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Use of products developed from potato flour, defatted soy flour and corn flour in combating malnutrition

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ABSTRACT

A technique for the development of potato flour was made. Five products like cake, biscuit, weaning food, panjiri and ladoo were prepared using potato flour, defatted soy flour and corn flour. Baking and roasting were used for the development of these products. Macronutrients of processed products were comparable to the raw potatoes which showed no variation in macronutrients on processing. Significant differences in protein, ash and fat values of all the developed products were noticed because of different composition of ingredients used. All the developed products were organoleptically acceptable and had good shelf life. They could be a vehicle in improving the nutritional status of masses.

Keywords: Potato flour, Baking, Roasting, Nutritional status

Introduction

Malnutrition, according to WHO refers to the deficiency, excess or imbalance in the intake of energy and/or other nutrients. Malnutrition especially in children is a one of the major health issues in most developing countries including India. "About 54 million under five children are underweight which constitutes about 37 % of the total underweight children in the world" (UNICEF, 2011). It is a great human suffering causing major loss on the potential for development of the nation. Some of the important effects of malnutrition are low weight, retarded growth and severe muscle wasting. It increases the chances of occurrence of infectious diseases. Malnutrition also leads to decline in cognitive and motor functions in young children. Malnourished children are found to have less resistance to infection and are thus more prone to diseases (Muller et al., 2005, Lakra et. al. 2016). Hence, there is an increasing recognition of the importance of good nutrition in numerous health-related and economic outcomes (Goates et al.,2016; Nashier Gahlawat et.al., 2017).

Potatoes are cultivated in most countries all over the world. Potato is fourth in order as the important crop after rice, wheat and maize. It has significant ability to contribute to food and nutrition security of our country. Potatoes are rich source of carbohydrates which make them a good source of energy. "They also provide good quality protein with an amino acid pattern well matched to the human requirement" (Gopalan et al., 2010). Potatoes provide important nutrients in our diet such as vitamin C, potassium and dietary fiber (McGill et al., 2013). Potatoes are also a source of vitamin B6 (Kant and Block, 1990) with a medium baked potato (173 grams) providing about 26% of the RDA (USDA, 2017). Higher water content of freshly harvested potatoes makes their transportation and storage difficult. Conversion of potatoes to potato flour will be a good alternative as it will extend the shelf life of potatoes and lower the storage cost. Potato flour up to 20% can be mixed with wheat flour to prepare highly acceptable leavened flat bread called naan (Ezekiel and Singh, 2011). Though potato flour is a wholesome food but for increasing its protein content it would be beneficial to use it in combination with protein rich source. Defatted soy flour is a good source of protein. It also has the property of being easily incorporated in various food preparations (Ugarcic et al, 1991, Mashayekh et al, 2008). It contains about 1 % fat and 53-55% protein (Shurtleff and Aoyagi, 2007). Biscuits with 20% defatted soy flour has been found to acceptable (Zaker et al., 2012). To enhance the taste, texture and product appeal of the potato flour products small amounts of corn flour can be incorporated. "Maize is an important food source for much of the world's population and represents a vehicle for vitamin and mineral deficiency intervention" (Gwirtz and Garcia-Casal, 2014. Lakra et. al. 2015). Inclusion of cereal grains and potato flour in snacks has been found to increase the product textural quality (Ibanoglu et al., 2006).

Thus, an effort was made towards this vein to formulate products utilizing potato flour, defatted soy flour and corn flour. Roasting and baking as processing techniques were used in the development of products. The developed products were nutritionally evaluated. To study their shelf life they were organoleptically evaluated at regular time intervals.

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Materials and Methods

Processing Procedure

Potato flour: Potatoes of the variety 'Kufri Badshah' were procured from 'Vegetable Crops department' of CCS Haryana Agricultural University, Hisar. Potatoes were thoroughly cleaned, peeled and cut into pieces and then cooked by pressure cooking in water containing 0.5 % potassium metabisulphite. Boiled pieces were finally dried in a big oven (60^0 C) by spreading as a thin film. Dried material was then ground finely.

Defatted Soy flour: Soybean was procured from Department of Plant Breeding of CCS Haryana Agricultural University and the used to make defatted soy flour. Soybean was blanched in boiling water for removing husk. Afterwards it was dried at 60 °C overnight and milled finely. For making defatted soy flour in a conical flask one gram of soybean was immersed in 20 ml chloroform: methanol (2:1) and left overnight. On the next day the flask was slightly warmed in a water bath for two minutes. It was filtered and then dried on filter paper in the oven at 60 °C for two hours.

Corn flour: Corn was procured from the local market in a single lot and milled finely.

Development of products

Various proportions of three raw ingredients were tried. Proportion of ingredients which was liked the best organoleptically was chosen for the formulation of final products. The following products were developed by mixing the three ingredients in different ratios. (Potato flour: defatted soy flour : corn flour)

- Cake (40:30:30)
- Biscuit (40:30:30)
- Weaning food (50:30:20)
- Panjiri (50:30:20)
- Ladoo (60:25:15)

Baking was used to developing products like cake and biscuit while roasting was used processing technique for the development of weaning food, panjiri and ladoo. Unprocessed formulations were formulated by mixing the three ingredients in the same proportions and these served as control samples for their respective products.

Analytical tests

The developed products were analyzed for crude protein, ash and fat employing standard methods (AOAC, 1980). A factor of 6.25 was used for conversion of N into crude protein. Organoleptic evaluation was done by a team of ten-member panel of teaching staff and students of the Department of Foods and Nutrition. The developed potato flour products were tested for their characteristic such as color, appearance, aroma, texture, taste, and overall acceptability. "The judges recorded quality characteristics of each sample on a nine point Hedonic rating scale that is 9,8,7,6,5,4,3,2,1 for like extremely, like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, dislike very much, dislike extremely, respectively"(Gahlawat,1994). The characteristics with mean scores obtained from different panelist were calculated.

Storage Studies

To know the shelf life of the products they were kept in airtight polythene bags at 35^0 C temperature and 70-80% relative humidity. Cake, biscuit and ladoo were stored for 21 days, while weaning food and panjiri were stored for 60 days.

Statistical analysis

"The data was subjected to analysis of variance" (Snedecor and Cochran, 1967). Significance was accepted at the $P<0.05$ level.

Results and Discussion

Nutritional evaluation: Protein, ash, fat content of potato flour was almost similar to raw potatoes which indicated non-significant ($P<0.05$) effect of processing on macro nutrients of potato (Table 1).

Similar fat values (1.02%) and little lower protein content (6.22%) was reported in potato flour by Kaur and Kochhar, 2014). "Defatted soy flour and corn flour contained protein 42.65% and 10%, ash 4.83% and 2.33% and fat 0.66 and 1.83% respectively" (Gahlawat, 1994). In soy flour higher protein, fat

Table 1: Proximate composition of raw ingredients (g/100g on dry matter basis)

S No	Product	Protein	Ash	Fat
1	Potato Flour	9.51±0.22	5.83±0.28	1.00±0.28
2	Raw Potato	9.56±0.43	6.00±0.20	1.00±0.50
3	Defatted Soy flour	42.6±0.10	4.83±0.28	0.66±0.28
4	Corn flour	10.00±0.21	2.33±0.28	1.83±0.28
	SE(d)	0.23	0.20	0.26
	CD(P<0.05)	0.53	0.47	0.61

(Source: Gahlawat, 1994, p 53)

Table 2: Proximate composition of developed products (g/100g on dry matter basis) (Source: Gahlawat, 1994, p 55)

S No.	Product	Protein	Ash	Fat
1	Cake (Raw) Cake (Processed0	18.60±0.39 18.64±0.27	4.33±0.28 4.46±0.28	14.00±0.60 13.66±0.76
2	Biscuit (Raw) Biscuit (Processed)	17.2±0.38 17.26±0.19	4.8±0.28 4.80±0.28	16.00±0.50 16.02±1.00
3	Weaning Food (Raw) Weaning Food (Processed)	16.92±0.15 16.99±0.06	4.80±0.28 4.86±0.58	8.00±0.50 8.66±0.58
4	Panjiri (Raw) Panjiri (Processed)	17.01±0.27 17.04±0.27	4.83±0.28 4.8±+0.48	10.33±0.76 10.59±0.86
5	Ladoo (Raw) Ladoo (Processed)	15.2±0.19 15.44±0.09	5.16±0.28 5.26±0.28	16.16±0.76 16.50±1.32
	SE(d)	0.21	0.25	0.63
	CD(P<0.05)	0.44	0.53	1.32

Table 3: Mean scores of organoleptic characteristics of products as affected by storage period (Source: Gahlawat, 1994, p 101)

Product	Color				Appearance				Flavor			
	7	14	21	28	7	14	21	28	7	14	21	28
Cake	8.56 ±0.25	8.03 ±0.30	7.66 ±0.15	- -	8.50 ±0.26	7.70 ±0.20	6.63 ±0.28	- -	8.36 ±0.15	7.80 ±0.10	7.33 ±0.21	- -
Biscuit	8.66 ±0.23	7.66 ±0.23	7.26 ±1.15	6.80 ±010	8.53 ±0.23	7.60 ±0.10	7.06 ±0.12	6.86 ±0.15	8.60 ±0.20	8.46 ±0.05	7.10 ±0.10	6.86 ±0.15
Ladoo	8.53 ±0.15	8.00 ±0.15	7.83 ±0.21	7.73 ±0.15	8.06 ±0.21	7.80 ±0.15	7.60 ±0.25	7.40 ±0.28	7.93 ±0.05	7.46 ±0.17	7.33 ±0.20	6.83 ±0.10
SE(D)	0.16	0.12	0.12	0.14	0.16	0.13	0.15	0.15	0.14	0.08	0.18	0.16
CD(P<0.05)	0.36	0.28	0.28	0.37	0.37	0.30	0.35	0.37	0.32	0.20	0.42	0.39
Product	Texture				Taste				Overall acceptability			
	7	14	21	28	7	14	21	28	7	14	21	28
Cake	8.43 ±0.15	7.70 ±0.10	6.73 ±0.15	- -	8.36 ±0.15	7.80 ±0.10	7.33 ±0.21	- -	8.43 ±0.15	7.70 ±0.10	6.73 ±0.15	- -
Biscuit	7.76 ±0.23	7.26 ±0.15	7.30 ±0.17	7.06 ±0.10	8.60 ±0.20	8.46 ±0.05	7.10 ±0.01	6.86 ±0.15	7.76 ±0.23	7.26 ±0.15	7.30 ±0.17	7.06 ±0.11
Ladoo	7.96 ±0.05	7.60 ±0.17	7.33 ±0.20	6.93 ±0.01	7.93 ±0.21	7.46 ±0.15	7.33 ±0.25	6.83 ±0.28	7.96 ±0.05	7.60 ±0.17	7.33 ±0.20	6.93 ±0.15
SE(D)	0.12	0.13	0.11	0.11	0.14	0.08	0.18	0.16	0.12	0.13	0.11	0.11
CD(P<0.05)	0.28	0.31	0.25	0.27	0.32	0.20	0.42	0.39	0.28	0.31	0.25	0.27

Table 4: Mean scores of organoleptic characteristics as affected by storage period (Source: Gahlawat, 1994, p 102)

Product	Color				Appearance				Flavor			
	7	14	21	28	7	14	21	28	7	14	21	28
Weaning Food	8.00 ±0.10	7.60 ±0.10	7.30 ±0.10	7.10 ±0.15	7.83 ±0.15	7.50 ±0.10	7.20 ±0.10	7.03 ±0.15	7.93 ±0.15	7.50 ±0.10	6.90 ±0.10	6.33 ±0.15
Panjiri	8.56 ±0.20	8.16 ±0.15	7.60 ±0.20	7.26 ±0.10	8.46 ±0.15	7.56 ±0.21	7.20 ±0.17	7.20 ±0.10	8.43 ±0.15	7.53 ±0.15	7.03 ±0.06	6.26 ±0.15
SE(D)	0.16	0.14	0.16	0.14	0.14	0.13	0.16	0.13	0.14	0.12	0.10	0.12
CD(P<0.05)	0.36	0.31	0.36	0.31	0.31	0.29	0.36	0.29	0.31	0.27	0.24	0.27
Product	Texture				Taste				Overall acceptability			
	7	14	21	28	7	14	21	28	7	14	21	28
Weaning Food	7.86 ±0.15	7.46 ±0.11	7.20 ±0.10	6.90 ±0.10	7.66 ±0.15	7.23 ±0.15	6.60 ±0.21	6.16 ±0.06	7.83 ±0.10	7.10 ±0.10	6.90 ±0.10	6.50 ±0.10
Panjiri	8.46 ±0.15	7.56 ±0.15	7.16 ±0.11	6.66 ±0.15	8.20 ±0.20	7.56 ±0.15	6.90 ±0.10	6.10 ±0.10	8.40 ±0.10	7.40 ±0.20	7.13 ±0.05	6.86 ±0.15
SE(D)	0.15	0.11	0.11	0.16	0.13	0.11	0.14	0.11	0.11	0.13	0.11	0.14
CD(P<0.05)	0.34	0.25	0.25	0.38	0.29	0.25	0.32	0.26	0.26	0.29	0.25	0.31

and ash values have been reported in previous studies (Chandrashekhara, 1983). "Similar protein and content (9.6 to 11.2%) somewhat higher fat content (5 to 6.2%) has been reported in maize" (Saxena et al., 1984).

Among the developed products cake contained significantly (P<0.05) higher protein content (Table 2).

The higher concentration of protein in cake could be attributed to the usage of eggs which were used in the preparation of cake. Ladoo contained significantly (P<0.05) low protein value due to the small amount of defatted soy flour used while preparing it. Incorporation of a higher amount of potato flour in the preparation of ladoo contributed towards its highest ash content. Also, ladoo contained the highest fat content as 50% fat was used when it was prepared. Thus, difference in values of macronutrients of developed products were due to their compositional differences and not because of the effect of compositional variation and not due to processing effect. "One serving of 100 gram of various developed products as a snack could provide about one fourth to one fifth RDA of protein and one half to three fourth RDA of fat of an adult man" (Gopalan et al., 2007).

Organoleptic Evaluation: On 0 day of storage, all the sensory attributes of cake were liked very much, but on 14th day color and flavor attributes declined and were liked moderately while appearance and texture were in the category of liked only slightly (Table 3). Attributes like color, appearance, and flavor of the fresh biscuit was liked very much on 0 day. But on the 21st day of storage except texture, all sensory attributes were in liked slightly category. On 0-day color and appearance of ladoo were liked very much whereas flavor, texture and taste deteriorated and was in category of were liked moderately.

Color of fresh weaning food was appreciated and was in category of liked very much, while appearance, flavor, texture and taste were down in the category of liked moderately (Table 4). All sensory attributes of freshly made panjiri were liked very much. However, on the 60th day of storage, attributes like color and appearance of weaning food and panjiri were only liked slightly.

Thus, after seeing at sensory attributes it was found that biscuit and ladoo was acceptable up to 21 days of storage. Cake had acceptability up to 14 days, while weaning foods and panjiri were organoleptically acceptable till 60 days. Biscuits made with inclusion of potato flour at 25% were comparable in taste to control sample (Saini, 2017). "Replacement of 10 % corn flour into wheat flour had similar nutritional and sensory qualities which provided the bread with an overall acceptability" (Begum et al, 2014). Storage studies showed that the product developed from minor cereals and legumes possessed good overall acceptability with a shelf life of 90 days (Pradeep et al., 2014). Jemziya and Mahendran (2017) also reported that cookies made by incorporating 40% sweet potato could be stored well at 30 °C and 75-80% relative humidity up to a period of 12 weeks without any major changes in quality aspects. Thus, nutrients rich food with amicable taste would help to provide better health (Nashier Gahlawat, 2017; Liu 2013) and help in combating malnutrition.

Conclusion

The results showed that the potato flour is a highly versatile raw material which blends well with many products. The products developed from potato flour, soy flour and corn flour had good nutritional value. Moreover, they had reasonably good shelf life which enables them to be easily consumed over a long period of time. Thus, they can be used as supplements in improving the nutritional status of the malnourished masses. These developed products can be used in supplementary feeding programs under government and non-government agencies.

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