J. Int. Sci. Technol. 2020, 8(1), 6-11 Article

Journal of Integrated
SCIENCE & TECHNOLOGY

Effect of processing on total and extractable mineral content of products developed using potato flour, defatted soy flour and corn flour

Poonam Lakra,[1*] Salil Sehgal,[2] Indu Nashier Gahlawat[1]

[1]*Aditi Manavidyalaya, University of Delhi, Delhi India.* [2]*CCS Hisar Agricultural University, Hisar, Haryana, India.*

Received on: 21-Mar-2020, Accepted and Published on: 01-May-2020

ABSTRACT

In the present study for making potato flour a technique was standardized. Defatted soy flour and corn flour were incorporated in proper ratio for making five different products viz. cake, biscuit, weaning food, panjiri and ladoo. The major processing techniques involved were baking and roasting for the preparation of these products. It was found that protein, ash and fat contents of potato flour was where comparable to values of raw one. It was observed that among the prepared products there was significant variation in protein, ash and fat contents. Total mineral content of the prepared products was unaffected by processing. The products thus developed had higher values for mineral availability when compared to the raw ones. These developed products can be of great use in eliminating prevalent mineral deficiencies.

Keywords: Potato flour, Soy flour, Corn flour, Baking, Roasting, Mineral Availability

INTRODUCTION

India is the major producer of potato in the world. But the potatoes are harvested just before the start of hot summers followed by the humid rainy season. Such conditions do not support safe storage of potato storage. Thus, cold storage is necessary to reduce the storage losses. In India large portion of available cold storage facilities are used only for potato storage, but still it is not sufficient to preserve all produce. Moreover, cold potatoes become brittle and may get easily bruised during handling. Presence of about 70-80% water in potatoes makes the transportation costly. If the potatoes are converted to potato flour with efficient technology it would be of great help to both growers and consumers. In the past potato flour has been linked with the baking of bread. Potato flour up to 20% can be incorporated into wheat flour to prepare leavened bread known as naan having high acceptability.[1] It can also be incorporated in preparing the noodles up to 35%. Moreover, incorporation of potato flour while preparation of noodles enhanced their taste and flavour.[2]

Although potato is considered to be a wholesome food but to further improve its nutritive value, especially protein content it is good to use it along with protein rich sources. Defatted soy flour is a commonly used in various common food preparations. The higher protein content of soyabean has a nutritional significance especially for the developing countries, where large proportion of population including children, rarely consume food with high protein value due to high cost .[3] Defatted soy flour have been easily used in the preparation of textured products, bread, biscuits, chapatis, and other snacks.[4,5] "Corn is a major source of carbohydrates, protein, vitamin B, vitamin A and minerals".[6] To make the products more appealing corn can be incorporated in some amounts. Maize is a popular grain for large proportion of the population in the world and can be used as a source to provide vitamins and minerals to the massess.[7]

*Corresponding Author: Dr. Poonam Lakra, Aditi Mahavidyalaya, University of Delhi, Delhi
Email: poonam03lakra@yahoo.com

Cite as: *J. Int. Sci. Technol., 2020, 8(1), 6-11.*

 ISSN: 2321-4635 http://pubs.iscience.in/jist

Cereals and pulses provide major portion of calories and protein in Indian diet. Due to antinutritional factors such as phytic acid[8] and polyphenols[9] present in large amounts, the HCl -extractability of minerals which indicates the bio- availability of minerals from cereal and pulses, may be less as they combine with divalent cations.[10] Some common antinutrients present in plants are phytate, saponins, tannins, polyphenolic compounds, and also protease inhibitors. These compounds inhibit the mineral absorption and protein digestibility and thus reduce the nutritive value of foods. They can also cause toxicity and some health ailments when consumed in higher amounts.[11] It was reported that consumption of antinutrients can lead to nutrient deficiencies.[12] Following the processing methods like fermentation and heat treatment the amount of phytic acid[13,14] and polyphenols[15] and trypsin inhibitors[16] reduce and availability of minerals improve.[17]

Keeping all these points into mind, a study was pursued to develop the products with value addition using three ingredients, potato flour, defatted soy flour and corn flour. Home level techniques processing techniques like baking and roasting were followed in the making of these products. The products thus developed were evaluated nutritionally and also effect of these processing methods on total and HCl-extractable minerals was investigated.

MATERIALS AND METHODS

MATERIALS

Potatoes (Solanum tuberosum) belonging to the variety 'Kufri Badshah' were taken from Vegetable Crops Department of the CCSHAU, Hisar. The potatoes were cleaned, cut into big pieces and then boiled in water having 0.5% potassium metabisulphite. The boiled potato pieces were mashed by masher, and spread as a very thin film and dried in the oven at 60 ℃. After drying it was ground in mixer into very fine powder.

Soybean was taken from the Plant Breeding Department of the university in the single lot. Soybean was cleaned and boiled in water for 10 min to remove the husk by rubbing. Dehulled soybean was then dried in the oven and milled into fine powder. For defatting process, one gram of soybean was weighed and soaked in conical flask containing mixture of chloroform and methanol (2:1) and it was left overnight undisturbed. The next day the flask was put in a water bath and warmed for 2 min. It was then filtered with the help of filter paper and dried in the oven at 60 ℃for 2 hours.

Corn was purchased from the nearby local market, cleaned washed, dried and milled.

PREPARATION OF PRODUCTS

These three raw ingredients were tried in different proportions for different chosen recipes. After sensory evaluation by hedonic scale the ratio of raw ingredients which was rated at high level was taken for making of final products. The following products were made by using the raw material in different combination. (Potato flour: Defatted soy flour: Corn flour)

1. Cake (40:30:30)

   Baking powder (1/2 t) was mixed properly to the mixture of flours (100 g) and then sieved in fine sieve. Four eggs were beaten till fluffy peaks were obtained and the mixture was beaten for some more time after addition of sugar. To this flour mixture was added and mixed thoroughly. Thirty grams of ghee was melted and mixed properly in it. After that the batter was transferred to the baking tin and baked in preheated oven for 15 minutes at temperature of 180 ℃.

2. Biscuits (40:30:30)

   Ground sugar (50 g) and ghee (40 g) was measured and creamed well in a mixing bowl. To the flour mixture (100 g) baking powder was mixed properly and sieved. The creamed mixture was beaten further after addition of half egg to it. The dough thus prepared was chilled in the freezer for half an hour. After that round and smooth balls were prepared from it and arranged in a baking tray. It was baked in pre heated oven for 10 minutes at 120 ℃. temperature

3. Ladoo (60:25:15)

   All three type of flours (100 g) were taken in the required ratio. In a wok ghee (50 g) was melted and flours mixture was roasted until it was brown. The wok was removed from fire and cooled and small ladoos were formed.

4. Weaning Food (50:30:20)

   In a wok all three type of flours (100 g) were roasted properly in ghee (10 g) on slow flame until brown. The mixture was then cooled and sugar was added to it.

5. Panjiri (50:30:20)

   In a wok all three flours (100 g) were roasted in ghee (15 g) on slow flame until brown. The mixture was then cooled and coconut powder (15 g) and sugar (50 g) was added to it.

For control unprocessed products were prepared using ingredients in the same combinations.

CHEMICAL ANALYSIS

Crude protein, ash and fat in the samples were determined as per AOAC[18] methods. The samples were wet acid digested using the mixture of nitric acid and perchloric (HNO_3:$HCLO_4$) in the ratio 5:1(V/V). The amounts of Fe and Zn in the digested sample was estimated by using atomic absorption spectrophotometry.[19] Ca in the digested sample was estimated by titration method[20] using hydroxylamine hydrochloride, triethanolamine, polyvinyl alcohol and adding calcon as the indicator. The violet colour thus obtained was titrated against 0.01 N EDTA solution to get a bluish green end point.

The minerals in the developed samples were extracted in 0.03 N HCl by shaking the mixture at 37 ℃for 3 h.[21] The clear extract received after filtration with Whatman - 42 filter paper was dried in oven at 100 ℃and digested as mentioned earlier. The amounts of extractable Ca, Fe and Zn in the samples were estimated by the methods described above for the determination of total amounts of the minerals.

Mineral extractability (%)

$$= \frac{\text{Mineral extractable in 0.03 N HCl} \times 100}{\text{Total minerals}}$$

STATISTICAL ANALYSIS:

Experiments were carried out in three replications. The data was analysed according to the standard methods of statistical analysis.[22]

RESULTS AND DISCUSSION

NUTRITIONAL VALUE

The results showed insignificant differences in protein, ash and fat content of potato flour and raw potatoes. It showed processing had no effect on macronutrients content of potatoes. The protein, ash and fat values of potato flour, defatted soy flour and corn flour ranged from 9.51 to 42.65 g/100g, 2.33 to 6.00 g/100g and 0.66 to 1.83 g/ 100 g respectively (Table 1, Figure 1).

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

	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

Note: Values are mean ± SD of three independent determinations. (Source: Gahlawat, 1994, p 53)[23]

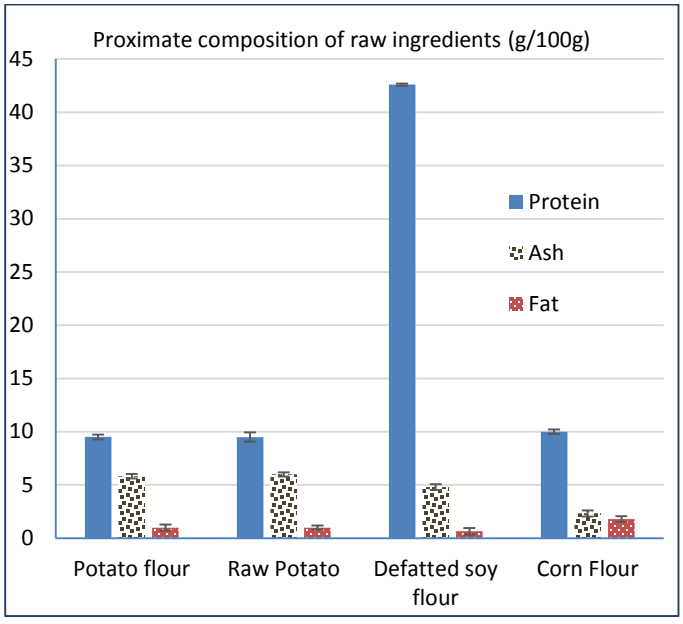

Figure 1. Proximate composition of raw ingredients (g/100g on dry matter basis)

Similar fat content (1.02%) and but lower amount of protein content (6.22%) was present in potato flour obtained in earlier studies[23]. Defatted soy flour and corn flour had protein content 42.65% and 10%, ash content 4.83% and 2.33% and fat content 0.66 and 1.83% respectively. But, somewhat higher amount of protein, fat and ash was reported in soy flour.[24,25]. Similar amount of protein (9.6 to 11.2%) and higher fat content (5 to 6.2%) was seen in maize.[26] Also, in another study 8-10% protein and 4-5% fat was present in corn.[27]

The protein, ash and fat values of developed products had variation from 15.44 to 18.64 g, 4.46 to 5.26 g and 8.66 to 16.50 g per 100 g respectively (Table 2).

Table 2: Proximate composition of developed products (g/100g on dry matter basis)

	Product	Protein	Ash	Fat
1	Cake (Raw) Cake (Proc)	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 (Proc)	17.20 ± 0.38 17.26 ± 0.19	4.80 ± 0.28 4.80 ± 0.28	16.00 ± 0.50 16.02 ± 1.00
3	Weaning Food (Raw) Weaning Food (Proc)	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 (Proc)	17.01 ± 0.27 17.04 ± 0.27	4.83 ± 0.28 4.80 ± 0.48	10.33 ± 0.76 10.59 ± 0.86
5	Ladoo (Raw) Ladoo (Proc)	15.20 ± 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

Note: Values are mean ± SD of three independent determinations. (Source: Gahlawat, 1994, p 55)[23]

It was observed that among baked and roasted products cake had significantly (P<0.05) higher protein content. This may be due to use of protein rich eggs in the preparation cake. Ladoo had significantly (P<0.05) lower amount of protein as it had less amount of protein rich defatted soy flour in its preparation. Ladoo ranked highest with regard to ash content as potato flour was used in greater amount in its preparation. In ladoo highest fat content was found due to 50% fat used in its preparation. Thus, different values in products developed is because to their different composition and not due to different processing effect. "One serving of 100 g of developed products as tea time snack is sufficient to meet about 1/4 to 1/5th recommended dietary allowances (RDA) of protein and 1/2 to 3/4th (RDA) of fat of an adult man".[28]

EFFECT OF PROCESSING

Mineral composition of potato flour and raw potato was similar which indicated no effect of processing on total mineral content (Table 3) (Figure 2-4).

Table: 3 Total calcium, iron and zinc(mg/100g) in raw ingredients (on dry matter basis)

	Ingredients	Total calcium	Total iron	Total zinc
1	Potato flour	86.66 ± 1.25	4.06 ± 0.16	4.90 ± 0.21
2	Raw potato	87.66 ± 4.04	4.11 ± 0.23	5.10 ± 0.36
3	Defatted soy flour	228.33 ± 10.10	10.13 ± 0.75	3.36 ± 0.11
4	Corn flour	19.68 ± 0.46	2.30 ± 0.27	2.38 ± 0.07
	SE(d)	3.18	0.35	4.47
	CD(P<0.05)	7.25	0.80	10.32

Note: Values are mean ± SD of three independent determinations. (Source: Gahlawat, 1994, p 77)[23]

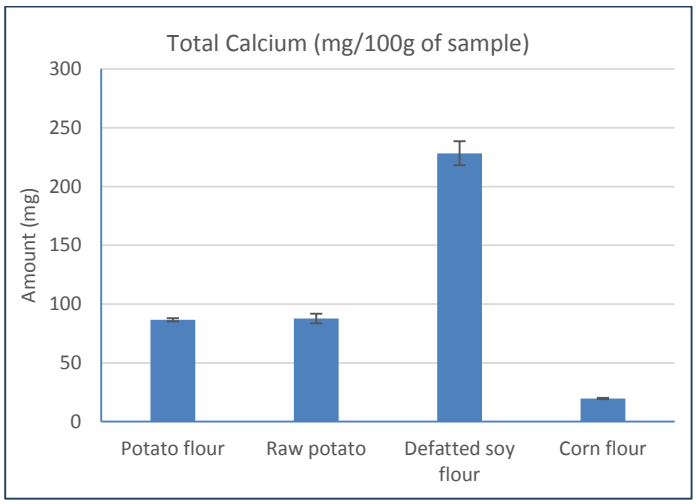

Figure 2. Total calcium content of the raw ingredients

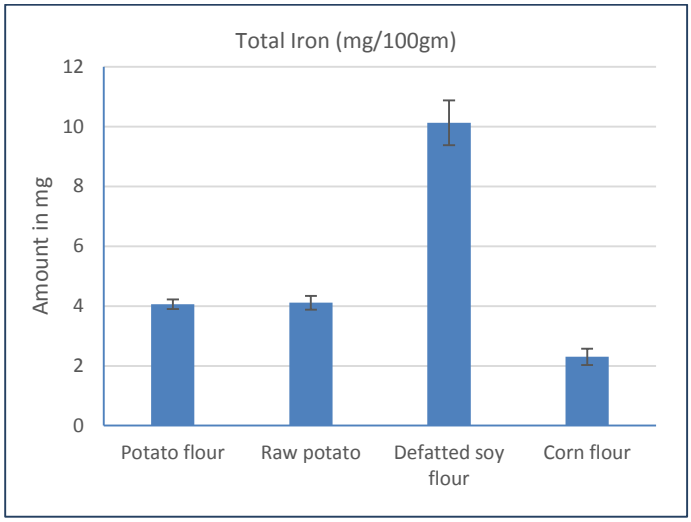

Figure 3. Total iron content of the raw ingredients

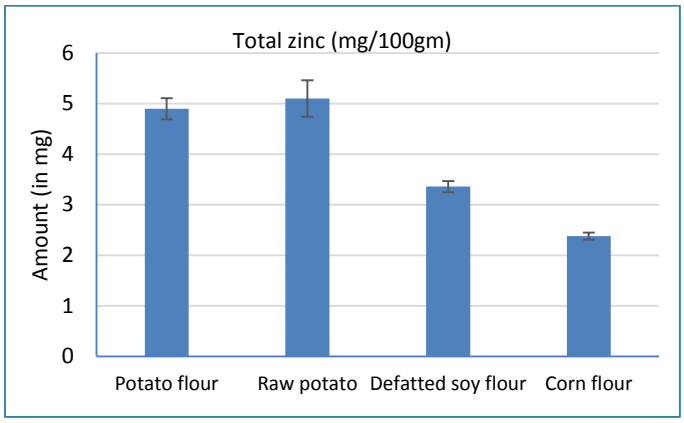

Figure 4. Total zinc content of raw ingredients

Non-significant differences were observed in calcium content of cake, weaning food, panjiri and ladoo (Table 4).

Table 4: Total calcium, iron and zinc (mg/100g) in products (on dry matter basis)

S No	Products	Total calcium	Total iron	Total zinc
1	Cake(raw)	117.33 ±2.02	5.33 ±0.21	3.88 ±0.12
	Cake (Proc)	118.00 ±0.50	5.36 ±0.23	3.90 ±0.22
2	Biscuit(raw)	114.83 ±1.75	5.30 ±0.22	3.95 ±0.13
	Biscuit (Proc)	113.16 ±2.08	5.28 ±0.26	3.93 ±0.17
3	Weaning food(raw)	119.25 ±0.35	5.50 ±0.14	4.27 ±0.17
	Weaning food(Proc)	117.83 ±3.54	5.43 ±0.12	4.26 ±0.10
4	Panjiri (raw)	117.00 ±3.12	5.31 ±0.16	4.31 ±0.10
	Panjiri (Proc)	117.80 ±3.96	5.30 ±0.17	4.28 ±0.15
5	Ladoo (raw)	114.66 ±2.02	5.16 ±0.17	4.28 ±0.10
	Ladoo (Proc)	114.50 ±3.00	5.20 ±0.15	4.23 ±0.12
	SE(d)	2.10	NS	0.12
	CD(P<0.05)	4.40		0.25

Note: Values are mean ± SD of three independent determinations. (Source: Gahlawat,1994, p 79)[23]

Iron content of the developed products were similar. Zinc content of weaning food, panjiri and ladoo was similar and significantly(P<0.05) higher than zinc content of cake and biscuit due to higher amount of potato flour (60%) used in their preparation. Processing had no significant effect on total mineral content. After cooking and autoclaving of legumes there was no variation in Mg, Fe, Mn and Zn amount of legumes.[29] Mineral content was same after baking in sweet potatoes.[30] The products developed in the study were good sources of minerals. "One serving (100 g) of developed products contributed approximately 1/4th of calcium RDA and 1/5th of iron RDA of an adult man".[28]

Potato flour, raw potato, defatted soy flour and corn flour had 48.4% to 56.3% calcium extractability, 34.4% to 39.2% iron extractability and 40.9% to 45.9% Zn extractability (Table 5; Figure 5).

Table 5: HCl extractability (%) of calcium, iron and zinc in raw ingredients (on dry matter basis)

	Ingredients	Calcium	Iron	Zinc
1	Potato flour	56.27 ± 2.06	39.17 ± 1.96	45.91 ± 1.02
2	Raw Potato	54.89 ± 1.77	38.94 ± 2.12	44.63 ± 1.09
3	Defatted soy flour	48.37 ± 0.97	34.35 ± 0.75	40.91 ± 0.87
4	Corn Flour	50.03 ± 4.19	35.05 ± 0.78	41.80 ± 2.03
	SE(d)	2.08	1.26	1.09
	CD(P<0.05)	4.79	2.91	2.52

Note: Values are mean ± SD of three independent determinations. (Source: Gahlawat, 1994, p 81)[23]

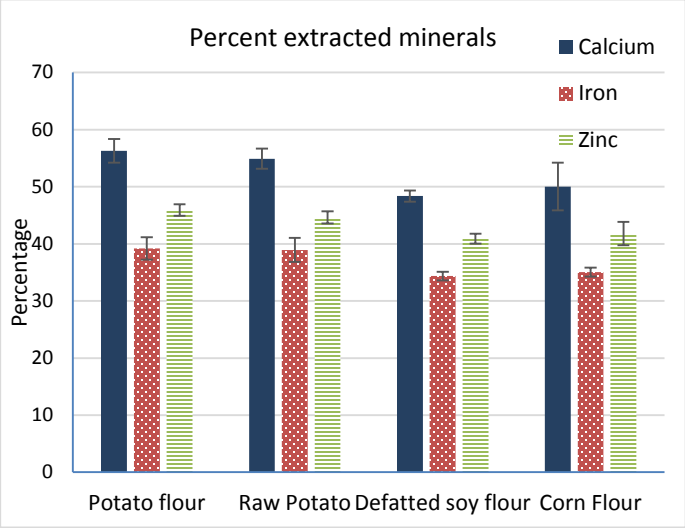

Figure 5. HCl extractability (%) of calcium, iron and zinc in raw ingredients (on dry matter basis)

HCl extractability of calcium, iron and zinc was almost similar in all products (Table 6). Baking and roasting increased the extractability of calcium, iron and zinc by 19.31 to 20.82 %, 15.12 to 16.48 % and 10.31 to 12.61 % respectively.

Table 6: HCl extractability (%) of calcium, iron and zinc in products (on dry matter basis)

	Product	Calcium	Iron	Zinc
1	Cake(raw) Cake (Proc)	46.79 ± 1.07 55.88 ± 1.35 (19.42)	35.97 ± 1.41 41.41±5.68 (15.12)	42.24 ± 1.94 47.57 ± 0.29 (12.61)
2	Biscuit(raw) Biscuit (Proc)	46.19 ± 2.22 55.11 ± 2.47 (19.31)	36.16 ± 1.96 41.69 ± 0.92 (15.29)	42.86 ± 0.95 48.09 ± 2.48 (12.20)
3	Weaning food(raw) Weaning food (Proc)	47.96 ± 1.45 57.31 ± 0.34 (19.49)	34.40 ± 0.65 40.07 ± 1.24 (16.48)	43.91 ± 1.78 48.67 ± 1.76 (10.84)
4	Panjiri(raw)	48.14 ± 1.78	35.16 ± 1.05	43.55 ± 1.76
	Panjiri (Proc)	57.97 ± 1.07 (20.41)	40.80 ± 1.00 (16.04)	48.55 ±1 .76 (11.48)
5	Ladoo(raw) Ladoo(Proc)	47.30 ± 0.84 57.15 ± 1.97 (20.82)	34.20 ± 1.12 39.45 ± 1.92 (15.35)	44.12 ±1.36 48.67 ±1.80 (10.31)
	SE(d)	1.32	1.83	1.32
	CD(P<0.05)	2.78	3.83	2.75

Values are mean ± SD of three independent determinations. Values in parentheses indicate per cent increase over control values. (Source: Gahlawat,1994, p 83)[23]

It was reported that the iron, magnesium, zinc and potassium extractability in the autoclaved samples were significantly (P<0.05) greater when compared to non-autoclaved soybean meal. It indicated there change in the solubility occurs during heat processing.[31] Phytic acid (myo-inositol hexaphosphate) is commonly present in cereals, nuts, legumes and oil seeds, up to 1–5%. A significant reduction of about 61% in phytic acid content was reported in roasted ragi.[32] In a study it was reported that autoclave and microwave treatments reduced the total phytic acid amount and increased the HCl extractability of minerals present in whole wheat bread.[33] It has been observed by some previous studies that on decrease of phytic acid content availability of the minerals increase.[34] A negative correlation is observed between the concentration of anti-nutrients and degree of bioavailability of micronutrients like minerals.[35] On roasting phytic acid content decreases by 40 % in wheat, barley and green gram.[36] Upon open-pan roasting moderate reduction of phytic acid level (12–20%) was reported in legume seeds. [37] Further it was also reported that the toasting procedure led to significant decrease in activity of trypsin-inhibitor of the toasted meal of soybean as compared to the seed.[38] Protease inhibitors because of their protein nature are easily denatured by heat treatment.[39] This study support and is in continuation of our reports for better nutritional values of foods.[40-44]

CONCLUSION

From the present study it can be summarised that potato flour is a versatile food ingredient and has the ability to be used with several other products. The developed products had nutritive value of good level. Roasting and baking which are commonly used in our household proves to be effective in decreasing antinutrients in the developed products. This further enhanced the HCl extractability of minerals in the developed products. These developed products could be an option to be introduced in feeding programmes organised by government departments for addressing the nutritional needs of poor children, malnourished pregnant women and lactating mothers.

Conflict of Interest: Authors declare no conflict of interest.

REFERENCES

1. R. Ezekiel, N. Singh, Use of Potato Flour in Bread and Flat Bread, Impact of fibres on physical characteristics of fresh and staled bake-off bread, *Breadmaking* (Second Edition). Improving Quality, **2011**, 247-259.
2. C. Lingling, T. Yange, T. Shuangqi, W. Yanbo, G. Fuqiang, Preparation of Potato Whole Flour and Its Effects on Quality of Flour Products: A Review, *Grain Oil Sci Technol.***2018**, 1(3), 145-150.
3. D. Edem, J. Ayatse, E. Itam, Effect of soy protein supplementation on the nutritive value of 'gari'(farina) from Manihot esculenta, *Food Chem.* **2001**, 75, 57–62.

4. Z. Ugarcic, S. Davidovic, V. Ferric, J. Krosto, Studies into use of defatted soy meal for bread making, *Hrana Ishrana*, **1991**, 32, 201-203.
5. M. Mashayekh, M.R. Mahmoodi, H.E. Mohammad, Effect of fortification of defatted soy flour on sensory and rheological properties of wheat bread, *Int. J. Food Sci. Technol.* **2008**, 43, 1693-1698.
6. A. Misra, K. Kulshrestha, Potato flour incorporation in biscuit manufacture, *Plant Food Hum. Nut* **2003**, 58, 1-9.
7. J.A. Gwirtz, M.N. Garcia-Casal, Processing maize flour and corn meal food products, *Annals New York Acad. Sci*. **2014**, 1312, 66-75,
8. A. Akond, H. Crawford, J. Berthold, Z.I. Talukder, K. Hossain, Minerals (Zn, Fe, Ca and Mg) and Antinutrient (Phytic Acid) Constituents in Common Bean, *American J. Technol.* **2011**, 6(3), 235–243.
9. B.M. Chauhan, N. Suneja, C.M. Bhat, Nutritional value and fatty acid composition of some high yielding varieties of bajra, *Bulletin Grain Technol*. **1986**, 21, 41-42.
10. K.B. Nolan, P.A. Duffin, Effect of phytate on mineral availability. In vitro studies on Mg2+, Ca^{2+}, Cu^{2+} and Zn^{2+} solubilities in the presence of phytate, *J. Sci. Food Agri*. **1987**, 40, 79-83.
11. M. Samtiya, R.E. Aluko, T. Dhewa, Plant food anti-nutritional factors and their reduction strategies: an overview. *Food Prod Process and Nutr*. **2020**, 2, 6.
12. A. Popova, D. Mihaylova, Antinutrients in Plant-Based: A Review, *The Open Biotechnol. J*. **2019**, 13, 68-76.
13. S.H. Awadha, A. Hady, B. Amra, M. Hassan, I. Ali, E.E. Babiker, Antinutritional factors content and availability of protein, starch minerals of maize (*Zea Mays*) and lentil(*Lens culinaris*) as influenced by domestic processing, *J. Food Technol.* **2005**, 2, 523-528.
14. N. Azhari, A. Sokrab, Isam A.M. Ahmed, E.E. Babiker, Supplementation and cooking of pearl millet: Changes in anti-nutrients and total minerals content and extractability, *Innovative Romanian Food Biotechnol.* **2014**, 15, 9-22.
15. S.C. Sidhu, N. Khetrapaul, Fermentation with one step single and sequential cultures of yeasts and lactobacilli: Effect on anti-nutrients and digestibilities (*in vitro*) of starch and protein in an indigenously food mixture, *Plant Foods Human Nut.* **2003**, 58, 1-10.
16. E. A. Shimelis, S. K. Rakshit, Effect of processing on antinutrients and in vitro protein digestibility of kidney bean (*Phaseolus vulgaris L.*) varieties grown in East Africa, *Food Chem.* **2007**, 103(1), 161-172.
17. W.H. Idris, R. Abdel, S.M. Rahman, H.B.El Maki, E.E. Babiker, E.I. Timay, Effect of germination, fermentation and cooking on phytic acid and tannin contents and HCl extractability of minerals of sorghum (*Sorghum biocolor*) cultivars, *J. Food Technol.* **2005**, 3, 410-416.
18. A.O.A.C. *Official methods of analysis*, 13th ed., Association of Official Analytical Chemists, Washington, DC, **1980**, 125-39, 746.
19. W.I. Lindey, M.A. Norwell, A new DPTA-TEA soil test for zinc and iron, *Agronomy Abstracts*, **1967**, 61, 84-90.
20. Vogel,*Text book of quantitative inorganic analysis*, 3rd edn. Longmans, London, **1962**.
21. W. H. Peterson, J.T. Skinner, F. M.Strong, *Elements of food Biochemistry*. Prentice Hall, New York, **1949**, p-73.
22. G.W. Snedecor, W.G. Cochran, *Statistical methods*. Oxford IBH Publishing Co., New Delhi, **1967**.
23. P. Gahlawat. Thesis. *Post-Harvest utilization of potatoes in development of nutritious food products* (Doctoral dissertation, College of Home Science Chaudhary Charan Singh Haryana Agricultural University Hisar). **1994** URL:http:/krishikosh.egranth.ac.in/handle/1/5810077083
24. A. Kaur, A. Kochhar, P. Prasad, Nutritional evaluation of value added products using potato flour. *International J. Health Sci. Res.* **2016**, 6, 466-472.
25. S. Chandrashekhara, S.R. Shurpalekar, Some chemical pasting, rheological and textural characteristics of composite flour based on wheat and tubers, *J. Food Sci. Technol.***1983**, 20, 308.
26. M.D. Zaker, T.R. Genitha, S.I. Hashmi, Effects of Defatted Soy Flour Incorporation on Physical, Sensorial and Nutritional Properties of Biscuits, *J. Food Processing Technol.* **2012**, 3, 4.
27. A.K. Saxena, A. K. Sharma, K. L. Sehgal, A. K. Bakshi, Proximate composition and nutritive value of some improved varieties of maize of Punjab, *Indian J. Nutrition Dietetics*, **1984**, 21, 233.
28. P.S. Prasanthi, N. Naveena, M. Vishnuvardhana Rao, K. Bhaskarachary, Compositional variability of nutrients and phytochemicals in corn after processing, *J. Food Sci. Technol*. **2017**, 54(5), 1080–1090.
29. C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian, S. C. Nutritive value of Indian foods. Hyderabad, India: National Institute of Nutrition. **2010**: 48- 98.
30. V.P. Borade, S.S. Kadam, D.K. Salunkhe, Changes in phytate phosphorus and minerals during germination and cooking of horse gram and moth bean", *Plant Food Hum. Nutr.* **1984**, 34, 151-157.
31. Z.M. Abdel-Kader, Effect of boiling and baking on the content of some of the nutrients of sweet potato, *Nahrung*, **1991**, 35, 321.
32. P.T. Chompreeda, M. L. Fields, Effect of heat and fermentation on the extractability of minerals from soybean flour and corn meal blends, *J. Food Sci.* **1984**, 49, 566.
33. B.S. Gunashree, R. Seva Kumar, R. Roobini, G. Venkateswaren, Nutrients and antinutrients of ragi and wheat as influenced by traditional processes, *Int. J. Current Microbiol. Applied Sci*.**2014**, 3(7), 720-736.
34. K.D. Mustafa, E. Adem, Comparison of autoclave, microwave, IR and UV-stabilization of whole wheat flour branny fractions upon the nutritional properties of whole wheat bread, *J. Food Sci. Technol.* **2014**, 51(1), 59-66.
35. Z.U. Rehman, W.H. Shah, Tannin contents and protein digestibility of black grams (Vigna mungo) after soaking and cooking, *Plant Food Hum. Nutr.* **2001**, 56, 265- 273.
36. M. Hendek Ertop, M, Bektas, Enhancement of bioavailable micronutrients in food with some processes. *Food and Health*, **2018**, 4(3), 159-165.
37. F.O. Sade, Proximate, antinutritional factors and functional properties of processed pearl millet, *J. Food Technol*.**2009**, 7, 92-97.
38. W.K. Novak, A.G. Haslberger, Substantial equivalence of antinutrients and inherent plant toxins in genetically modified novel foods, *Food Chemical Toxicol.* **2000**, 38, 473-483.
39. R. Fernando, P. Pinto, A. Pathmeswaran, Goitrogenic food and prevalence of goitre in Sri Lanka, *J. Food Sci*. **2012**, 41,1076-81.
40. V. Vellingiri, H.K. Biesalski, Effect of certain indigenous processing methods on the bioactive compounds of ten different wild type legume grains, *J. Food Sci. Technol*. **2012**, 49(6), 673–684.
41. P. Lakra, I. Nashier Gahlawat. The role of Nutrition in the Immune system functions. *Integr. J. Soc. Sci.* **2016**, 3 (1), 30–33.
42. P. Lakra, I. Nashier Gahlawat. Prospective Phytochemicals for alleviation of different chronic ailments. *Integr. J. Soc. Sci*. **2015**, 2 (1), 36–39.
43. I. Nashier Gahlawat, P. Lakra. Contextual implicit role of PROBIOTICS in improving the Human Health. *J. Integr. Sci. Technol*. **2017**, 5 (2), 50-53.
44. P. Lakra, S. Sehgal, I. Nashier Gahlawat, M. Wadhwa nee Dasbas. Use of products developed from potato flour, defatted soy flour and corn flour in combating malnutrition. *Integr. J. Soc. Sci.* **2018**, 5 (1), 47–50.
45. I. Nashier Gahlawat. Emerging new insights into significance and applications of Plant Pigments. *J. Integr. Sci. Technol.* **2019**, 7 (2), 29–34.