IJFANS
International Journal of Food And Nutritional Sciences

Volume 6, Issue 1, January 2017, www.ijfans.com e-ISSN: 2320-7876

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

IMPACT FACTOR ~ 1.021

Official Journal of IIFANS

IJFANS International Journal of Food and Nutritional Science

e-ISSN 2320 -7876 www.ijfans.com
Vol. 6, No. 1, January 2017

Research Paper ***Open Access***

SUITABILITY OF FULL FAT SOY FLOUR FOR THE DEVELOPMENT OF INSTANT MANGODI MIX

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Received on: 6th September, 2016 Accepted on: 27th December, 2016

Mangodi, a legume based deep fried traditional Indian cuisine prepared from green gram dahl which is a widely consumed pulse and is an excellent source of protein. Soybean is significantly known not only for its nutrient content but also for its health related benefits. Therefore, the present study was conducted to test the suitability and optimization of full fat soy flour in instant mangodi mix. Under the study, modified mangodi prepared by replacing 30-50% of green gram flour by full fat soy flour and rice flour in different combinations. Various parameters, i.e., sensory, physical, hunter colour values, functional, nutritional, storage studies along with its cost analysis have been made and summarized. The mangodi formulation prepared from green gram (50), full fat soy flour (25) and rice (25) was found most acceptable. The value added mangodi was found nutritionally superior in terms of protein, fat, ash and mineral contents. The instant mangodi mix can be stored safely in polypropylene package up to 60 days. This study suggests that this instant mangodi mix is a potential way to enhance soy utilization for better nutritional security.

Keywords: Full fat soy flour, Instant mangodi mix, Traditional foods, Husked green gram

INTRODUCTION

Traditional foods play an important role in local identity, consumer behavior, the transfer of cultural heritage for future generations, and the interaction of this heritage with the rest of the world. Mangodi, a legume based deep fried traditional Indian cuisine, prepared from green gram dahl. Green gram (*Vigna radiata*) belongs to the family leguminosae is one of the most wholesome among pulses in India. Green gram is a low fat, protein rich staple food. It contains about 25% protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. It is consumed in the form of split pulse as well as whole pulse, which is an essential supplement of cereal based diet. Once cooked, the bean is sweet and soft in texture, and it is easily digestible, so it doesn't produce flatulence like many other legumes and considered as complete diet.

Although the trend is towards lowering fat consumption, frying still represents a product of high demand. Deep fat fried food products are popular due to their unique flavour and texture characteristics (Nor Fishah, 2012). The popularity of deep fried products is due to the basic structure imposed on them by the way in which they are cooked. The soft and moist interior along with the porous outer crispy crust in fried foods provides increased palatability.

The very term 'instant food' means simple, fast, and convenient food which is easy and time saving to prepare and also convenient to eat (Lily, 2014). Due to the availability of wide range of instant food products in recent years, the consumers are more opted to use the products available in the market at convenient packages and reasonable rate (Unika and Jaffer, 2014). Instant mix products offer great convenience to the homemakers to prepare traditional delicacies.

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Pulses and legumes have high fiber, complex carbohydrates and low fat. These nutrients make pulses an important part of any healthy diet and can help in maintaining health. Soybean is usually identified as a 'Miracle golden beans', and its protein is very useful in enhancing growth and development in human beings. Soybean, rich in isoflavones is also rich in phenolic acids and has a high antioxidant capacity (Malencic *et al.*, 2007).

The biological value improves greatly, when wheat or rice is combined with green gram because of the complementary relationship of the essential amino acids. It is particularly rich in Leucine, Phenylalanine, Lysine, Valine, Isoleucine, etc. Rice flour and starch are also popular ingredients due to their unique properties and broad application across multiple product categories. Rice is important to many people because it is the least allergic grains and is a staple for those with celiac disease and gluten intolerance. Keeping this in mind, a new innovative idea of making an instant mangodi mix was introduced using full fat soy flour and rice.

MATERIALS AND METHODS

Green gram (*Vigna radiata*) dahl with husk, Rice (*Oryza sativa*) and Soybean (*Glycine max*) were procured from the local market of Adhartal, Jabalpur.

Preparation of Full Fat Soy Flour

Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The cleaned grains were soaked in water for 8 hours and autoclaved for 20 minutes to remove the beany flavour and as well as to enhance easy dehulling. The autoclaved beans were cooled and dried at 60 °C for about 3-4 days. The dried beans were milled to make fine flour and sieved through 80-100 mesh sieves (Ajibola and Filani, 2015).

Preparation of Green Gram Flour

Green gram dahl (with husk) was soaked in water (1:3w/v) for 12 h at room temperature (~25 °C) according to Mubarak (2005) and Khalil (2006). The water was drained off and the seeds dried in an oven at 65 °C for 2 days. The seeds were then milled, sieved and packed for further analysis.

Development and Optimization of Instant Mangodi Mix

Preliminary studies were performed for the purpose of identifying the appropriate proportions of ingredients, sample combinations and cooking and accordingly percentage of fortification was established through sensory evaluation.

Several compositions of raw materials and main ingredients were tried to arrive at the desired formulation with optimum percentage as recommended by acceptability studies. All experimental samples were prepared using the traditional method. Various acceptability parameters such as colour and appearance, taste, flavour, texture, after taste and overall acceptability were considered as deciding factors by using the method described by (Amerine *et al.*, 1965).

Table 1: Sensory Attributes of Mangodi Prepared from Instant Mangodi Mix

Formulations	Colour and Appearance	Taste	Flavour	Texture	After Taste	Overall Acceptability
MF1	8.65	8.87	8.4	8.3	8.62	8.9
MF2	8.27	8	8.13	8.03	8	8.43
MF3	8.42	8.5	8.35	8.12	8.43	8.65
MF4	7.6	7.45	7.62	7.31	6.25	7.72
MF5	6.5	6.75	6.25	6.5	7.25	7.36
MF6	7.45	7.34	7.12	7.06	6.87	7.5
MF7	7.67	7.8	8	7.87	7.75	8.01
SEM ±	0.082	0.077	0.059	0.071	0.212	0.331
CD at 5%	0.25	0.21	0.18	0.217	0.644	1.004

Note: MF1 - Green gram (100), MF2 - Green gram + soy flour + Rice (40:30:30), MF3 - Green gram + soy flour + Rice (50:25:25), MF4 - Green gram + soy flour + Rice (30:35:35), MF5 - Green gram + soy flour + Rice (30:40:30), MF6 - Green gram + soy flour + Rice (40:40:20), MF7 - Green gram + soy flour + Rice (30:50:20).

Different combinations (Table 1) were taken and mixed well. All spices, i.e., chilli powder, turmeric powder, salt, dried chilli/onion/coriander were added and packed in LDPE and PP. For the preparation of mangodi, batter was prepared using instant mix and water and left for 10 minutes. Mangodi were deep fat fried in hot oil till 5-6 min.

Quality Evaluation

Prepared mangodi were subjected to sensory analysis based on 9-point hedonic scale using a panel of 15 members who are familiar with the product. The rating was given as per the hedonic rating 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, Dislike extremely 1. The nutritional evaluation, i.e., moisture, fat, protein, carbohydrate, ash, crude fiber of instant mangodi mix was carried out by standard methods (AOAC, 1992). Mineral contents of different mangodi mix were obtained by calculation using table value (Gopalan *et al.*, 1996). Bulk density of mangodi mix was measured according to the method of (Jones *et al.*, 2000). Colour was measured using Hunter colour lab analyzer where L, a and b values were recorded for the different mangodi and instant mangodi mixes by CIE method (1976). Fat absorption and water absorption capacity of instant mangodi mix were measured by the method of Sosulski *et al.* (1976) and Sosulski (1962) respectively. The best instant mangodi mix found in sensory evaluation was selected for storage studies, i.e., free fatty acid (AOAC, 1992) and peroxide value (Ranganna, 1986). Instant mix packed in polypropylene and low density polyethylene and stored at ambient temperature (35±5 °C, 75±10% RH) for 60 days. The overall acceptability of control as well as improved mix was evaluated on 0, 30, 60 days of storage. A complete randomized design was adopted for statistical analysis of data of experiments related to storage studies by following the procedure as described by Panse and Sukhatme (1963).

RESULTS AND DISCUSSION

Development and Optimization of Mangodi Mix

Instant mangodi mix were prepared with varying levels of ingredients such as green gram (husked) dahl, full fat soy flour, rice, chilli powder, turmeric powder, salt, sesame seed, oil and water using earlier mentioned basic recipe for mangodi. Accordingly mangodi were prepared with 30-40% green gram flour, 25-50% full fat soy flour and 20-35% rice flour. Control mangodi was prepared with 100% green gram. Spices, i.e., chilli powder (0.5 g), salt (4 g), turmeric powder (0.5 g), dried chilli (0.5 g), dried onion (2 g) and dried coriander (0.5 g) were added in all combinations. Some studies have been undertaken on traditional snack foods by Holikar *et al.* (2005) and Ahlawat and Punia (2012), who explored various aspects of research related to fried snacks. Similarly, a deep fat fried product, Kachori was modified using soya granules, moong dal, jowar flour, wheat flour, methi leaves and olive oil by (Agrawal and Sengupta, 2014).

In the primary sensory evaluation test different mangodi were prepared from different formulations and were evaluated by panelists. Previously, the mangodi were prepared by the flour prepared directly by raw materials without any primary processing. Panelists suggested presoaking the green gram and rice to make flour rather than direct use of flour of raw materials to get softness, crispiness, good taste and texture of mangodi. The score for the products with 40-50% green gram flour, 20-30% rice and 25-40% full fat soy flour were highest in terms of all sensory attributes. It was also suggested to use granulated flour replacing fine flour to maintain the originality of the product. They also suggested that frying time more than 4-5 min adversely affected the colour and texture of the final product. The amount of water 100-110 ml/100 gm of instant mix required for improving the texture of full fat soy flour mangodi. The resting period of batter was maintained for 10 minutes to smoothen the batter and for air incorporation into it. Similar findings were demonstrated by (Holikar *et al.*, 2005) about the necessity to presoak the moong dal to get desirable sensory characteristics after frying.

Sensory Analysis

The formulation MF3 scored highest scores than other variations for all the sensory characteristics. Addition of 25% soy flour had improved the overall sensory attributes of the mangodi and thereafter, it has decreased with the levels, i.e., 30, 35, 40 and 50% soy flour with less variation (Table 1).The mangodi formulation MF3 prepared from full fat soy flour (25), green gram (50) and rice (25). Findings of Deepa *et al.* (1992) regarding addition of 30-40% soybean flour in prepared products are in contrast with the present findings whereas results of Dhore (2011) are similar to present study. The acceptability of the mangodi also increases with the reduction in oil absorption capacity due to addition of soy flour and rice. Alpaslani and Hayta (2008) also suggested that soy ûour, rice our and semolina caused a reduction in oil absorption. The incorporation of green

gram flour with husk may be responsible for the crispy texture of mangodi in relevance of the control mangodi.

Proximate Analysis

Due to the varying composition of full fat soy flour, the proximate composition also presents its specific enhancement in nutritional levels. As can be seen from the Table 2, moisture content varied from 8.09 to 8.97%, fat 1.26 to 12.2%, crude fiber 2.06 to 3.5%, ash 3.02 to 4.18%, protein 23.95 to 28.33%, carbohydrate 43.87 to 59.12%. There is gradual increase in protein, fat, and ash content whereas decrease in carbohydrate and crude fibre with modification. The protein and fat content of mangodi mixes increased with increased level of full fat soy flour and green gram. The energy value varied from 343.62 to 398.8 kcal/100 g with the highest energy value of MF7 and the lowest being the control sample. Full fat soy flour and green gram are the rich source of protein and fat and responsible for their enrichment. The similar results are reported by Senthil *et al.* (2002), Olaoye *et al.* (2006), Dhore (2011) and Abioye *et al.* (2011). The findings of present study are in contrast with the finding of Chauhan and Tomar (1998) with regards to soy snacks. Here, the decreased level of carbohydrate with increased level of soy flour substitution supporting the claims of Akpapunam *et al.* (1997). While going through the energy value of the instant mangodi mix, it was analyzed that there was an increment with the increase in soy ingredients ratio as being the potential source of protein and fat which collaborate in the computation of energy value.

Mineral Composition

An appreciable amount of calcium, iron and phosphorus content was found in all instant mixes (Table 3). The supplementation of full fat soy flour and husked green gram flour may increase the phosphorus, calcium and iron content in instant mixes. The similar result reported by Reema *et al.* (2006). The increase is possibly due to addition of soybean flour which is excellent source of micronutrients (Singh and Roy, 2004).

Physical Properties

Bulk density is a measure of heaviness of flour (Nicole *et al.*, 2010) and is generally affected by the particle size and the density of the flour. An appraisal of Table 3 showed that, the bulk density of instant mixes ranged from 0.62 to 0.89 g/ml. Significantly lower bulk density was observed in MF7 whereas highest was observed in MF1. On contrast, low bulk density would be an advantage in the formulation of complementary foods (Akpata and Akubor, 1999).

Hunter Colour Analysis for Instant Mangodi Mix and its Mangodi

Colour is an important quality attributes in the quality of deep-fat fried products that influence consumer acceptance of many food products. Consumer do not accept products in which colour varies from the expected normal appearance. Products prepared with green gram, full fat soy flour showed significant differences in colour values which may be due to incorporation of different concentration of the flours in mixes. In present study, deep fat fried snacks showed only minor variation in brightness (L* values), a* and b* values at different levels of soy flour incorporation (Tables 4 and 5). The wide range in lightness values observed for the samples may also be due to the processing conditions such as frying time and temperature. Similar findings were given by Hung and Nithianandan (1993) and Senthil *et al.* (2002).

Functional Attributes of Instant Mangodi Mix

The value of fat absorption capacity of instant mangodi mix

Table 2: Proximate Analysis of Instant Mangodi Mix

Formulations	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Crude Fibre (%)	Ash (%)	Energy Value (Kcal/100 g)
MF1	8.77	23.95	1.26	59.12	3.5	3.4	343.62
MF2	8.09	24.08	8.44	54.09	2.08	3.22	388.64
MF3	8.97	24.34	7.26	53.29	2.68	3.46	375.86
MF4	8.97	24.08	8.82	52.99	2.12	3.02	387.66
MF5	8.33	25.76	10.4	50.21	2.06	3.24	397.48
MF6	8.75	26.64	9.88	48.19	2.5	4.04	388.24
MF7	8.55	28.33	12.2	43.87	2.82	4.18	398.8
SEM ±	0.262	0.378	0.416	0.655	0.168	0.134	0.437
CD at 5%	0.794	1.148	1.263	1.241	0.511	0.408	1.327

Table 3: Mineral Composition of Instant Mangodi Mix (mg/100 g)

Formulations	Calcium	Iron	Phosphorus
MF1	124	4.4	326
MF2	114.4	3.88	326.6
MF3	116	3.96	326.5
MF4	112.8	3.79	326.7
MF5	122.6	4.08	343.4
MF6	134	4.45	360
MF7	142.2	4.64	376.8

Table 4: Physical Attributes of Instant Mangodi Mix

Formulations	Hunter Colour Analysis			Bulk Density (g/ml)
	L	a	b	
MF1/MG1/MO1	79.95	0.17	15.24	0.89
MF2	77.8	-0.8	33.32	0.67
MF3	76.85	-0.49	31.85	0.68
MF4	75.21	0.65	35.82	0.67
MF5	75.18	0.5	35.55	0.65
MF6	75.18	0.19	34.48	0.71
MF7	74.14	0.77	35.36	0.62

Table 5: Colour Analysis of Mangodi Prepared from Different Formulations

Formulations	Hunter Colour Analysis		
	L	a	b
MF1	32.21	9.39	23.25
MF2	29.9	7.17	20.01
MF3	31.07	9.06	20.52
MF4	32.62	9.34	21.86
MF5	24.73	7.76	17.56
MF6	28.61	11.04	20.65
MF7	29.61	8.82	20.43

presented in the Table 6 was found to be higher in MF7 (255 ml/100 g) and the lower in MO1 (215 ml/100 g). Increase in fat absorption capacity may be due the addition of soy flour in mangodi. The similar value was reported by Nath and Narsing Rao (1981) for soya meal and higher value reported by Tasneem *et al.* (1982) with regard to soya flour.

Table 6: Functional Attributes of Instant Mangodi Mix

Formulations	Water Absorption Capacity (ml/100 g)	Fat Absorption Capacity	
		Mangodi Mix (ml/100 g)	Mangodi (%)
MF1	281	215	17.4
MF2	279	220	20
MF3	290	226	16.8
MF4	284	228	17.5
MF5	282	239	18.6
MF6	279	236	19.2
MF7	328	255	20.8

Heat processing may increased the fat absorption capacity of different flour blends used in mangodi preparation. This increase could also be due to both dissociation of proteins that may occur on heating and also denaturation which is expected to unmask the non polar residue from the interior of the molecules. Since the products based on pluses, absorbed lesser fat on thermal treatment, it can be concluded that it did not affect the textural quality adversely. The similar result reported by Geethalakshmi and Prakash (2000).

Studies of water absorption capacity of proteineous material are useful in assessing potential food application products. The WAC of different mangodi mixes ranged from 279 to 328 ml/100 g in instant mangodi mix whereas the highest value attained by MF7 and that of lowest by MF2. Water absorption capacity was increased due to addition of soy flour. Similar findings were reported by Dhawan (1998), Senthil *et al.* (2002) and Abioye *et al.* (2011) with regards to soy flour incorporation.

Storage Studies

The compatibility of packaging materials with food is a necessary criterion for selection of packaging material. As revealed from Table 7, the moisture content of mangodi mix MF_3 found to be 8.97 at initial stage, further increased upto 9.5 in P_1MF_3 and 10.34 in P_2MF_3. The amount of free fatty acid in food product indicates the extent of fatty acid deterioration due to hydrolysis of fatty acid double bonds. Hence, formation of free fatty acid could enhance rancidity of food. The initial value of instant mangodi mix was 0.448, increased upto 0.51 (P_1MF_3) and 0.729 (P_2MF_3). The peroxide value of the product at the end of the storage period found to be increased from 5.1 to 6.2 meq/kg for P_1C and 5.1 to 6.9 meq/kg for P_2C. The PV of the instant mangodi mix ranged from 6.3 to 13.8 (P_1MF_3) and 6.3 to 15.3 (P_2MF_3). It has been

Table 7: Storage Studies of Instant Mangodi Mix

Parameters	Formulations	0 days	30 days	60 days
MOISTURE	P1C	8.77	8.78	8.8
	P2C	8.77	8.78	8.85
	P1MF3	8.97	8.99	9.5
	P2MF3	8.97	9.1	10.34
FFA (% Oleic Acid)	P1C	0.45	0.43	0.507
	P2C	0.45	0.561	0.617
	P1MF3	0.448	0.478	0.51
	P2MF3	0.448	0.673	0.7293
PV (meq. of O_2/kg Fat)	P1C	5.1	5.5	6.2
	P2C	5.1	5.8	6.9
	P1MF3	6.3	10.7	13.8
	P2MF3	6.3	12.1	18.3
OAA	P1C	8.9	8.7	8.4
	P2C	8.9	8.6	7.97
	P1MF3	8.65	8.45	8.16
	P2MF3	8.65	8.25	7.8

Note: P1- Polypropylene, P2 - Low Density Polyethylene; C - MF1; Best formulation in sensory analysis - MF3.

showed that overall acceptability of all mangodi was decreased with increase in storage period. The overall acceptability of the product at the end of the storage period found to be decreased from 8.9 to 8.4 for P_1C and to 7.97 for P_2C. Formulation MF3 packed in polypropylene (P_1MF_3) exhibited the highest acceptability (8.16) up to the end of storage at 60 days followed by packed in low density polyethylene (P_2MF_3) with 7.8 score as compared to control sample. This revealed that polypropylene (PP) performed well over low density polyethylene (LDPE) for the storage studies' parameters for the instant mangodi mix.

Cost Analysis

Dealing with the cost efficiency of soy fortified instant mangodi mix, it was found that soy fortification in instant mangodi mix is a cost effective affair. The price of green gram dahl (husked) was Rs. 110/kg whereas the soybean cost was Rs. 50/kg and rice was Rs.20/kg. Besides, full fat soy flour cost was same as the soybean. From the above evidence it was concluded that the mangodi prepared from green gram costing Rs. 110/kg and mangodi prepared from full fat soy flour with best combination charged at Rs. 72.50/ kg. Thus soy fortification was found to be cost effective in terms of economic feasibility.

CONCLUSION

It can be concluded that replacement of green gram flour upto 50% with 25% each of full fat soy flour and rice flour resulted in substantial increase in protein, fat, ash and mineral content, which could be nutritionally balanced, advantageous and easily affordable food. It could also serve to increase soybean utilization and add to diversification in the market which is mostly dependent on products from wheat and rice. Thus, it opens up new opportunities for instant mix snack manufacturers to develop high-quality protein and fibre fortified instant mix and promotes food distribution and security.

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