International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Development and Nutritional Evaluation of Products Using Potato Flour for Malnourished Children

Amandeep Kaur[1], Anita Kochhar[2], Priyanka Prasad[1]

[1]Research Scholar, [2]Professor,
Department of Food and Nutrition, Punjab Agricultural University, Ludhiana-141004, Punjab, India.

Corresponding Author: Priyanka Prasad

Received: 30/03/2015 *Revised: 14/05/2015* *Accepted: 21/05/2015*

ABSTRACT

Five wholesome value added products like biscuits, *vadiyan*, *kheer* and *papad* were developed and evaluated organoleptically using nine point hedonic rating scale. Accepted level of potato flour was 10, 20 and 40 per cent in biscuits, *vadiyan*, *kheer* and *papad* respectively. Highest overall acceptability score of 8.5 on nine point hedonic rating was obtained for *papad*. The developed products were analyzed for protein, fat, fiber, ash, iron and calcium by standardized methods. Incorporation of potato flour showed significant increase ($p< 0.05$) in fat, fibre, iron and calcium content of developed products as compared to control. The developed value added products could be supplemented to malnourished children under supplementary feeding programmes.

Key words: Potato flour, sensory evaluation, nutritional composition, malnourished children

INTRODUCTION

Protein energy malnutrition is the major health burden in developing countries and the most important risk factor for illnesses and death especially among young children (Muller and Krawinkel 2005). The World Health Organization estimates that about 60 per cent of all deaths, occurring among children aged less than five years in developing countries could be attributed to malnutrition (Faruque *et al* 2008). There are more than 200 million children under 5 years of age in developing countries are not developing to their full potential (McGregor *et al* 2007). In India, about 20 per cent of children under five are wasted, 43 per cent underweight and 48 per cent stunted. In terms of numbers, about 54 million under five children are underweight which constitutes about 37 percent of the total underweight children in the world (UNICEF 2011).

Potatoes (*Solanum tuberosum* L.) are one of the most important staple crops for human consumption, together with wheat, rice and corn. India occupies the third place in the global production (FAO 2012). About 328.87 million tonnes of potato are produced in the world over an area of about 19.13 million hectare. India has ample production of potatoes with average yield of 22.7 kg per hectare of Indian soil. Punjab has average yield of potato as 25.01 kg per hectare (Anonymous 2013). A higher potato

production with inadequate, expensive and unevenly distributed storage facilities has resulted in wastage of potatoes and economic loss to the farmers. So processing of potatoes is an important element to prevent post harvest losses and provide a better shelf life and nutrient quality. There is a need to process potatoes into value-added products (Mishra *et al* 2012). Processing is a viable option which can help extend the storage life, solve the storage problem, cater to the consumer preference belonging to different age groups and social strata and serve as a means to increase the supply in off seasons thus maximizing potato utilization (Avula 2005). According to estimations 25 per cent of the potatoes, which are spoiled due to several reasons may be saved by processing potatoes into various value added products and their preservation (Raj *et al* 2011). Moreover, potato is rich in carbohydrates, proteins with an amino acid pattern well matched to human requirements, phosphorus, iron, calcium, vitamin C, B_1 and B_2 and has high protein calorie ratio (Gopalan *et al* 2010). So the present study aims at preparation of different value added products using potato flour for improving nutritional status among vulnerable group.

MATERIALS AND METHODS

Procurement of raw material

Potatoes of variety 'Kufri Pukhraj' were procured from Punjab Agricultural University Seed Farm Ladhowal Ludhiana. The potatoes were sorted, washed to remove adhering dirt , peeled, sliced and blanched in boiling water for 4 min, dipped in 10% salt solution and 0.05% KMS (Potassium Metabisulphite) for 15min to avoid browning, dried in hot air oven at 60±5ºC for 8-9hr. The dried slices of potatoes were ground to fine powder and sieved. Other ingredients like wheat flour, refined wheat flour and Bengal gram flour, oil, spices, powdered sugar were procured from local market in a single lot.

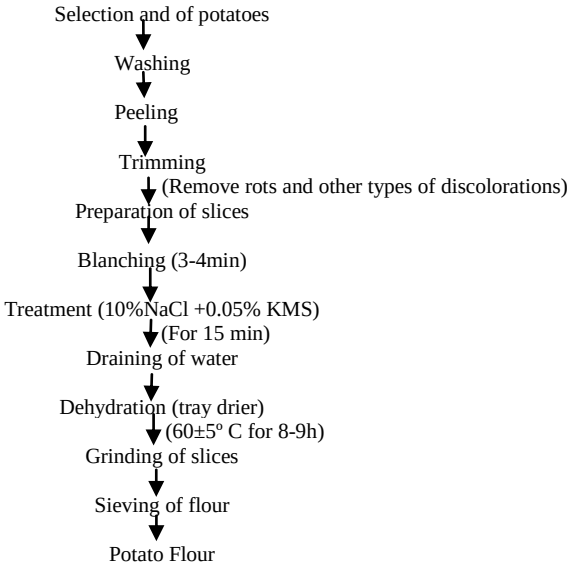

Figure 1 Preparation of potato flour

Development of value added products

Four value added products namely biscuits, *vadiyan*, *kheer* and *papad* were developed from different combinations of potato flour at different levels with other cereal and pulses. The sensory evaluation was carried out to select the most acceptable level of potato flour used in the development

of value added products. The panel of judges including faculty of Department of Food and Nutrition were provided with score card of Hedonic Rating Scale to score the test samples for their color, flavor, texture, taste and overall acceptability (Larmond 1970). To improve shelf life of developed products appropriate sanitary procedures like sterilization of utensils and preparation area, use of mouth and hand cover were adopted.

The following value added products were prepared using standardised recipes with addition of potato flour at different percentage of potato flour. The blending ratio of raw ingredient with and potato flour is shown in brackets.

1. Salty Biscuits (90:10)

Fat was creamed (50g) on clean surface. Mix maida (90g), potato flour (10g) and baking powder (1g) in maida and sieve 2-3time. Mix sugar (15g) and salt (2g) in water. Mix water (10ml) in maida, add creamed fat in maida mix thoroughly. Knead evenly till smooth dough. Roll the dough, sprinkle ajwain (2g) on dough. Cut into shape and bake at 150°c for 15-20 minute.

2. *Vadiyan* (80:20)

Soak black gram dal (80g) in water for 6 hrs. Then grind it and add a pinch of hing and 1/5th of red chilli powder in it. Keep it overnight. Add potato flour (20g) into it and make it into round shape on a cloth. Put it in the sun for drying. .

3. *Kheer* (60:40)

Soak broken rice (60g) in water for 4-5 hrs. Boil milk (500ml), add rice to it. Cook soaked rice in milk and add potato flour (40g) in it. Simmer until it reduces to half of its original quantity. Add sugar (90g) and simmer for 10-15 minutes.

4. *Papad* (60:40)

Mix rice flour (60g), potato flour (40g), a pinch of jeera, pinch of ajwain, salt 2 pinches, water 200ml and a pinch of sodium bicarbonate. Put them all in boiling water. Cook it till it binds together and starts leaving the vessel. Take it out and knead it properly. Now roll it in the shape of *papad* and keep it in the sun for drying. Fry till golden brown.

Proximate composition

Potato flour and the developed value added products were analyzed for moisture, protein, fat, fibre and total ash contents employing standard methods of AOAC (2000). A factor of 6.25 was used to convert nitrogen into crude protein.

Mineral and vitamin content

Calcium content of the potato flour and the value added products was determined by the titrimetric method of AOAC and the iron content was estimated AOAC (2000) method. Vitamin C content of potato flour and the products was estimated by AOAC (2000) method and Beta- carotene was estimated spectrophotometrically by method of Rao (1967).

Statistical Analysis

From the data obtained the mean values and standard error for each sample was calculated. The significant difference between the sensory scores and nutritional composition of the samples were analyzed using the analysis of variance (one way ANOVA) (Cheema and Sidhu 2004).

RESULTS AND DISCUSSION

The data of sensory evaluation of value added products using potato flour is presented in Figure 2. Biscuits, *vadiyan, kheer and papad* were acceptable at 10-40 per cent level of potato flour. Biscuits with 10 per cent of potato flour obtained highest score with overall acceptability 8.08 which was at par to control with overall acceptability of 7.98. *Vadiyan* with 20 per cent of potato flour obtained highest overall acceptability score of 8.20. *Kheer* with 40 per cent of potato flour obtained highest

overall acceptability score of 8.5 as compared to control with overall acceptability of 8.22. *Papad* with 40 per cent of potato flour obtained highest score with overall acceptability 8.5 which was liked at par to control with overall acceptability score of 8.2. Similar results value added products with potato flour for biscuits were reported by Yadav *et al* (2006) and Seevaratnam *et al* (2012).

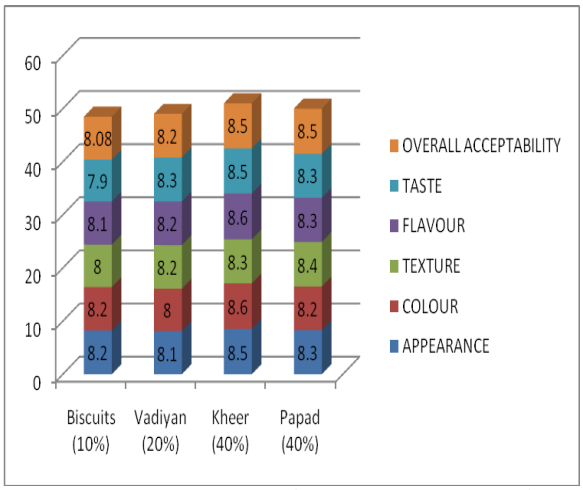

Figure 2 Sensory evaluations of products using potatoes flour

The proximate composition of potato flour has been presented in the Table 1. The moisture content potato flour was found to be 13.07. The protein content was found to be 6.22g whereas in fresh potatoes it was 1.6g/100g. Crude fat and crude fibre content in potato flour was 1.02 and 4.22 g respectively which was higher than that present in fresh potatoes. Total energy content provided by potato flour was 327.42 higher as compare to that of fresh potatoes. Calcium content in fresh potatoes was 10mg whereas in potato flour it was 19.38mg/100g. Iron content in fresh potatoes was 0.48mg whereas in potato flour it was 3.82mg/100g. Potato flour gives 0.88mg of beta-carotene and 9.95mg of vitamin C.

Table 1 Nutrient Composition of Potatoes and Potato Four (per 100g) (dry weight basis)

	Potatoes	Potato flour
Moisture (g)	74.7 g	13.07 g
Crude Protein(g)	1.6 g	6.22 g
Crude Fat (g)	0.1 g	1.02 g
Crude Fibre (g)	0.4 g	4.22 g
Carbohydrates (g)	22.6 g	73.34 g
Energy (Kcal)	97 Kcal	327.42 Kcal
Beta-Carotene (µg)	24 µg	0.88 µg
Vitamin C (mg)	17 mg	9.95 mg
Calcium (mg)	10 mg	19.38 mg
Iron (mg)	0.48 mg	3.82 mg

The proximate composition of value added products developed using potato flour is summarized in Table 2. The moisture content of biscuits ranged from 6.4% for control to 6.6% with incorporation of potato flour in accepted level (10%). The protein content of the control was significantly different ($p<0.05$) with that of the acceptable level of 7.53%. The fat content ranged from 36.1% for control to 36.4% for accepted level with potato flour. The fibre content of biscuits ranged between 0.2% for control to 1.0% for accepted level with significant difference ($p<0.05$). The ash content of biscuits ranged from 0.42% for control to 0.51% for accepted level. The moisture content of *vadiyan* ranged from 2.5% for control to 2.36% potato flour in accepted level (20%). The protein content of the control was found to be 8.36% which was significantly different ($p<0.05$) from the acceptable level. The fat content ranged from 6.73% for control to 5.58% for accepted level. The fibre content of *vadiyan* ranged between 0.8% for control to 1.48% for accepted level. The ash content of *vadiyan* ranged from 2.4% for control to 2.56% for accepted level with significant difference ($p<0.05$). The moisture content of *kheer* ranged from 4.58% for control to 4.99% with incorporation of 40 per cent potato flour in accepted level. The protein content of the control was significantly different ($p<0.05$) from acceptable level of 13.89%. The fat content ranged from 3.1% for control to 2.78% for accepted level. The

fibre content of *kheer* ranged between 0.45% for control to 2.5% for accepted level with significant difference ($p<0.05$). The ash content of control *kheer* differed significantly ($p<0.05$) with that of accepted level of *kheer* with potato flour. The moisture content of *papad* ranged from 0.35% for control to 0.89% with potato flour at accepted level (40%). The protein content of the control was found to be 6.8% while the acceptable level was 6.56% with significant difference ($p<0.05$) as compare to control. The fat content ranged from 5.5% for control to 5.7% for accepted level with no significant difference ($p<0.05$) as compare to control. The fibre content of *papad* ranged between 1.2% for control to 1.80% for accepted level. The ash content of *papad* ranged from 1.3% for control which was significantly different ($p<0.05$) with that of accepted level. Munasinghe et al. (2013) reported significantly higher protein, fat, energy, total ash content in yoghurt based supplementary food. Energy, fat and protein content were reported as 430 kcal, 16 % and 14% in corn soy based supplementary food (Amegovu et al 2014). Similar results for proximate composition were reported by Sadana and Chabra (2004).

Table 2 Proximate composition of developed products (% dry weight basis)

Products	Protein %	Fat %	Fibre %	Ash %
Biscuits				
Control	7.9±0.12	36.1±0.3	0.2±0.3	0.42±0.1
Accepted	7.53±0.13	36.4±0.3	1.0±0.3	0.51±0.1
t-value	34.7**	NS	97.9**	12.24**
Vadiyan				
Control	8.36±0.14	6.73±0.21	0.8±0.1	2.4±0.3
Accepted	7.93±0.13	5.58±0.20	1.48±0.1	2.56±0.3
t-value	34.2**	68.83**	29.7**	10.44**
Kheer				
Control	15.67±0.035	3.1±0.01	0.45±0.3	2.08±0.2
Accepted	13.89±0.03	2.78±0.02	2.5±0.28	2.36±0.3
t-value	36.04**	7.36**	89.05**	7.94**
Papad				
Control	6.8±0.26	5.5±0.062	1.2±0.02	1.3±0.06
Accepted	6.56±0.24	5.7±0.061	1.80±0.2	1.46±0.5
t-value	7.95**	NS	NS	10.39**

** Significant at 5% level

The mineral content in developed products is summarized in Table 3. With addition of potato flour at 10%-40% level, the iron content increased significantly ($p<0.05$) for biscuits, *kheer* and *papad* when compared to control which while no significant difference was observed for *vadiyan*. The iron content of biscuits with 10 per cent potato flour was 2.61mg/100g, *vadiyan* with 20 per cent potato flour was 4.40 mg/100g. The iron content of *papad* and *kheer* at 40 per cent level of potato flour was found to be 1.78 and 1.26 mg/100g respectively. The calcium content of biscuits was 16.48 mg /100g. The calcium content of *vadiyan* at 20% level of potato flour as 96.67 mg/100g differed significantly ($p<0.05$) from control. The calcium content of control *kheer* and *papad* were found to be 920.3 mg and 5.68 mg/100g which increased to 968.56 mg and 9.72mg/100g with incorporation of 40 per cent potato flour with significant difference ($p<0.05$). Amegovu et al (2014) reported iron content as 12 to 16 mg in supplementary foods. Ghatge (2012) observed iron content as 6.3 n soy based supplementary food.

Table 3 Mineral content of developed products (mg/100g on dry weight basis)

Products	Iron (mg/100g)	Calcium mg/100g)
Biscuits		
Control	2.27±0.02	16.52±0.22
Accepted	2.61±0.021	16.48±0.23
t-value	9.34**	NS
Vadiyan		
Control	4.34±0.2	109.19±0.3
Accepted	4.40±0.19	96.67±0.2
t-value	NS	76.8**
Kheer		
Control	0.92±0.14	920.3±0.12
Accepted	1.26±0.13	968.56±0.11
t-value	3.17**	703.86**
Papad		
Control	0.58±0.4	5.68±0.38
Accepted	1.78±0.34	9.72±0.03
t-value	42.13**	46.91**

** Significant at 5% level

Yeast count in potato flour at 1 month, 2 month and 3month interval was 1.3×10^4, 1.8×10^4 and 2.9×10^4 cfu/g

respectively. Yeast count of developed value added product biscuits at 1 month, 2 month and 3 month interval ranged from 1.0 to 6.5×10^4 cfu/g, for *vadiyan* ranged from 2.23 to 2.7×10^4 cfu/g, for *kheer* ranged from 2.0 to 3.9×10^4 cfu/g and for *papad* ranged from 2.52 to 3.0×10^4 cfu/g respectively. Microbial testing of potato flour revealed that the flour can be kept safely in polyethylene pouches for three months without any spoilage.

Popularization of the value added products using potato flour among self help groups

Five days training course on "Value Addition of Potatoes" was organised for members of self help group in PAU, Ludhiana. Members of self help groups from different villages of Ludhiana district of Punjab namely Ayali Kalan, Bains, Lohara, Moga and members from local areas of Ludhiana city participated in the training course. Value added products using potato flour were popularized among the self help groups by lectures, demonstrations and distributing booklet on potato based recipes for nutritional and health benefits of children.

CONCLUSION

Potato flour can be stored safely with no adverse changes in nutritional value for up to three months both at room temperature. The developed value added products using potato flour could be recommended for malnourished children, pregnant and lactating mothers under supplementary feeding program run by government and non- government agencies.

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How to cite this article: Kaur A, Kochhar A, Prasad P. Development and nutritional evaluation of products using potato flour for malnourished children. Int J Health Sci Res. 2015; 5(6):554-560.

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