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Formulation of a Multi Flour Mix and its Nutritional Estimation for Development of Value Added Products

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ABSTRACT

In developing countries like India, Malnutrition continues to be major public health problem. Diets in developing countries generally lack in essential nutrients, ie macro as well as micronutrients. Identifying certain ingredients according to their nutritive value and incorporating them in specific proportions helps in developing nutritious mixes which can then further be used to develop certain recepies to overcome the problem of malnutrition among children. The present study includes the formulation of nutritious multi flour mix from locally available ingredients and development of value added products for the children of age 3 to 6 years. The composition of nutritious food mix consisted of wheat (40g/100g), Bajra (20g/100g), Soybean (15g/100g), Bengal Gram dal (20 g /100 g) and skimmed milk powder (5g/100g). Nutritional and Anti nutritional estimations were performed the protein content of the mix was 15.0g/100gm, Iron 3.65mg/100gm and calcium 411.3 mg/100gm. For organoleptic sensory evaluation and acceptability trail, four standardized recipes (Cake, Laddo, Dhokla and Mathri) were developed by incorporating Multi Flour mix in varying proportions (10%, 20%, 30% and 40%). Result of the study concluded that the developed recipes were acceptable at 20% incorporation level. On the basis of present study it could be concluded that developing multi flour mix at household levels and incorporating recepies prepared by it in daily diets of children. Hence by the strategy of dietary diversification malnutrition can be combated.

1. Introduction

Life cannot be sustained without adequate nourishment as it is important component for proper growth and development resulting into an active and healthy life. Hence diets must be well balanced to provide all the nutrients in proper proportions. The most innovative, challenging and crucial phase in human feeding is meeting nutritional needs of infants and children both qualitatively as well as quantitatively (WFP, 2002).

Nutrition is of uttermost importance for everyone, but it has greater significance for children because it will pose a striking impact on child's development as proper nutrition influences brain development, behavior and attention span. It plays a major role in increased risk of PEM, Blindness, Anemia etc (DeOnis et al, 1998).

Intellectual development of a child is also affected equally by inadequate nutrition. Undernourished children are 16% more likely to perform poor in school and enter school later than their well-nourished counterparts. According to the United Nations standing committee poor nutrition is correlated not only to stunted growth but also poor academic performance and low mental aptitude (ACC/SCN, 2000).

According to World Bank India is ranked 2nd in the world in number of children suffering from malnutrition after Bangladesh. In context of underweight children India is among the highest in world. Twenty percent children under five year of age are designated as wasted due to acute under nutrition. On the basis of NFHS 3 (2005-2006), 43% under five children were under weight and 48% stunted due to chronic under nutrition. More than 3 out of every 10 stunted children worldwide lives in India and about half of children under age of five years are chronically malnourished. Underweight is best and basic indicator of population health status and composite index of chronic or acute malnutrition.

According to Global Hunger Index report India is at 67th position and the hunger situation is even worse than nations like North Korea or Sudan from this it was highlighted that twenty five percent of all hungry people worldwide lived in India. Malnutrition is linked with serious implications during child hood associated with impedes motor, sensory, cognitive, social and emotional development besides this there is impairment in immune function resulting into increased vulnerability to infectious diseases thereby increasing morbidity and mortality.

The importance of food-based approaches for the prevention and control of micronutrient deficiencies as well as for the improvement of nutrition in general is fully recognized by the Food and Agriculture Organization of the United Nations. Hence keeping in mind the prevalence rate of malnutrition among children particularly in developing country like India and role of diet in combating it motivated us to design the present research with Objective of identifying and formulating multi flour mix and estimating its proximate principals and anti nutritional components as well as developing value added products and their organoleptic evaluation.

2. Materials and Methods

The present study was accomplished in several phases:-

2.1 Identification and procurement of ingredients for formulation of multi flour mix

Primary consideration while selecting the ingredients included Allergenicity of various ingredients , compatibility of the mixed material to give desired flavor and appearance in the end product, availability and nutritional aspect of the formula

Considering these points basic ingredients were identified and selected for developing the multi flour mix which included wheat, bajara, soyabean and Bengal gram dal. Several permutation combination were worked in biochemistry laboratory of IIS University and finally a composition was arrived wheat (40%), Bajara (20%), Soyabean (15%) and Bengal gram dal (20%) and skimmed milk powder (5%).

2.2 Nutritional and anti-nutritional estimations

Standard techniques as mentioned in manuals of AOAC, 2005 were used for estimating Proximate composition and anti nutritional properties of the mix. All the methods were standardized in the Biochemistry laboratory of the University and then readings were recorded in triplicates finally the mean and standard deviations were calculated and reported in results. Anti nutritional estimations were carried out in a same way to evaluate the presence of oxalate and phytates in the food mix.

2.3 Development and Oragnoleptic evaluation of value added products.

Common recipes of Indian cuisine popular among the children were selected for value addition. Value added products were prepared by substituting the base flour in the standard recipe with 10%, 20%, 30% and 40% of multi flour mix. Recipes selected for value addition included Laddo, Baked Mathri, Cake and Dhokla.Organoleptic Evaluation of all the recipes containing different levels of formulated nutritious mix was done on the basic of their appearance, color, taste, texture and overall acceptability using five point Hedonic Rating scale.

3. Results

3.1 Proximate Composition

Proximate Composition and Anti nutritional estimations of Multi flour mix was done using the standard procedure as described in AOAC (2005). The results of proximate composition of nutritional and antinutritional components are documented below (Table 1)

Table 1
Proximate composition of Multi Flour mix

S.no	Component	Multi Flour mix
1	Moisture %	0.19± 0.0047
2	Ash(gm)	2.14± 0.041
3	Crude fiber(gm)	4.33± 0.024
4	Fat(gm)	6.21± 0.0081
5	Protein(gm)	15.07± 0.016
6	Calcium(mg)	411.3± 0.94
7	Iron(mg)	3.65± 0.04
8	Carbohydrate(gm)	79.1 ±1.7

(mean ± sd)

As per the results proximate value for moisture content was estimated to be as low as 0.206% per 100 gm, which indicates that this flour had better shelf life. However the flour moisture is influenced by weather, environmental and storage conditions such as humidity as well as storage temperature. The ash content of the product acts as an index of mineral content in biota. As learnt from the results of estimation, the ash content of the multi flour mix was estimated to be 2.15% per 100 gm. The high ash content is a reflection of the mineral contents preserved in the flour. The major constituents of the ash in flour are calcium, phosphorus, Iron , sodium , potassium , and halogens. The result therefore suggest a good deposit of mineral elements in the formulation. The fiber content of the flour is estimated to be around 4.36%. This could be attributed to the use of whole wheat and soybean, both of which have high fiber contents. The crude fiber most likely from the bran of the whole wheat flour and the hull of the soybean, represents variable fraction of lignin, cellulose and hemi cellulose components (Mannay and Shadaksharaswany, 2005; Islam et al.,2007). The fat content of the multi flour mix was estimated to be 6.210gms/100gms . Fat contribution to soybeans as it is an oilseed. Fat content of the mix is near to the prescribed minimum level of 6% as specified by Codex (2006), for treating moderate malnutrition prevalent among children. Sample of multi flour mix showed 15.07g/100gms of protein. Soybeans has a high protein value of over 43.00%. Soybean contain about 3% lecithin important for brain development. Blending of cereals with legume also helps in provided desirable protein pattern by mutual supplementation. In the present study, the calcium content of the multi flour mix was estimated to be 412mg/100gm. Calcium content was increased by incorporating soybean and skimmed milk powder. In this multi flour mix; bajra was incorporated to increase the iron content, as bajra is a good source of iron among the millets. The estimated iron content of the sample was estimated to be 3.86 mg /100gm. Carbohydrates was calculated by the composite method and were estimated to be 77.83g/100gms.

Table 2
Ant nutritional Estimation

S.No.	Component	Nutritious mix
1	Oxalic acid(mg/100g)	39.9± 0.150
2	Phytic acid(mg)	9.5±0.408

(Mean ± SD)

3.2 Antinutritional components

Oxalates and phytates interfere with absorption of Iron , calcium and other minerals. However pretreatment like roasting reduces their inhibitory effects. The estimated values of oxalates in the multi flour mix was 39.9%. The phytate content of the multi flour mix was estimated to be 9.5%. However the estimations were performed in flour produced by roasting of beans however application of further cooking methods for development of recipes further reduces the inhibitory effects of these anti nutritional factors.

3.3 Development and Organoleptic Evaluation of Value Added Products

Four different value added recipes were developed incorporating multi flour mix along with the control recipes. Multi flour mix was incorporated in different recipes at various

incorporation levels of 10%, 20%, 30% and 40% respectively. The organoleptic assessment was conducted at the Department of Home science, IIS University, Jaipur. Five different panelist were selected on the basis of sensitivity threshold test and five point hedonic rating scale was used for organoleptic evaluation. On the basis of popularity and different methods of cooking among children four different recipes were shortlisted ie cake, dhokla, ladoo and baked mathri served for sensory evaluation with regards to color, texture, flavor and overall acceptability. Taste is the primary factor which determine the acceptability of any product, which has the highest impact as far as the market success and acceptance of the product is concerned. In present study, overall acceptance of a 20-30% of multi flour mix. Results of the organoleptic evaluation highlighted that an after taste was felt in almost all the preparations on consuming the recipe prepared by incorporating 30% and 40% of the multi flour mix. In case of sweet preparations i.e cake and laddo more after taste was felt rather than other two salty preparations. The overall results revealed that addition of multi flour mix at 20% level to cereal flour had no adverse effects on the sensory attributes. Also the processing (roasting) done to the cereal grains imparted a pleasing aroma and flavor.

Table 3
Organoleptic evaluation of Cake

Variants	Appearance	Color	Texture	Taste	Overall Acceptability
Control	4.8+0.23	4.8+0.23	4.8+0.23	4.9+0.18	4.9+0.18
10%	4.75+0.29	4.75+0.29	4.75+0.29	4.75+0.29	4.75+0.29
20%	4.7+0.2	4.7+0.2	4.7+0.2	4.6+0.47	4.6+0.47
30%	4.6+0.37	4.5+0.35	4.6+0.4	4.3+0.37	4.5+0.35
40%	4.3+0.53	4.3+0.53	4.4+0.71	3.5+0.40	4.0+0.5

(Mean ± sd)

Results of organoleptic evaluation of cake highlighted that the recipe prepared by incorporating 20% nutritious mix was well accepted in terms of all sensory attributes. However increasing the incorporation resulted in after taste which was felt on consuming the product. From this it can be interpreted that 20% incorporation level is the most acceptable and similar to control recipe.

Table 4
Organoleptic evaluation of Dhokla

Variants	Appearance	Colour	Texture	Taste	Overall Acceptability
Control	4.91+0.1	4.9 +0.1	4.8+0.3	5+0	4.9+0.18
10%	4.75+0.3	4.6+0.4	4.6+0.4	4.91+0.1	4.6+0.4
20%	4.5+0.4	4.4+0.4	4.5+0.4	4.25+0.6	4.5+0.4
30%	4.8+0.3	4.6+0.4	4.8+0.3	4.6+0.4	4.9+0.1
40%	4.4+0.4	4.2+0.38	4.5+0.4	4.2+0.38	4.2+0.38

(Mean ± sd)

Dhokla is a steamed dumpling made up of maize flour. The sensory evaluation of Dhokla presented markedly different response wherein 30% recipe got more appreciation than control recipe. Maize flour being gluten free showed less binding and usually needs efforts to keep it in shapes. As we go on replacing base ingredient with multi flour mix texture and taste however no significant change in color or overall acceptability was noticed. Variant with 30% incorporation level was very well accepted however variant with 40% incorporation reported to have some after taste.

Table 5
Organoleptic evaluation of Laddo

Variants	Appearance	Colour	Texture	Taste	Overall Acceptability
Control	5+0	5+0	4.8+0.3	5+0	5+0
10%	4.3+0.50	4.5+0.50	4.7+0.5	4.7+0.5	4.7+0.5
20%	4.6+0.30	4.8+0.20	4.6+0.3	4.5+0.4	4.8+0.23
30%	4.4+0.4	4.4+0.4	4.4+0.4	4+0	4.4+0.4
40%	4.3+0.4	4.3+0.4	4.3+0.4	4.1+0.3	4.25+0.3

(Mean ± sd)

Organoleptic evaluation of Laddo as observed by the panelists revealed that the variant 20% of the nutritious mix is acceptable in all sensory attributes. A slight bitter after taste at the higher replacement levels was observed. The texture and shape of laddos remained constant at all the replacement levels. The golden brown color got darker with the increased incorporation level.

Table 6
Organoleptic evaluation of Baked Mathari

Recipe	Appearance	Colour	Texture	Taste	Overall Acceptability
Control	5+0	5+0	5+0	5+0	5+0
10%	5+0	5+0	5+0	5+0	5+0

20%	4+0	4+0	4+0	4.8+0.23	4.9+0.18
30%	4.5+0.45	4.5+0.45	4.9+0.18	4.5+0.40	4.6+0.37
40%	4.3+0.47	4+0.5	4.4+0.6	3.9+0.53	4+0.28

(Mean ± sd)

Similar results of organoleptic evaluation were obtained in case of baked mathri too, however the overall acceptable scores of 40% variant was 4.0 which shows that it was liked by the panelist .The sensory attributes showed no apparent changes till 20% variant levels. At 30% incorporation levels color, texture, appearance and taste were in acceptable ranges, without representing any inedible off flavours or appearance. As per the secondary researches baked items have a better shelf life instead of deep fried ones moreover deep fat frying increases the trans-fat content and ill effects of oil rancidity.

4. Discussion

The moisture content is the loss in weight of a sample when heated under specified conditions. It is an important parameter which determines the shelf life of the product. The increase in moisture content encourages mould growth and hence spoilage and lump formation of the product during storage. Level of moisture content was found to be 0.20%, which is within the recommended range (<10%).The results were not different from that obtained from literatures (Weiss et al, 2000 and Potter & Hotchkiss, 2006). The moisture content of the multi flour mix decreases as the proportion of soybean increases hence producing a more shelf stable product. Findings also agrees with that of Sanni et al 2005, who performed moisture estimation for Nigerian rice varieties. Ash content of any sample includes inorganic residue which is left after ignition or complete oxidation of organic matter. For reliable and authentic results ashing procedures and equipments should therefore be reliable. (Ponnusha, Subramaniyam, Pasupathi and Virumandy, 2011). Approximately two percent of ash content is present in the multi flour mix and similar results are coded in other researches (Hurell, 2002 & Weshly and Ranum, 2004). The ash content in the present study fall within the range of 1.62-2.92% as reported in other researches too whole wheat has better mineral composition because most of the minerals are accumulated in the bran of the grains. Crude fiber is essentially the residue left after sequential hot digestions. It is generally agreed that the crude fiber value cannot be considered an accurate estimate of dietary fiber, but is only a rough indicator. The increased fiber and the lower carbohydrate content have several health benefits, as it will aid in the digestion of the flour in the colon and reduce constipation. The crude fiber content was estimated to be 4.36% shows an increase in the range because of the presence of whole wheat and soybean. The results are similar to that obtained by Manny & Shadaksharaswamy et al, (2005). The increased fiber content of composite flour have several health benefits and it also aid in good digestion as observed in similar literatures (Onwubali et al, 2009 and Elleuch et al, 2011). Vitalis et al in 2009 reported that using soybean and legume with whole wheat flour resulted in the improved fiber as well the nutritional and functional properties. Cereals are generally considered to have low fat content as determined by ether extraction. But cereals together with pulses contribute to meet the EFA needs. Soybean has the highest fat content among the ingredients. This could be attributed to the fact that soybean is an oilseed. The high fat levels are in line with the value reported in the literature. Fat is also needed in the absorption of vitamin A and vitamin E. These vitamins are necessary for immediate recovery from acute malnutrition and to reduce disease incidents. Milk and soy based products have been demonstrated to boost growth and immunity (Diopel et al ,2003). The protein levels of the food samples agreed with other previous researchers (Weiss, 2000; Potter and Hotchkiss 2006) . Legume proteins are rich in lysine which is limiting in the cereals and cereals on the other hand are high in methionine and cysteine which are deficit in legumes. Milk proteins are of high biological value and it is added in the form of Skimmed milk powder. The estimated protein content agreed with other previous researches (Weiss, 2008;Potter & Hotchkiss, 2006). Incorporation of soybean in the nutritious mix increased the protein levels too. Improvement in quality and quantity of protein may also be due to the incorporation of skimmed milk powder. It could be assumed that addition of skimmed milk powder has a good potential in overcoming Protein Calorie Malnutrition . Calcium is the most abundant mineral in the body and the body needs calcium to maintain strong bones and to carry out many important functions. In addition, calcium is used to help blood vessel move blood throughout the body and to help release hormones. The calcium composition of the multi flour mix was appreciable; this could be attributed to incorporation of soybean and skimmed milk powder in the mix. Potter and Hotchkiss (2006) suggested that the proximate values of calcium increase with the increasing levels of soybean. Skimmed milk powder added possess proteins of high biological value and hence increases the potential outcomes. Addition of SMP also decreases the need of bulk adding of other protein sources to the mix. Iron is an essential trace element for hemoglobin formation, proper functioning of the neurons and also in the oxidation of the metabolites (Hassan and Umar, 2006). About 65 to 75% of the body's iron is in the blood in the form of hemoglobin. However the Iron content estimated is 3.86 g/100gms. It was reported by several studies that minerals content of wheat flour increased by the addition of soybean in it, Rawat et al,1994 stated that soy supplemented chapattis have a higher level of Iron than prepared from only whole wheat flour. Iron content of wheat rotis was improved on supplementing it with soyabean. The iron content of the biscuit increased from 1.56% to 1.99% with the increase in supplementation of soybean. Carbohydrate content decreased marginally with the increase in the addition of soybean, similar trends in decrease of the carbohydrate content was also reported by Ayo et al, (2014) on the supplementation of malted soy flour on the production of biscuits. The decrease in carbohydrate content could be due to the low carbohydrate content of added soybean which is roasted (Potter & Hotchkiss, 2006). Oxalic acid, a di carboxylic acid or its salts are widely distributed in the plant foods. These are mostly calcium salts. These are known to interfere with calcium absorption by forming insoluble salts with calcium. However the effect of oxalate on calcium absorption in humans is less clear (Heaney and Weaver, 1989). These inhibitory components binds with minerals and inhibits mineral absorption. It is the main inhibitor of iron and zinc absorption. Phytates are high in food rich in fibers especially wheat bran,

whole grain and legumes. Phytates constitute 1-3% of cereal grain, legume and nuts. In general, cooked products have lower content of phytates as compared to raw flour. The phytate concentration were comparable to the values reported in the literature (Kirby and Nelson, 1988). Oxalates and Phytates were estimated to be 0.04% and 0.05% respectively in the nutritious mix. Dietary levels of phytates and oxalates of 1% or more have been reported to interfere with mineral availability however researches have reported that low levels of antinutritional components can be achieved by roasting of the soybean added. The phytate level within safe limit (<0.07) does not interfere with the mineral absorption. Similarly Kumar et al, (2010) reported similar findings for the biscuits prepared with incorporation of soybean flour instead of whole wheat flour. Ugwuona et al, (2009) results were supporting the fact that the incorporating legume with cereal based Nutritious mix may result in slight variation in the taste till 20% incorporation, which is quite acceptable.

5. Conclusion

It is a known factor that mixture of legumes and cereals are complementary resulting in balance of the essential amino acids needs of the human body. It is therefore clear that adoption of this simple technology at household levels will result in serving of better protein enriched meals. This study revealed that enriched multi flour mix formulated from locally available ingredients can meet the macro-nutrient requirement of children. However certain aspects like the digestibility and bio availability of macro nutrient content need further investigation. The result from the study suggest that properly cooked recipes out of this multi flour mix can provide nutritious palatable yet tasty and readily acceptable meals to malnourished children. This is believed to be a practical food based approach aimed at combating malnutrition among preschoolers and school going children of Rajasthan and the nation as a whole. Incorporation of this multi flour mix for value addition in traditional recipes can be encouraged and popularized in order to improve intake of protein, fat, calcium, iron and carbohydrate. This can also be helpful for providing variety in the daily dietaries in addition to their nutritional benefits. This can be considered as a preventive food based approach to improve overall nutritional status of preschoolers, overtime that can be integrated with other interventions also in the effort to reduce mal nutrition. It could also be expected to be the most effective approach in achieving a child health impact if mandated at the national level and can help achieve international child health goals.

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