

Studies on incorporation of potato flour on the physical properties and acceptability of chapathi and butter biscuits

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The present study was concerned with the incorporation of various proportions of potato flour in chapathi and butter biscuits. Potato flours were prepared by drying the potato slices treated with potassium meta-bisulphite and without pretreatment. Four substitution levels of potato flours from 7.5 g to 15.0 g were used in the formulations of chapathi in conjunction with wheat flour, salt, baking powder and water. Chapathies were prepared with potato flour without pretreatment and blanched plus potassium meta-bisulphite (KMS) treated sample of potato flour. The three substitution levels of potato flours from 15g to 25g were used in the formulation of butter biscuits in conjunction with maida flour, margarine, sugar, cardamom flavour and soda. The study revealed that chapathi prepared at 15 per cent potato flour and biscuits prepared at 30 per cent potato flour had most suitable baking properties among different proportions. The statistical analysis of sensory evaluation data indicated that the chapathi and biscuits prepared with potato flour prepared by blanching, treated with KMS were ranked better and were more acceptable than those made from incorporation of potato flour without pretreatment.

Key Words : Potato flour, Blanching, Baking, Chapathi, Butter biscuits

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INTRODUCTION

Potato is a starchy tuberous crop from the perennial *Solanum tuberosum* of the Solanaceae family. Potato is one of the most widely grown tuber crop in the world and fourth largest food crop in terms of fresh produce after rice, wheat and maize. The potato's potential for a beneficial role in the world food production, owing to its status as a cheap and

plentiful crop which can be raised in a wide variety of climates and locals. Potato is fed as staple food in many countries of the world such as Poland, Holland, Belgium, Peru, Ireland, Denmark and Germany. Its nutritional value is undeniable, is readily digested, is a source of several vitamins, especially vitamin C and some important B group vitamins, rich in minerals such as potassium and iron. Potato has high quality protein although they are deficient in the essential amino acid methionine. Lysine contents in potatoes are similar to animal protein and its flour can be utilized to overcome protein and calorie malnutrition.

India is the second country in highest potato production next to China. The country had produced over 36.6 million tons of potato in the year 2010. The excess potato production as well as the damaged tubercles from the commercial standard can be transformed in to other products, such as potato flour (Oliveira *et al.*, 2006). The country now produces enough and 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

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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 the above views in consideration, the present study has been under taken to achieve the given objectives to prepare potato flour from raw potato with or without pretreatments, to select the suitable and effective ratio of potato and wheat flour for formulation of baked products such as chapathi and butter biscuits and to evaluate the quality of baked products prepared with different proportions of potato flours.

METHODOLOGY

The experiment was conducted in the laboratory of the Department of Food Science and Technology, Agricultural College, Hassan. The potato, wheat and other raw materials were procured from Hassan local market. The plastic container, high density polyethylene bags and required chemicals were used from the laboratory stock.

Two different types of potato flours were prepared. One among them, raw potato was cleaned with water and sliced by 3mm thickness with hand knife, second, the raw potato was cleaned with water and sliced by 3mm thickness with a hand knife and immediately blanched in water at 90°C for 8 minutes and cooled quickly in cold water and then treated with potassium meta-bisulphite (0.25%) solution for 10 minutes.

Preparation of potato flour:

The potato slices were spread on a tray and dried in the

cabinet dryer at 60°C for 8 hours which approximately reduced the moisture content to 10-12 per cent. After drying the potato slices were cooled and ground to powder in flour mill to prepare potato flour and was stored in the plastic containers.

Procedure for preparation of potato flour based products:

Chapathi:

During the preparation of chapathi with various combinations of potato flour viz., T₁: 7.5 g, T₂: 10g, T₃: 12.5 g and T₄: 15g, the weighed quantity of wheat flour was mixed with salt, baking powder and water (Table A). After mixing all the ingredients soft dough was prepared by adding water. The dough was allowed for fifteen minutes and then divided in to two equal parts and rolled with chapathi roller. The chapathi was cooked in a preheated non stick frying pan.

Butter biscuits:

Butter biscuits with various combinations of potato flour viz., T₁: 15 g, T₂: 20g, and T₃: 25 g were prepared with basic ingredients of maida flour, margarine, sugar, cardamom and soda (Table B). Weighed quantity of sugar powder and margarine were mixed and creamed to obtain light fluffy texture. Measured amount of sieved maida flour, two drops of cardamom and ¼ tea spoon of soda were mixed thoroughly with different proportion of potato flours. Then the dough was kept for a few minutes. The dough was rolled to a uniform sheet of thickness; uniform sized biscuits were prepared with a biscuit cutter and baked in the oven at 210°C for 10 minutes, cooled to ambient temperature and packed in plastic bags.

Data analysis:

The quality evaluations of potato flour, blanched at 90°C treated with KMS were studied for thickness, width and spread ratio in chapathi and biscuits. The moisture content were

Table A. Basic formulation of chapathi with different proportion of potato flours

Proportion of potato flour	Ingredients			
	Wheat flour (g)	Salt (g)	Baking powder (g)	Water (ml)
T ₁ : 7.5g potato flour	42.5	1.0	0.5	37.0
T ₂ : 10.0 g potato flour	40.0	1.0	0.5	37.0
T ₃ : 12.5 g potato flour	37.5	1.0	0.5	37.0
T ₄ : 15.0 g potato flour	35.0	1.0	0.5	37.0
Control: 0 g potato flour	50.0	1.0	0.5	37.0

Table B. Basic formulation of butter biscuits for various composition of potato flour

Proportion of potato flour	Ingredients				
	Maida flour (g)	Margarine (g)	Sugar (g)	Cardamom	Soda
T ₁ : 15g potato flour	85	60	50	Two drops	¼ tsp
T ₂ : 20.0 g potato flour	80	60	50	Two drops	¼ tsp
T ₃ : 25 g potato flour	75	60	50	Two drops	¼ tsp
Control: 0 g potato flour	100	60	50	Two drops	¼ tsp

evaluated as per the method of AOAC (2004).

Analysis of chemical components:

The moisture, protein, fat, ash, crude fibre and vitamin C content were determined from raw potato, potato flour, wheat flour by AOAC (2004) method. The carbohydrate content of raw potato, potato flour, wheat flours were determined as total carbohydrates by subtracting the percentage of other nutrients from 100g. Vitamin C contents were analyzed using the methods of Ranganna (2005).

Evaluation of sensory attributes:

A sample of ten semi trained panelists were selected randomly and were requested to assign score for sensory attributes viz., colour, flavour, texture and overall acceptability of chapathi and butter biscuits. The results were evaluated by analysis of five point hedonic scale.

OBSERVATIONS AND ASSESSMENT

The results of chemical compositions are represented in the Table 1 and Fig. 1. The moisture content of raw potato and potato flour were 78 per cent and 10 per cent, respectively while the moisture content of wheat flour was found to be 12 per cent. The drying process significantly reduced the moisture content in potato slices. 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 content of raw potato and potato flour were 1.5 per cent and 4.0 per cent, respectively whereas protein content of wheat flour was 11.6 per cent which was significantly higher compared to potato flour. It was observed that potato flour contained lower protein and higher starch or carbohydrate than wheat flour. The fat content of raw potato and potato flour were 0.1 per cent and 0.45 per cent, respectively which were lower than the fat content in wheat flour 1.5 per cent. The same results were observed by Khaliduzzaman *et al.* (2010). The ash content in potato flour was significantly higher (2.50%) than the wheat

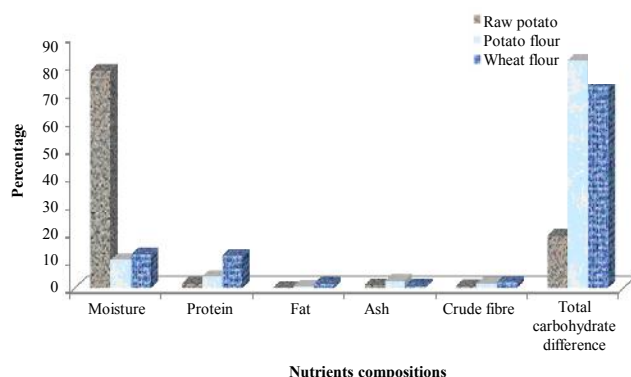


Fig. 1. Nutrients composition in raw potato, potato flour and wheat flour

flour (0.70%) and this might be due to peel content and milling conditions. The crude fibre content of wheat flour is slightly higher (2.0%) than the crude fibre content of potato flour *i.e.* 1.50 per cent. The crude fibre content of wheat flour (2.0%) was higher than the potato flour (1.5%). The raw potato contains 18.8 per cent of carbohydrates; potato flour was rich in total carbohydrate *i.e.* 81.55 per cent. This may be because of concentration of nutrients due to drying. The wheat flour contained 72.10 per cent of total carbohydrates. Studies on vitamin C content of raw potato and potato flour made from blanched treatments showed that raw potato contained 18 mg/100g and potato flour contained 4.5mg/100g of treatment. This difference was due to loss of vitamin C during heat treatment and oxidative properties of vitamin C when contact with air.

Nutrient composition of chapathi and butter biscuits:

The data obtained from proximate analysis of chapathi and biscuits incorporated with potato flour blanched and treated with potassium meta-bisulphite are shown in the Table 2 and Fig. 2. The data were statistically analyzed. The moisture content of chapathi was higher (30%) than the biscuits (8%). The protein content of chapathi was found to be 5.45 per cent which was lower than biscuits (7.2%). The fat content of chapathi was recorded 1.1 per cent. However, the fat content

Table 1. Nutrients composition in raw potato, potato flour and wheat flour

Nutrients	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Total carbohydrate by difference (%)	Vitamin C (mg)
Raw potato	78	1.5	0.1	1.0	0.6	18.8	18
Potato flour	10	4.0	0.45	2.50	1.50	81.55	4.5
Wheat flour	12	11.6	1.5	0.70	2.0	72.10	12.0

Table 2. Nutrients composition in potato flour incorporated Chapathi * and Butter biscuits**

	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Total carbohydrate (by difference) (%)
Chapathi	30	5.45	1.1	3.5	1.2	66.75
Biscuits	8	7.2	22.2	1.0	1.8	59.80

* Chapathi (Incorporated with 7.5 g potato flour)

** Butter biscuit (Incorporated with 15 g potato flour)

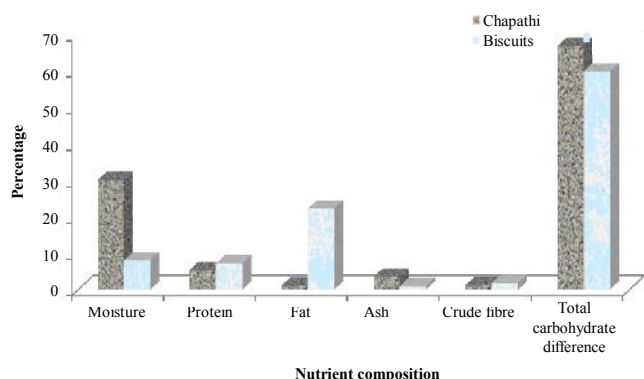


Fig. 2. Nutrients composition in chapathi and butter biscuits

of biscuits was 22.2 per cent which is due to addition of margarine to biscuits. The ash content was more in chapathi (3.5%) than that of biscuits (1.0%). The total carbohydrate content observed was more in chapathi *i.e.* 66.75 per cent than biscuits which contained 59.8 per cent.

Effect of different proportion of potato flour on the physical properties of chapathi:

The different proportion of potato flour on the physical properties of chapathi *viz.*, width, thickness and spread ratio are presented in the Table 3. The data were statistically analyzed

by completely randomized design. The width of the chapathi with different levels of incorporation of potato flour showed statistically no significant difference. With regard to the thickness of chapathi the study revealed statistically significant difference with high thickness in T₄; 15g of potato flour incorporation followed by T₃; 12.5g of potato flour incorporation. The study also revealed non significant difference in the spread ratio of chapathi with different levels of incorporation of potato flour.

Effect of different proportion of potato flour on the physical properties of butter biscuits:

Table 4 shows the effect of incorporation of different proportions of potato flour on the physical properties of butter biscuits *viz.*, width, thickness and spread ratio. The data were statistically analyzed by completely randomized design. No significant difference was found in the width of the butter biscuits with all the treatments. The study also showed insignificant difference in the thickness of the butter biscuits with the incorporation of different proportions of potato flour. The table also shows that supplementation of different levels of potato flour have no significant effect on the spread ratio of biscuits.

Table 5 presents the mean scores on sensory attributes *viz.*, colour, flavour, texture and overall acceptability of chapathi. The results revealed that the mean scores of all the

Table 3. Effect of different proportion of potato flour on the baking properties of chapathi

Type of potato flours	Treatments	Physical properties		
		Width (W) cm	Thickness (T) cm	Spread ratio W/T
Potato flour without pretreatment	Control: 0 g potato flour	16.9	0.169	100.00
	T ₁ : 7.5g potato flour	16.8	0.167	100.59
	T ₂ : 10.0 g potato flour	17.1	0.168	101.78
	T ₃ : 12.5 g potato flour	17.2	0.170	101.17
	T ₄ : 15.0 g potato flour	16.8	0.171	98.24
	F-test	NS	S	NS
	S.E ±	----	0.001	----
	C.D. (P=0.05)	----	0.003	----
	C.V.	----	0.592	----
Potato flour blanched and treated with KMS	Control: 0 g potato flour	16.9	0.169	100.00
	T ₁ : 7.5g potato flour	17.0	0.170	100.00
	T ₂ : 10.0 g potato flour	17.0	0.170	100.00
	T ₃ : 12.5 g potato flour	17.1	0.168	101.78
	T ₄ : 15.0 g potato flour	NS	NS	NS
	F-test	----	----	----
	S.E. ±	----	----	----
	C.D. (P=0.05)	----	----	----
	C.V	----	----	----

S= Significant NS= Non-significant

sensory attributes were high in chapathi incorporated with 7.5g (15%) of potato flour in both the types of potato flours (with or without pretreatments). The chapathi made with 7.5g of potato flour was the most accepted one securing mean score 4.1 with lowest standard deviation 0.74 and 4.4 with lowest standard deviation 0.471 on overall acceptability. The study also showed that pretreated potato flour incorporated chapathi had higher mean scores in all the sensory attributes and over all acceptability compared to the chapathi prepared with potato

flour without pretreatment.

Table 6 reveals the mean scores on sensory attributes viz., colour, flavour, texture and overall acceptability of butter biscuits. The results shows that the mean scores of all the sensory attributes were high in biscuits incorporated with 15g (30%) of potato flour in both the types of potato flours (with or without pretreatments). The biscuits made with 15g of potato flour was the most accepted one securing mean score 4.1 with standard deviation 0.99 and 4.4 with lowest standard deviation

Table 4. Effect of different proportion of potato flour on the physical properties of butter biscuits

Type of potato flours	Treatments	Physical properties		
		Width (W) cm	Thickness (T) cm	Spread ratio W/T
Potato flour without pretreatment	Control: 0 g potato flour	3.3	0.134	23.74
	T ₁ : 7.5 g potato flour	2.9	0.150	19.46
	T ₂ : 10.0 g potato flour	2.9	0.147	19.72
	T ₃ : 12.5 g potato flour	3.0	0.155	19.35
	T ₄ : 15.0 g potato flour	2.4	0.152	19.12
	F-test	NS	NS	NS
	S.E ±	---	---	---
	C.D. (P=0.05)	---	---	---
Potato flour blanched and treated with KMS	Control: 0 g potato flour	3.3	0.134	23.74
	T ₁ : 7.5g potato flour	3.0	0.128	23.80
	T ₂ : 10.0 g potato flour	2.9	0.125	23.20
	T ₃ : 12.5 g potato flour	2.8	0.125	22.40
	T ₄ : 15.0 g potato flour	2.3	0.122	21.20
	F-test	NS	NS	NS
	S.E. ±	---	---	---
	C.D. (P=0.05)	---	---	---
C.V.	---	---	---	

NS= Non-significant

Table 5. Sensory attributes of chapathi made from potato flour

Type of potato flours	Treatments	Sensory attributes			
		Colour mean± S.D.	Flavour mean± S.D.	Texture mean± S.D.	Overall acceptability mean± S.D.
Potato flour without pretreatment	Control: 0 g potato flour	4.2±0.63	4.1±0.74	4.9±0.32	5±0.00
	T ₁ : 7.5g potato flour	4.0±0.66	4.0±0.94	4.8±0.42	4.1±0.74
	T ₂ : 10.0 g potato flour	3.1±0.88	3.4±0.97	3.5±0.71	3.4±1.07
	T ₃ : 12.5 g potato flour	2.2±1.14	2.2±1.14	2.1±0.88	1.9±1.10
	T ₄ : 15.0 g potato flour	1.9±1.29	1.5±1.08	1.9±1.10	1.4±1.17
Potato flour banched and treated with KMS	Control: 0 g potato flour	4.4±0.516	4.3±0.483	5.0±0	5.0±0.0
	T ₁ : 7.5g potato flour	4.2±0.422	4.2±0.422	5.0±0	4.4±0. 471
	T ₂ : 10.0 g potato flour	3.6±0.517	3.8±0.632	3.6±0.516	3.6±0.516
	T ₃ : 12.5 g potato flour	2.4±0.516	2.2±0.422	1.9±0.568	2.0±0. 516
	T ₄ : 15.0 g potato flour	2.2±0.422	1.6±0.517	2.0±0.471	1.6±0.516

Table 6. Sensory attributes of butter biscuits made from potato flour

Type of potato flours	Treatments	Sensory attributes			
		Colour mean± S.D.	Flavour mean± S.D.	Texture mean± S.D.	Overall acceptability mean± S.D.
Potato flour without pretreatment	Control: 0 g potato flour	4.5±0.53	4.2±0.63	4.4±0.52	4.5±0.71
	T ₁ : 15g potato flour	4.3±0.67	4±0.67	4.2±0.63	4.1±0.99
	T ₂ : 20.0 g potato flour	4.1±0.74	3.9±0.74	3.9±0.74	3.9±0.99
	T ₃ : 25 g potato flour	3.2±0.79	2.3±0.82	2.6±0.84	3.2±0.92
Potato flour bunched and treated with KMS	Control: 0 g potato flour	4.7±0.483	4.5±0.527	4.5±0.483	4.6±0.316
	T ₁ : 15 g potato flour	4.5±0.483	4.2±0.422	4.5±0.483	4.4±0.317
	T ₂ : 20.0 g potato flour	4.4±0.527	4.0±0.471	4.1±0.527	4.1±0.516
	T ₃ : 25 g potato flour	3.0±0.0	3.1±0.517	2.5±0.527	3.1±0.517

0.317. The study also showed that pretreated potato flour incorporated biscuits have higher mean scores in all the sensory attributes and over all acceptability compared to the biscuits prepared with potato flour without pretreatment.

Conclusion:

The study conducted on incorporation of 15 per cent potato flour in chapathi and 30 per cent in butter biscuits showed best performance on sensory characteristics in both the products. More over the nutritional quality of chapathi and butter biscuits improved with the addition of potato flour as it is high in protein and fibre. Potato flour can also be used in other baked products, mixed with other flours like rice flour (to prepare gluten free breads and cookies) and wheat flours to prepare the bakery products. Hence, potato flour may prove to be quite economical and acceptable to replace other flours in many food preparations. This helps to reduce the post harvest losses in potato through value addition thereby helps to attain food security at least to some extent in the world.

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