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Development of composite biscuits supplementing with potato or corn flour

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ABSTRACT

The study was conducted to utilize the potato flour (PF) and corn flour (CF) for the preparation of biscuits with other necessary ingredients. The wheat flour (WF) was supplemented by the PF or CF with the amount of 10, 15 and 20%. The chemical analysis in wet weight basis (wb) showed that WF contained the highest amount of moisture (14.37%) and protein (11.46%), while PF had the highest ash (2.3%) and carbohydrate (81.3%) content among three flours. But, CF gave the highest fat content of 3.62% and energy of 370.1 Kcal/100 g. Physical characteristics of developed biscuits varied due to supplementation of PF or CF to WF. Chemical analysis showed that the control biscuits having 100% WF had the highest moisture content (4.91%), while the highest ash content (1.09%) was found in the sample containing 20% PF and 80% WF. The fat content increased and the protein content decreased with the increasing of PF or CF percentage. Sensory analysis of biscuits revealed that supplementation with 15% PF or CF achieved the best consumer acceptance.

Keywords: Biscuit, supplementation, potato flour, corn flour, wheat flour

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1 Introduction

Biscuit is an important processed food in human diet and is usually eaten by all classes of people. It is low moisture containing flour based bakery product which is also available to us in the form of confectionery. It becomes a top growing segment of processed foods because of consumer demands. Day by day it is seen that the consumers' demand of tasty, safe, convenient and nutritious food products has been increasing (Masoodi, 2012). According to

Khaliduzzaman et al. (2010), potato is one of the most popular food items consumed throughout the world. It is the fourth largest food crop after rice, wheat and maize in terms of total production and is the world's most widely grown tuber crop. PF is a great source of carbohydrate, fiber and vitamins, minerals, 6-12% protein and negligible fat content. It can be added into various food items as a supplementary ingredient.

Corn or maize is a major source of carbohydrates, protein, vitamin B, vitamin A and minerals. (Misra

and Kulshrestha, 2003) attributed it as a major ingredient in many industrialized food items and in home cooking.

Utilization of composite flour in food is considered as advantageous in developing countries as it encourages the use of locally grown crops as flour and reduces the importation of WF (Hugo et al., 2000; Mamat et al., 2013)s to evaluate the feasibility of alternative locally available flours as a substitute of WF (Abdelghafor et al., 2013).

In Bangladesh, during the production season of potato and corn, the price remains lowered and sometimes due to improper facilities of storage and marketing the producers face a higher loss. Incorporation of potato and corn flour to wheat flour can help to enhance the sensory characteristics of biscuits and will be economical in biscuit manufacturing. But, very few researchers have worked on utilization of potato in biscuits production while utilization of corn in biscuit has not investigated yet in Bangladesh. By keeping the above points in mind, this study was undertaken to analyze the proximate composition of wheat, potato and corn flour and to assess the physical, nutritional and sensory properties of composite biscuits developed by supplementing PF or CF.

2 Materials and Methods

2.1 Material

Wheat flour (Teer brand), Corn flour, potato, daldah (Pusti brand), salt (ACI brand), eggs, sugar (Fresh brand), vanilla essence, milk powder (Fresh brand) and baking powder (Noor nobi brand) were bought from local market. Analytical Research (AR) grade chemicals (high grade chemicals suitable for different analysis) were used for analysis of the raw materials and final products.

2.2 PF preparation

To prepare PF, the method described by Seevaratnam et al. (2012) was followed. Collected potatoes were washed in running tap water to remove any adhering soil, dirt and dust. Then the potatoes were peeled and sliced into thin slices of 2-3 mm thickness and steam blanched for 10 minutes. The blanched potato slices were dried for about 15 hours in a cabinet drier at 60-70 °C. After complete drying, the slices were milled and passed through 30 mesh standard sieve. Then the flour was packed in high density poly ethylene bags for further use.

2.3 Experimental design

In this study, certain percentage of PF or CF was incorporated to WF in biscuit preparation. The final products were coded as 101 = 100% WF, 123 = 90%

WF + 10% PF, 231 = 85% WF + 15% PF, 321 = 80% WF + 20% PF, 456 = 90% WF + 10% CF, 564 = 85% WF + 15% CF, and 654 = 80% WF + 20% CF. In this study, the different ingredients used in the preparation of 100 g dough are presented in Table 1.

2.4 Development of composite biscuits

Biscuits were prepared by modifying the method as mentioned by Sarker et al. (2013). At first, the fat was mashed finely and pre-blended sugar was added to it. Egg, salt, milk powder and vanilla essence were added and mixed well. After that, the flours and baking powder were added and mixed well to produce dough. Then the dough was rolled into thin uniform sheet of 3 mm thickness. After sheeting, the sheet was cut out using a round biscuit cutter of 3 cm diameter. Then the biscuits were baked at 180 °C for 15 minutes by using baking oven. The prepared biscuits were cooled at room temperature and packed for storage to use further.

2.5 Nutritional analysis of flours and developed biscuits

WF, PF, CF and processed biscuits were analyzed for moisture, ash, protein, fat, total carbohydrate content. All the determinations were done in triplicate and the results were expressed as the average value \pm standard deviation for wet basis values and dry basis values were calculated from mean values of wet basis. The moisture, ash, protein and fat content were determined by following AOAC (2012) using air oven, muffle furnace, kjeldahl apparatus and soxhlet apparatus respectively. Carbohydrate content was determined as total carbohydrate by subtracting the measured protein, fat, ash and moisture from 100 (Pearson, 1970). Total Carbohydrate = 100 - (moisture + ash + protein + fat). The energy value in calorie was calculated using Atwater factors of 4 \times % Protein, 4 \times % carbohydrate, 9 \times % fat, and then taking the sum (Okoye, 1992).

2.6 Physical analysis

The prepared biscuits were analyzed for thickness, spread-ratio, volume, and density. All of these data are presented as average value \pm standard deviation of triplicate determinations. Weight (g) of four individual biscuits was measured with the help of digital weighing balance and height (cm) by stacking four biscuits on top of each other. Spread-ratio was calculated by dividing the average value of diameter by average value of thickness.

$$\text{Spread ratio (S/R)} = \frac{D}{T} \quad (1)$$

Table 1. Formulation of PF or CF supplemented biscuits

Ingredients [†]	Amount of ingredients in different samples [‡]						
	101	123	231	321	456	564	654
WF (g)	40	36	34	32	36	34	32
PF (g)	0	4	6	8	0	0	0
CF (g)	0	0	0	0	4	6	8
Sugar (g)	20	20	20	20	20	20	20
Fat (daldah) (g)	16	16	16	16	16	16	16
Milk powder (g)	2	2	2	2	2	2	2
Egg (g)	20	20	20	20	20	20	20
Baking powder (g)	1	1	1	1	1	1	1
Vanilla essence (drops)	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Salt (g)	0.5	0.5	0.5	0.5	0.5	0.5	0.5

[†] Amount per 100 g; [‡] Sample 101 = 100% WF, 123 = 90% WF + 10% PF, 231 = 85% WF + 15% PF, 321 = 80% WF + 20% PF, 456 = 90% WF + 10% CF, 564 = 85% WF + 15% CF, and 654 = 80% WF + 20% CF

where, D = average diameter (cm) of biscuits, and T = average thickness (cm) of biscuits.

Volume of biscuits was calculated using the formula:

$$\text{Volume (cm}^3\text{)} = \frac{\pi D^2}{4} \times T \quad (2)$$

where, D = average diameter (cm) of biscuits, and T = average thickness (cm) of biscuits.

Density was obtained following the method used by [Srivastava \(2012\)](#).

$$\text{Density (g/cm}^3\text{)} = \frac{\text{Weight}}{\text{Volume}} \quad (3)$$

2.7 Sensory analysis

Seven biscuit samples containing various proportions of WF, PF and CF were evaluated for their sensory attributes (color, flavor, texture and overall acceptability) by a panel of 12 panelists as mentioned by [Ranganna \(2005\)](#), who noted 10–25 semi-trained panelists' number for hedonic rating test. The panelists were selected from the teachers, students and employees of the department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh and were briefed before evaluating sensory quality of the biscuits. For statistical analysis of sensory data, a 9–point hedonic rating test ([Amerine et al., 1965](#); [Sarker et al., 2013](#)) was performed to assess the degree of acceptability. One biscuit from each lot was presented to 12 panelists as randomly coded samples. The taste panelists were asked to rate the sample on a 9–point hedonic scale for color, flavor, texture and overall acceptability with the ratings of: 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely.

2.8 Statistical analysis

The obtained data were analyzed for standard deviation, single factor and two factor Analysis of Variance (ANOVA) by using Microsoft Office Excel 2013. Fisher's LSD Multiple Comparison Test procedures of the Method of Statistical (MSTAT) system was performed to determine significant difference among the various samples by taking 5% level of significance by following [Gomez and Gomez \(1984\)](#).

3 Results and Discussion

3.1 Nutritional composition of wheat, potato and corn flours

WF, PF and CF were analyzed for moisture, protein, fat, ash, and total carbohydrate content. The results are shown in [Table 2](#).

From wet weight basis (wb) analysis ([Table 2](#)), it is seen that WF had the highest moisture value of 14.37%, followed by CF (11.26%) while PF had the lowest moisture (8.84%) among three flours. The highest ash (2.3%) and total carbohydrate (81.3%) were obtained from PF, while WF gave the lowest ash (0.51%) and fat (0.64%), but the highest protein (11.46%). CF was rich in fat (3.62%) and gave the maximum energy of 370.1 Kcal for per 100 g consumption, while the lowest energy (360.1 Kcal/100 g) was provided by PF. [Khaliduzzaman et al. \(2010\)](#) reported that the composition of WF as: moisture 13%, ash 0.70%, protein 11.50%, fat 1%, crude fiber 2.50% and total carbohydrate 73.80% in wb, while 10% moisture, 5% protein, 0.86% fat, 2.5% ash, 5.5% crude fiber and 81.65% total carbohydrate in PF. [Hussein et al. \(2013b\)](#) reported that CF contained moisture of 12.65%, 9.60% protein, 4.39% fat, 1.22% ash, 81.49% total carbohydrate in db. Extent of drying, varietal variation, environmental condition, pre and post-harvest processing may

Table 2. Composition of wheat, potato and corn flour[†]

Components		Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy (Kcal/100g)
WF	wb	14.37±0.65a	0.51±0.10b	11.46±0.21a	0.64±0.06c	73.02±0.98b	343.70±2.97c
	db	16.78	0.6	13.38	0.75	85.27	401.4
PF	wb	8.84±0.94c	2.30±0.16a	6.63±0.38c	0.93±0.06b	81.30±1.35a	360.10±4.64b
	db	9.7	2.52	7.28	1.02	89.21	395.1
CF	wb	11.26±0.95b	0.74±0.10b	9.28±0.23b	3.62±0.07a	75.07±1.17b	370.10±4.19a
	db	12.69	0.83	10.46	4.08	84.64	417.1
LSD		1.73	0.23	0.53	0.11	2.16	7.51

[†] Samples having the same superscript do not differ at 5% level of significance; wb = wet weight basis (mean ± standard deviation); db = dry weight basis (values were calculated only by using the mean wb values)

cause the compositional difference with other authors as mentioned above.

3.2 Physical properties of biscuits

The physical properties (diameter, thickness, volume, spread ratio and density) of the biscuits were evaluated and the average results are presented in Table 3. The diameter increased with the increasing of PF or CF up to 15%, but decreased for further addition of PF or CF. The density of the sample 456 was the highest and the sample 564 gave the lowest weight. Spread ratio is one of the most important quality parameter of biscuit, significantly influenced by the addition of potato or corn flour in the biscuit formulation.

15% supplemented biscuits gave the minimum spread ratio, but the value increased with more addition of PF or CF. Biscuits' thickness grown up slightly with the increasing level of PF replacement up to 25% and spread ratio decreased with the increasing of PF due to higher water holding capacity of PF (Khaliduz-zaman et al., 2010).

3.3 Nutritional composition of formulated biscuits

The biscuits samples were analyzed for moisture, ash, protein, fat, and total carbohydrate and the results are depicted on Table 4.

3.3.1 Moisture

The moisture content of seven different biscuit samples was in the range of 4.35–4.91% (wb) and 4.55–5.16% (db) (Table 4). Some variations in moisture contents in biscuits might be due to the difference in initial moisture content of different flour, for baking, subsequent storage conditions and packaging materials. Moisture content of control biscuit (sample 101) was higher than those of others. This might be due to

the fact that potato and corn flours contained higher amount of solid matter compared to WF. However moisture content of WF could be reduced initially and thus control biscuits could give lower moisture content. Moisture content of composite biscuits reported by Grah et al. (2014) was in the range of 5.13–7.17% in db, while Hussein et al. (2013a) reported moisture content in control biscuit as 3.26% (db) and 3.80–4.62% (db) in corn-fenugreek composite biscuits. Biscuits were formulated by Debnath (2003) with composite soy flour and WF gave a range of moisture content from 4.75 to 5.32% (wb). The moisture contents in biscuits samples under study were almost in agreement with those reported by other authors and comply with the actual moisture (<5%) of standard quality biscuits.

3.3.2 Protein

Different biscuits samples coded as 101, 123, 231, 321, 456, 564 and 654 gave the protein of 8.27, 7.92, 7.83, 7.75, 8.17, 8.09 and 8.02 (db) respectively. Protein content decreased with the increased of PF or CF, while sample 321 gave the lowest protein content. Seevaratnam et al. (2012) observed 6.6% (db) protein in WF biscuit and 6.1% (db) in PF supplemented biscuits (20% PF). Grah et al. (2014) found protein content in composite biscuit in the range of 6.88–11.45% (db). So it reveals that low protein biscuits can be processed with addition of PF or CF.

3.3.3 Fat

The fat content of the samples was in the range of 17.60–17.83% (wb) and 18.43–18.69% (db) (Table 4). Variation of fat content was very slight in case of PF supplementation but fat content was increased due to CF supplementation. This observation was complied with Seevaratnam et al. (2012), who reported 25.8% (db) fat in 20% PF supplemented biscuits while the control had 25.9% (db) fat.

Table 3. Effect of PF and CF on physical properties of biscuits[†]

Sample [‡]	Density (g/cc)	Diameter (cm)	Thickness (cm)	Volume (cm ³)	Spread ratio
101	0.63±0.026b	3.70±0.044b	0.68±0.072b	7.31±0.069cd	5.44±0.451b
123	0.61±0.026b	3.74±0.056ab	0.70±0.035b	7.69±0.056c	5.34±0.184b
231	0.49±0.040cd	3.85±0.062a	0.78±0.061ab	9.08±0.148a	4.94±0.324bc
321	0.53±0.026c	3.80±0.056ab	0.72±0.046ab	8.16±0.101b	5.27±0.281bc
456	0.91±0.026a	3.62±0.147b	0.50±0.062c	5.15±0.108e	7.24±0.532a
564	0.43±0.044d	3.82±0.066ab	0.82±0.056a	9.40±0.520a	4.66±0.251c
654	0.60±0.056b	3.69±0.061b	0.70±0.070b	7.49±0.082c	5.27±0.594bc
LSD	0.062	0.129	0.1	0.363	0.669

[†] Samples having the same superscript do not differ at 5% level of significance [‡] Sample 101 = 100% WF, 123 = 90% WF + 10% PF, 231 = 85% WF + 15% PF, 321 = 80% WF + 20% PF, 456 = 90% WF + 10% CF, 564 = 85% WF + 15% CF, and 654 = 80% WF + 20% CF

Table 4. Chemical composition of composite flour biscuits[†]

Component		Sample [‡]							LSD
		101	123	231	321	456	564	654	
Moisture (%)	wb	4.91±0.07a	4.45±0.06cd	4.41±0.03d	4.35±0.05d	4.75±0.14b	4.66±0.13bc	4.59±0.05c	0.14
	db	5.16	4.66	4.61	4.55	4.99	4.89	4.81	
Ash (%)	wb	0.77±0.04c	0.83±0.03c	1.01±0.07a	1.09±0.05a	0.79±0.04c	0.84±0.04c	0.91±0.06b	0.08
	db	0.81	0.87	1.06	1.14	0.83	0.88	0.95	
Protein (%)	wb	7.86±0.03a	7.57±0.06d	7.48±0.10d	7.41±0.05d	7.78±0.06b	7.71±0.04bc	7.65±0.10c	0.11
	db	8.27	7.92	7.83	7.75	8.17	8.09	8.02	
Fat (%)	wb	17.60±0.05	17.61±0.04c	17.62±0.08c	17.63±0.04c	17.72±0.03b	17.78±0.05ab	17.83±0.04a	0.08
	db	18.51	18.43	18.43	18.43	18.6	18.65	18.69	
Carbohydrate (%)	wb	68.86±0.15b	969.54±0.05a	69.48±0.16a	69.52±0.41a	68.96±0.10b	69.01±0.15b	69.05±0.14b	0.33
	db	72.42	72.78	72.69	72.68	72.4	72.38	72.34	
Energy (Kcal/100g)	wb	465.28±0.43b	466.84±0.46a	466.33±0.17ab	466.30±1.33ab	465.63±0.30b	466.36±0.36ab	466.82±0.38a	1.01
	db	489.35	488.67	487.95	487.59	489.68	489.73	489.77	

[†] Samples having the same superscript do not differ at 5% level of significance; [‡] Sample 101 = 100% WF, 123 = 90% WF + 10% PF, 231 = 85% WF + 15% PF, 321 = 80% WF + 20% PF, 456 = 90% WF + 10% CF, 564 = 85% WF + 15% CF, and 654 = 80% WF + 20% CF; wb = wet weight basis (mean ± standard deviation); db = dry weight basis (values were calculated only by using the mean wb values)

Table 5. Mean score for color, flavor, texture and overall acceptability of composite biscuits[†]

Sample	Sensory attributes			
	Color	Flavor	Texture	Overall acceptability
101	7.17±0.751b	7.00±0.603ab	7.00±0.739b	7.00±0.603bc
123	7.25±0.754b	6.58±0.515bc	6.42±0.515c	6.83±0.718bc
231	7.75±0.622a	7.56±0.522a	7.58±0.515a	7.92±0.669a
321	7.08±0.669b	6.42±0.515bc	6.50±0.522c	6.58±0.669c
456	6.42±0.515c	6.42±0.793bc	7.00±0.603b	6.75±0.622bc
564	7.33±0.651ab	6.83±0.835b	7.09±0.669ab	7.17±0.718b
654	6.50±0.522c	6.17±0.577c	6.17±0.718c	7.17±0.718b
LSD	0.461	0.529	0.476	0.522

[†] Samples having the same superscript do not differ at 5% level of significance

3.3.4 Ash

Ash content of sample 321 (20% PF) was the maximum (1.09% wb and 1.14% db) and the sample 101 (control) gave the lowest ash content (0.77% wb and 0.81% db). Ash content of the biscuits increased in addition of PF because of its higher mineral content compared to WF. [Agu et al. \(2007\)](#) found the ash value in composite biscuit in the range of 0.99 to 1.13% (wb), while [Seevaratnam et al. \(2012\)](#) reported 1.4% (db) ash in control biscuit and 1.7% in 20% PF containing composite biscuit.

3.3.5 Total carbohydrate

The total carbohydrate content of the samples was in the range of 68.86–69.94% (wb) ([Table 4](#)). The variation in the total carbohydrate contents among biscuits sample may results from the different in the level of protein, fat, ash and moisture content.

3.3.6 Energy

Total energy in calorie for 100 g consumption of the developed biscuits was not varied largely for PF or CF supplementation. This might be due to the fact that amount of protein, fat and carbohydrate content in the developed biscuits were not dispersed largely.

3.4 Sensory evaluation (Hedonic Rating Test)

The mean score obtained from sensory analysis is depicted on [Table 5](#). There was significant difference in color preference among the samples and were not equally acceptable. The color score of biscuits were in decreasing order as: sample 231 > sample 564 > sample 123 > sample 101 > sample 321 > sample 654 > sample 456. In case of flavor, sample 231 and 101 did not differ significantly, also sample 101, 123, 321, 456 and 564 with each other, while the sample 654 differed significantly. For texture, the sample 231 and 564 were not significantly different, while 101, 456 and 564 were not differed significantly also at 5% level of significance. In case of overall acceptability, sample 231 secured the best score and differed significantly from other samples but all other samples except 321 were equally acceptable. So in terms of consumer choice, Fisher's LSD multiple comparison test revealed that the sample 231 (15% PF) was the best among all samples and among CF supplemented biscuits, sample 564 (15% CF) was the best.

4 Conclusion

Due to improper storage facilities, farmers sell the potato and corn at a low price during the production season. But, potato and corn can be used as po-

tential ingredients in biscuit production. Nutritious biscuits with exceptional flavor can be prepared by using potato or corn flour with wheat flour. Potato or corn flour can be supplemented up to 15% with wheat flour to get more consumers' preferable biscuits. The formulation may be improved by addition of food colors, flavors and vitamins. Further study can be performed for micronutrients, storage stability, sorption behavior, antioxidant activity etc.

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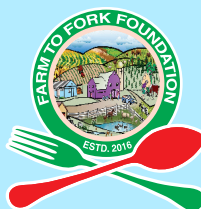
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