailability of minerals because it has strong binding affinity to them. This chelation process increases the incidence of mineral deficiency diseases because the minerals are made unavailable for absorption by the intestine (Ekholm *et al.*, 2003). In general the anti nutritional factors in Health mixes were found to be within safe levels.

In the case of tannins, variation 1 contained a maximum of 256µg and basic health mix had a minimum of 53µg per 100g. Aletor and Adeogun (1995) reported that high level of tannins (76 to 90g kg Diabetes Mellitus) could be lethal if consumed. Sheep that consumed 0.9g hydrolysable tannins per kg of body weight showed signs of toxicity in 15 days (Kumar, 1991). In the case of alkaloids, variation 1 had 85.06 per cent being the highest whereas other basic health mix had 73.90mg per 100g.

2. Shelf life of the Functional Food mixes: The Prevention of Food Adulteration Act (PFA, 1954) recommends a total bacterial count not more than 40,000 per g and absence of yeast and mould count in 0.1g of the sample in cereal based food products. The total bacterial count of the health mixes was nil initially and ranged between 3×10^3 and 4×10^3 per g at the end of three months storage period which was within safe limits. The yeast and mould counts were found to be below detectable limits in all the four food mixes both initially and after a three months storage period. This indicates that the health mixes were free from spoilage and safe for consumption up to three months after preparation.

3. Cost of the Functional Food mixes: Cost is an important criteria to be considered for any supplementation. The total cost in the preparation of the health mixes was Rs.15.50 per 100g for Basic health mix, being the minimum followed by Rs.21.30 per 100g for variation 1. The cost of 100g of health mixes ranged from Rs.15.50 to Rs. 21.30. It is evident that the health mixes are far more economical, affordable and can be easily prepared at home compared to commercial health mixes.

4. Conclusion

From the study it might be concluded that the Functional Food mixes are rich in vitamins and minerals. The anti nutritional factors in health mixes were found to be within the safe levels, shelf life of the health mixes were free from spoilage and safe for consumption upto three month after preparation. The cost of the health mixes are far more economical, affordable and can be easily prepared at home compared to commercial health mixes. There is great scope for developed health mixes to be used effectively for treating chronic diseases.

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