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Studies on the preparation of chapatti and biscuit supplemented with potato flour

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Abstract

The present study was concerned with the preparation of potato flour with various treatments and to formulate the chapatti and biscuit incorporating potato flours were prepared by treating the raw potato slices as blanched, blanched plus potassium meta-bisulphite (KMS) treatment and one as control. Various substitution levels from 15 % to 30 % of potato flour was used in the formulations of chapatti and biscuit in conjunction with wheat flour. Chapatti and biscuit prepared with either blanched or blanched plus KMS treated sample of potato flour had very good physical and baking quality. And chapatti prepared with 20% potato flour and biscuit containing 25 % had the most suitable baking properties among other proportions. The statistical analysis of sensory evaluation data indicated that the baked products prepared with potato flour from blanched plus KMS-treated samples ranked very well and were more acceptable than those made from blanched sample.

Keywords: Potato flour, Drying, Chapatti, Biscuit

Introduction

Potato is the world's most widely grown tuber crop and the fourth largest food crop in terms of fresh produce after rice, wheat, and maize. The potato's potential for a beneficial role in world food production, owing to its status as a cheap and plentiful crop which can be raised in a wide variety of climates and locales (Wade, 2008). In many countries of the world such as Poland, Holland, Belgium, Peru, Ireland, Denmark, Germany potato is fed as staple food. Its nutritional value is undeniable, having proteins, vitamins and minerals among others. The excess potato products, as well as the damaged tubercles from the commercial standard can be transformed into other products, such as potato flour (Oliveira *et al.,* 2006). Potato flour is an inexpensive, nutritious, and ordinarily harmless source of carbohydrate calories and potato skins are an excellent source of vitamin C. If production is high and price quite low, potato could be such one item that can help reduce dependence on rice. The country now produces enough potatoes and its price is also within affordable limits of the average people. So, there is likely to be no dearth of potato for use not only as vegetable but also as staple food by supplementing the wheat flour. Thus research involving the development of integrated process for production of shelf stable potato flour and further baked products mixed with wheat flour should be initiated in order to diversify the use of potato as well as to enhance nutritional quality of products since the protein quality of potato is the best among other plants protein. For making baked products, a strong gluten is not required but water absorption of the flour should be high (Kent, 1984). So a substantial amount of potato flour can be used as a supplement to the wheat flour. With above views in consideration, the present study has been undertaken to achieve the following objectives: i) to prepare potato flour from raw potato with or without pretreatments; ii) to select suitable and effective ratio of potato and wheat flour for formulation of baked products such as chapattis, biscuits; and iii) to evaluate the quality of baked products incorporating potato flours prepared with different treatments.

Materials and Methods

The study was conducted in the laboratory of the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh. The potato, wheat flour and other raw materials were procured from local market of Mymensingh, Bangladesh. The plastic container, high density polyethylene bags and required chemicals were used from the laboratory stock and also procured from the local market.

Treatments of potato before of drying

Three different treatments were given on raw potato to prepare potato flours. One sample of raw potato was cleaned with water and sliced (3 mm thickness) with hand knife. Second sample of raw potato was cleaned with water, sliced (3 mm thickness) with hand knife, immediately blanched in water at 90 ^{0}C for 08 minutes and cooled quickly in cool water and another sample was cleaned, sliced, immediately blanched for 08 minutes at 90 ^{0}C and then treated with KMS solution (0.25%) for 10 minutes.

Preparation of potato flour

Cabinet dryer (Model OV- 165) was used for drying of treated potato slices. The slices were spread in tray and dried at 60 ^{0}C for 08 hours which approximately reduce the moisture content to 10-12% (wb). After drying the potato slices were cooled, ground to powder in a flour mill to prepare potato flour and was stored in plastic containers.

Procedure for preparation of baked products

Chapatti: The basic ingredients of different types of chapattis (S_{510}, S_{511}, S_{512}, S_{513}, S_{514}) with various proportion of wheat and potato flour are presented Table 1. At first the flour was mixed with salt, baking powder and then mixed with water to prepare dough. The dough was divided into four equal portions, rounded and rested for a couple of minutes, sheeted to a flat and round shape upto thickness of 2.5 mm and cut out with a round chapatti cuter of 10.5 cm diameter. The chapatti was cooked in a preheated non-sticky frying pan.

Biscuit: The basic formulations used for preparation of biscuits from three different treated samples are outlined in Table 2. All the ingredients were weighed accurately. The pre-weighed flour, sugar, salt and baking powder were mixed thoroughly. Then shortening and egg were added and mixed properly to make adequate dough and kept rest for a while then the dough was rolled to a uniform sheet of thickness. The sheet was the cut according to the desired shape and size of biscuits with a cutter and baked in the oven at 210 ^{0}C for 8 min, cooled to ambient temperature and packed in plastic bags.

Table 1. Basic formulation of chapatti for every treatment of potato flour

Ingredients	Samples (g)				
	S_{510}	S_{511}	S_{512}	S_{513}	S_{514}
Wheat flour	100	85	80	75	70
Potato flour	0	15	20	25	30
Salt	2.0	2.0	2.0	2.0	2.0
Baking powder	1.0	1.0	1.0	1.0	1.0
Water	75	75	75	75	75

Table 2. Basic formulation of biscuit for each treatment of potato flour

Ingredients	Samples (g)				
	S_{510}	S_{511}	S_{512}	S_{513}	S_{514}
Wheat flour	100	85	80	75	70
Potato flour	0	15	20	25	30
Powdered sugar	30	30	30	30	30
Shortening	15	15	15	15	15
Milk powder	05	05	05	05	05
Soyabean oil	10	10	10	10	10
Salt	0.5	0.5	0.5	0.5	0.5
Baking powder	1.5	1.5	1.5	1.5	1.5
Egg	30	30	30	30	30

Quality evaluation of baked products

The chapattis were evaluated for thickness, width, spread ratio, yield and moisture content. The biscuits were evaluated for thickness, width, spread ratio and moisture content. The moisture contents were determined as per methods of AOAC (2004).

Chemical analysis

The raw potato, potato and wheat flour, baked products were analyzed for their moisture, ash, fat, protein, total carbohydrate and vitamin C contents. Moisture, fat and protein contents were determined adopting AOAC (2004) method. **The carbohydrate content of the sample was determined as total carbohydrate by subtract the percentage of others from 100.** Vitamin-C content of potato and potato flour were determined using the method of Ranganna (2003).

Sensory evaluation

The 11 panelists were requested to assign score for characteristics color, flavour, texture and overall acceptability of Chapatti and Biscuit. The results were evaluated by analysis of variance (ANOVA) and Duncun's Multiple Range Test (DMRT) procedures of the statistical analysis system (SAS, 1985).

Results and Discussion

Composition of raw potato, potato flour and wheat flour

The results of the proximate composition analysis of potato, potato flour and wheat flour are presented in Table 3. The moisture content of raw potato and potato flour were 76.0 % and 10.0 %, respectively while the moisture content of wheat flour was 13.0 %. The drying process significantly reduced the moisture content in potato slices and hence potato flour. The potato flour has slightly less moisture content than wheat flour and this might be due to compositional difference and extent of drying. The protein contents of raw potato and potato flour are 2.0 % and 5.0 % respectively where as protein content of wheat flour is 11.5 %. Potato flour contained lower protein and higher starch or carbohydrate than wheat flour. The fat content of raw potato was very low of 0.2% and of potato flour was 0.86% which was slightly lower than the wheat flour sample (1.0%). The value of fat contents in raw potato was higher than those found by Schwimmer and Burr (1967) who mentioned 0.1% fat content in raw potato and the fat content of wheat flour was higher than those found by Mollik and Shams-Ud-Din (2007) who mentioned 0.88 % in wheat flour. This variation in fat content may result from varietal difference, chemicals used for fat extraction and milling process differences. The ash content of potato flour contained substantially higher ash than wheat flour and this might be due to peel content and milling conditions. The crude fibre content of raw potato was 2.2% and that of potato flour (5.5%) was about doubled of wheat flour sample (2.5%). This might be due to higher fibre content of raw potato sample than the wheat grain and loss of crude fibre fraction during grinding process. The crude fibre content of wheat flour (2.5%) is higher than those reported by Mollik and Shams-Ud-Din (2007) who found 1.8% crude fibre in whole meal wheat flour. The raw potato contained 19.0% carbohydrate. Potato flour sample was rich in total carbohydrate (81.64%) content than that of wheat flour (73.8%) due to higher starch content of potato as a tuber crop. These variations may be also from the differences in the level of moisture, protein, fat and ash contents. The vitamin C was determined for raw potato and potato flour made from blanched sample and it was seen that raw potato contained 20 mg /100g of sample and potato flour contained 05mg/100 g sample. This difference was due to its heat liability and oxidative properties of vitamin C when contact with air.

Table 3. Composition of raw potato, potato flour and wheat flour

	Raw potato	Potato flour (Blanched sample)	Wheat flour
Moisture (%)	76.0	10.0	13.0
Protein (%)	2.0	5.0	11.5
Fat (%)	0.2	0.86	1.0
Ash (%)	1.0	2.5	0.70
Crude fibre (%)	2.2	5.5	2.5
Total carbohydrate (% by difference)	19	81.64	73.80
Vitamin C, mg/100 gm	20	5	-

Table 4. Composition of Chapatti and Biscuit formulated with 20 % potato flour

	Chapatti	Biscuit
Moisture (%)	34.0	5.0
Protein (%)	9.4	15.2
Fat (%)	0.93	10.2
Ash (%)	3.7	2.8
Crude fibre (%)	19.2	22.5
Total carbohydrate (% by difference)	51.97	66.80

Proximate composition of baked products

The data obtained from proximate analysis of chapatti, biscuits incorporating 20% potato flour with blanched and KMS treated sample are shown in Table 4. The moisture content of chapatti was higher of 34.0% than biscuits of 5.0%. The protein content of chapatti was 9.4% which was lower than biscuit 15.2%. The ash and fibre contents of chapatti and biscuit were more or less similar.

The chapatti prepared from blanched and KMS treated sample incorporating 20 % potato flour was analyzed for its compositions, since its physical and baking qualities were the best among others. As shown in Table 4, the moisture content of chapatti was 34.0%, protein was 9.4%, fat was 0.93%, ash was 3.7%, crude fibre was 19.2 % and total carbohydrate was 51.97 %. The moisture content of chapatti were higher than those found by Mollik and Shams-Ud-Din (2007) who mentioned 28.21 to 29.83% moisture content and similar to protein contents who mentioned 9.10 to 9.64 % proteins in whole meal flour chapattis.

As shown in Table 4, the biscuit contained moisture content 5.0%, protein 15.2%, fat 10.2%, ash 2.8%, crude fibre 22.5 % and total carbohydrate 66.80%. The moisture and protein content of biscuits were similar to those found by Debnath (2003) who mentioned 4.75 to 5.32% moisture content and 10.50 to 19.50 % proteins in biscuits formulated with composite flour of soy and wheat flour.

Observation of different parameters of baked products

The thickness, diameter, yield and moisture content of chapattis prepared with different treatments and levels of composite flour in the formulation are presented in Table 5. The thickness, diameter, spread ratio and moisture content of biscuits prepared with two treatments such as from blanched sample and blanched plus KMS treated sample were presented in Table 6. The yield was determined by dividing the weight of chapatti after baking to the weight of chapatti before baking multiplying 100. The spread ratio is the ratio of width of biscuit to the thickness of the biscuit.

Chapatti

The physical properties of chapattis prepared from potato flour with blanched and blanched followed by KMS treatment were more or less similar but chapattis made from untreated potato flour had the inferior properties. It may be due to oxidation and enzymatic activity following drying process. The highest thickness of chapattis made from untreated sample was 3.5 mm when incorporating 30 g potato flour in chapatti formulation where as the highest thickness of chapattis made from potato flour with treatment 2 and 3 (Table 5) were same of 3.4 mm. The maximum yield of chapattis made from potato flour with Treatment-1, 2, and 3 were 82.45%, 83.84% and 84.54% respectively. The highest moisture content was 34.80% for chapatti made from blanched and KMS treated sample containing 20% potato flour (T_3 S_{512}).

In general, the trends of width, spread ratio, yield and moisture content were increased in the chapatti as the potato flour substitution increased upto 20% of potato flour in every treatment (Table 5). More specifically, chapatti containing 20% potato flour with blanched plus KMS treated sample showed the highest width (10.90), spread ratio (33.03), yield (84.54%) and moisture content (34.80%). The higher spread ratio is associated with good texture, tearness, chewiness, and other quality attributes of the chapattis. This result may due to the reason that wheat flour may contain higher protein than requirement of chapatti formulation and this might be minimized to a optimum level of protein and gluten content using potato flour. Another reason that potato flour had higher water holding capacity than wheat flour results in higher moisture content in the products. However, higher potato flour content might here reduced the protein proportion below the required amount for chapatti preparation (10.0% protein) and hence chapattis containing 30% potato flour had the weak gluten ultimately affecting product quality.

Table 5. Effect of treatment and various proportion of flour on the baking properties of chapatti

Flour types used in chapatti	Sample types	Thickness (T) in cm	Width (W)in cm	Spread ratio (W/T)	Yield %	Moisture content, %
	S_{510}	0.33	10.60	32.12	81.10	27.00
T_1. Potato flour (without treatment)	S_{511}	0.33	10.61	32.12	82.02	28.88
	S_{512}	0.33	10.63	32.21	82.45	32.52
	S_{513}	0.34	10.58	31.12	82.11	33.16
	S_{514}	0.35	10.58	30.23	82.09	32.85
T_2. Potato flour (Blanched sample)	S_{511}	0.33	10.63	32.22	82.20	34.0
	S_{512}	0.33	10.84	32.84	83.85	34.54
	S_{513}	0.34	10.76	31.67	82.85	34.14
	S_{514}	0.34	10.67	31.38	82.09	33.71
T_3. Potato flour (Blanched & KMS treated)	S_{511}	0.33	10.64	32.24	82.56	33.54
	S_{512}	0.33	10.90	33.03	84.54	34.80
	S_{513}	0.34	10.79	31.74	83.20	34.01
	S_{514}	0.34	10.69	31.44	82.25	33.85

Where

S_{510} = 100 g wheat flour (control)

S_{511} = 15 g potato flour + 85 g wheat flour

S_{512} = 20 g potato flour + 80 g wheat flour

S_{513} =25 g potato flour + 75 g wheat flour

S_{514}= 30 g potato flour + 70 g wheat flour

Biscuit

The physical properties such as thickness, diameter, spread ratio and moisture content of biscuits only for two treatments such as blanched and blanched plus KMS treatment were measured and shown in Table 6. The thickness and moisture content of all the biscuits made from treated potato flour were higher than the control biscuits but the diameter was lower than those of the control biscuit. The biscuits made from different treatment such as blanched and blanched followed by KMS treated samples had no significant variation in the properties at same proportion of wheat and potato flour. The biscuit containing 25 % potato flour with T_2 had the highest thickness and moisture content of 0.66 cm and 5.12 % respectively among the all biscuits. From the Table 6 it is seen that thickness and moisture content of biscuit increased slightly with the increasing level of potato flour replacement upto 25g. On the other hand diameter of biscuits and spread ratio are decreased as substitution level of potato flour increased in the baked samples and this may be due to the higher water holding capacity of potato flour.

Table 6. Effects of potato flour on thickness, diameter and moisture content of biscuit

Treatment	Potato flour, g	Wheat flour	Diameter (W) cm	Thickness (T) cm	Spread Ratio (W/T)	Moisture Content (wb) %
	0 (control)	100	4.02	0.63	6.38	4.95
T-412. Blanched	15	85	3.95	0.64	6.17	5.03
	20	80	3.89	0.64	6.11	5.06
	25	75	3.85	0.65	5.93	5.10
	30	70	3.83	0.64	5.98	5.03
T-413. Blanched + KMS treated	15	85	3.97	0.64	6.20	5.02
	20	80	3.91	0.65	6.02	5.07
	25	75	3.86	0.66	5.98	5.12
	30	70	3.83	0.63	6.00	5.04

Sensory evaluation of baked products

For sensory evaluation, at first three types of chapattis and biscuits made from three different treated potato flours are selected separately. Sample -411 was made from potato flour without treatment, sample-412 was made from blanched potato flour and sample-413 was prepared from blanched plus KMS treated flour. This sensory evaluation was performed to assess the best treatment of potato flour for preparation of baked products. The baked products such as chapatti and biscuits made from blanched plus KMS treated potato flour at different proportions were also evaluated for sensory attributes to obtain the best proportion of potato and wheat flour for products formulation.

Chapatti

The DMRT test revealed that sample-413 (Table 7) is the most acceptable than others two in terms of colour and overall acceptability. Though there is no significant different between sample-412 and sample-413 in terms of flavour and texture, the sample-413 secured the highest score 7.20 indicating “Like Moderately”.

Table 7. Mean score for colour, flavour, texture and overall acceptability of Chapatti made by 20 % potato flour

Sample no.	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
411	4.82^{b}	5.55^{c}	5.27^{b}	5.10^{c}
412	6.64^{a}	6.46^{b}	6.91^{a}	6.64^{b}
413	7.20^{a}	7.20^{a}	7.20^{a}	7.36^{a}
LSD (P< 0.05)	0.573	0.6252	0.7410	0.5277

Means with different superscripts within a column are significantly different at p < 0.05
Sample-411: Chapatti made by potato flour without treatment;
Sample-412: Chapatti made from blanched sample; and
Sample-413: Chapatti made blanched and KMS treated sample.

As shown in DMRT (Table 8) revealed that the chapatti made with 20% potato flour is the most acceptable among others considering all sensory attributes securing mean score 7.10 to 7.46 indicating like moderately followed by sample of chapatti containing 25 % potato flour with wheat flour securing scores from 6.55 to 7.20. While all the samples were acceptable, control and sample containing 30% potato flour the least acceptable products.

Table 8. Mean score for colour, flavour, texture and overall acceptability of chapatti made from blanched + KMS treated potato flour

Sample no.	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
510	6.10^{cd}	6.00^{c}	$6.10b^{c}$	5.909^{c}
511	6.64^{bc}	6.73^{b}	6.10^{bc}	6.545^{b}
512	7.46^{a}	7.28^{a}	7.10^{a}	7.28^{a}
513	7.20^{ab}	7.00^{ab}	6.55^{ab}	6.82^{ab}
514	6.00^{d}	6.20^{c}	5.64^{c}	6.00^{c}
LSD (P< 0.05)	0.5538	0.4890	0.5690	0.4744

Means with different superscripts within a column are significantly different at p < 0.05
S_{510} = 100 g wheat flour
S_{511} = 15 g potato flour + 85 g wheat flour
S_{512} = 20 g potato flour + 80 g wheat flour
S_{513} =25 g potato flour + 75 g wheat flour
S_{514}= 30 g potato flour + 70 g wheat flour

Biscuits

As shown in Table 9 the DMRT of biscuits showed that sample-413 (biscuits made from blanched plus KMS treated potato flour) was the most acceptable regarding all attributes and ranked as like moderately interms of colour, texture and overall acceptability and like slightly interm of flavour, though there was no significant different between sample-412 and sample-413 in terms of flavour and overall acceptability. Sample-411 was the least acceptable product considering all sensory attributes and ranked as 'neither like or dislike'

Table 9. Mean score for colour, flavour, texture and overall acceptability of biscuits made by 20 % potato flour

Sample no.	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
411	4.55^{c}	5.00^{b}	5.20_{c}	4.64^{b}
412	6.91^{b}	6.55^{a}	6.55^{b}	6.82^{a}
413	7.46^{a}	6.91^{a}	7.20^{a}	7.30^{a}
LSD (P< 0.05)	0.516	0.5156	0.3826	0.4992

Means with different superscripts within a column are significantly different at p < 0.05

The DMRT (Table 10) for biscuits made from five different proportions of composite flour of wheat and potato revealed that biscuits containing 25 % potato flour as a supplement (sample 513) secured the highest score in terms of all sensory attributes among others, though all samples are acceptable. Sample-513 could be ranked as like slightly in case of flavour (6.91) and like moderately in terms of colour (7.73), texture (7.46) and overall acceptability (7.82) where as sample-412 was ranked as like slightly, the second highest ranking among others.

Table 10. Mean score for colour, flavour, texture and overall acceptability of Biscuits made from blanched plus KMS treated potato flour

Sample no.	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
510	5.55_{d}	6.28^{bc}	6.10^{c}	6.10^{d}
511	6.10^{c}	6.64^{ab}	6.37_{bc}	6.55^{bc}
512	6.64^{b}	6.82^{a}	6.73_{b}	6.91^{b}
513	7.73^{a}	6.91_{a}	7.46^{a}	7.82^{a}
514	7.00^{b}	6.00^{c}	6.00^{c}	6.46^{cd}
LSD (P< 0.05)	0.4552	0.430	0.4921	0.4352

Means with different superscripts within a column are significantly different at $p < 0.05$

Conclusion

The study was conducted to find out the best treatment and best proportion of wheat and potato flour to formulate the chapatti and biscuit. Chapatti prepared with 20% potato flour treated with blanching plus KMS had the most suitable baking properties and this might result from low protein content of potato flour which gave the composite flour optimum level of protein for chapatti formulation and higher water holding capacity of flour. Biscuit containing 25 % potato flour showed the best baking performance compared to other proportion of flour used. To reduce pressure on rice and change food habits this investigation could be influential for the use of non-rice commodity for production of convenient food products. A substantial amount of potato is spoiled and wasted due to inadequate cold storage facilities and insufficient post harvest handling facilities in the country. Minimization of post harvest losses of potato through proper handling and processing into value-added products is thus warranted in order to help attain food security at least to some extent in the country.

References

AOAC. 2004. W. Horwitz (Editor), Official Method of Analysis. Association of of Official Agricultural Chemist. 12th Ed. Washington. D.C.

Debnath, T. 2003. Studies on the Quality of Salted Biscuits Prepared from Soy Flour and Wheat Flour Blend. MS thesis, Dept. of Food Tech. and Rural Ind. BAU, Mymensingh. Bangladesh

Kent, N.L. 1984. Technology of Cereals. An Introduction for Students of Food Science and Agriculture. Third edition. Pergamon Press, Oxford. P.86.

Mollik, M. and Shams-Ud-Din, M. 2007. Processing and Preservation of Chapattis from Whole Meal Flour. Bangladesh Journal of Ag. Engg. Vol. 18 (1&2):55-71

Oliveira, D.M., Reis, K.C., Pereira, J. and Graduacao, E.M. 2006. Agronomia/UFLA, Lavras, MG, Brazil. Revista-Brasileira-de-Armazenamento. 31(2): 125-135

Ranganna, S. 2003. Hand Book of Analysis of Quality Control for Fruit and Vegetable Products. 2nd Ed. TATA McGraw- Hill Pub. Co. Ltd. New Delhi, India.

SAS, 1985. SAS Users Guide: Statistics, Version 5th ed. SAS Institute Inc., Cary, NC.

Shafiquzzaman, M. 2008. Study On The Effects Of Processed Lentil Husks On Cake Quality . MS Thesis, Dept. of Food Tech. and Rural Ind. BAU, Mymensingh. Bangladesh.

Schwimmer, S. and Barr, H.K. 1967. Structure and chemical composition of the potato tuber. In: Potato Processing. ed., Talburt, W.F., and Smith, O. Avi, publising Co., Westport, Conn.

Wade, T. 2008. As Other Staples Soar, Potatoes Break New Ground, Reuters.