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Quality assessment of noodles made from mixer of potato, rice and wheat flour

Md. Abdul Momin Sheikh[1*], Md. Akhtaruzzaman[3], Joysree Roy[1], Shanjida Akthar Shanta[2], Md. Kamal Uddin Sarker[2]

1. Department of Food Engineering and Technology 2.Department of Agricultural and Industrial Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh 3.Department of Agro Product Processing Technology, Jashore University of Science and Technology, Jashore-7408, Bangladesh
(Md. Abdul Momin Sheikh)

Abstract
The present study was concerned with the preparation of potato flour with various treatments and formulation of noodles incorporating potato flours as supplement to wheat flour. Four types of potato flours were prepared by treating the raw potato slices as blanched, blanched plus potassium meta- bisulphite (KMS), boiled and smashed and one as control without any treatment. Only blanched plus KMS treated potato flour was used because its colour and flavour was good. Various substitution levels such as 0, 10, 20, 30 and 40% of potato flour was used in the formulations of noodles in conjunction with wheat flour. The raw potato, potato flour, wheat, wheat flour, rice, rice flour, prepared noodles were analyzed for their composition. For noodles the highest nutritional compositions varied with different percentages of potato flour. But, the moderate level of nutritional compositions for noodles was observed for 20% potato flour. The prepared noodles containing various levels of potato flour were evaluated for their sensory attributes by a panel of twenty (20) panelists. The noodles containing 30% potato flour were most preferred for colour than the noodles containing various levels of potato flour and control noodles. Noodles with (control) 0% potato flour had least colour acceptability. The flavour, texture and overall acceptability of noodles containing 20% potato flour were significantly different from that of others and secured the highest scores in terms of all quality attributes and ranked as 'like moderately' to 'like very much'.

Keywords: *Potato; Noodles; Flour; Organoleptic qualities; Formulation*

I. Introduction

As one of the necessary staple foods in Asian countries, noodles are very convenient, rich in nutrition, as well as easy to cook and delicious (Ahmed et al., 2015; Kaur et al., 2015). Traditional noodles are generally made from common wheat flour, water and/or salt through several processes such as dough mixing, sheeting and cutting (Fu, 2008). Besides, some products prepared by using rice, buckwheat or starches derived from potato, sweet potato and pulses can also be identified as noodles (Fu, 2008). Nowadays, in order to enrich the varieties of noodles, wheat noodles have been fortified with various ingredients. Researchers have attempted to prepare wheat noodles by adding broken rice, oat flour, barley flour, sweet potato flour, and/or buckwheat flour (Ahmed et al., 2015; Guo et al., 2017; Mitra et al., 2016; Montalbano et al., 2016; Ndayishimiye et al., 2016). However, some above-mentioned raw material does not contain gluten protein. Thus, substitution of wheat flour with these gluten-free components will generally negatively affect noodle quality including color, sensory and cooking characteristics. Nevertheless, noodles with an appropriate addition of these components are acceptable and can also provide an improved nutritional value (Ahmed et al., 2015).

Potato (Solanum tuberosum L.), the fourth most important crop worldwide after rice, wheat, and maize, is a tuber that is largely used for food, and contains many nutrients such as starch, dietary fiber, amino acids, minerals, vitamins, and phenolic compounds (Akyol et al., 2016; Burlingame et al., 2009). Besides, potato protein has a balanced amino acid composition, high total vitamin and mineral levels, which is superior to that of cereal protein (Bartova et al., 2015; Ezekiel et al., 2013). In the food industry, a substantial portion of cultivated potatoes is dehydrated in order to resolve the difficulties in potato storage and expand the usage of potato. Typical dehydrated potato flours are produced through blanching or cooking, drying, grinding, and sieving. Due to the retention of nutritive value and the gelatinization of starch, potato flours are frequently used in many food stuffs such as mashed potatoes, gnocchi or snacks (Gosset et al., 2008).

Potato is edible tuber of the cultivated plant *Solanum tuberosum* of the family Solanaceae. It is now one of the staple foods in Bangladesh. Most varieties are cultivated during the winter in all the districts of Bangladesh and harvested February-March. Of the total 401,850 hectares of land used for potato cultivation

during 2007-2008, 81,370 hectares for local and 320,480 hectares for high yielding varieties. The gross production of potato during 2007-2008 was 6.65 million MT (BBS, 2008).

Composite flour technology refers to the process of mixing various flours from tubers with cereals or legumes with or without addition of wheat flour in proper proportions to make economic use of local cultivated crops to produce high quality food products. Some studies were reported on the use of cereal-tuber-legume combination for the production of various products (Akubor and Ukwuru, 2005; Oladunmoye et al., 2010; Kadam et al., 2012). It can be deduced from these reports that the qualities of product depend on the proportional composition of the composites and flour properties (Oladunmoye et al., 2010).

Rice is the staple food for more than half the population in the world and is becoming popular in other parts of the world as well. There are almost 25,000 varieties of rice all over the world, but the most commonly consumed ones are white rice and brown rice.

Processing is a fast growing factor within world potato economy. Due to the increased demand for convenience food and the expanding institutional market, the consumption of processed potato products is of increasing importance. The most popular processed products of potato are chips, French fries, powder, cubes, slices, starch. Processing is mainly confined to developed countries and it is only in its infancy stage in most of the developing countries with the exception of China (12%), Korea (6%) and Mexico (8%). Currently about half of the annual crop in the USA is processed.

Bangladeshi people love rice. Sometimes, particularly in villages, people consume rice three times a day. But the national production of rice is not enough to fulfill the current demands. Also the price of rice is high. On the other hand there is enough production of potato beyond the capacity of the cold storages existing in Bangladesh (only 36%). If potato could be consumed as a replacement of rice, the pressure on rice could be reduced and potato consumed at peak season would help farmers getting good price for their products. Farmer would be encouraged to maximize production, which would go a long way in solving the overall food deficit currently faced by the country.

Objectives of the Research Work:

With the above views in mind the present study was undertaken to achieve the following objectives: To determine the proximate composition of potato, rice and wheat; To prepare composite flour from potato, rice and wheat flour; To develop noodles from composite flour; To determine the proximate composition of noodles; To assess the overall acceptability of prepared noodles.

II. Materials And Methods

The study was conducted in the laboratories of the Department of Food Engineering and Technology, Food Science and Nutrition, Food Processing and Preservation and Agricultural Chemistry of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

Materials

Good quality potatoes, rice and commercial wheat flour of 'Pata' brand (12-13% moisture and 8-9% protein) were collected from the local market. Necessary chemicals and solvents such as Potassium Meta-bisulphite (KMS), Salt (NaCl), Sodium Benzoate, Potassium Nitrate (KNO_3), Starch powder, Ammonium Sulphate ($(NH_4)_2SO_4$) were used from laboratory stocks. Wheat flour (12-13% moisture and 8-9% protein) was commercial wheat flour of 'Pata' brand. High density polyethylene bags were used for package and storage of the samples. Other minor ingredients were used from laboratory stocks.

Methods

Treatments of potato before drying

Four different pretreatments were given on raw potato to prepare potato flours. (1) Sample of raw potato was cleaned with water and sliced (3 mm thickness) with hand knife (control). (2) Sample of raw potato was cleaned with water, sliced (3 mm thickness) with hand knife, immediately blanched in water at 90 °C for 10 minutes and cooled quickly in cold water. (3) Sample was cleaned, sliced, immediately blanched for 10 minutes at 90^0C and then treated with KMS solution (the slices were soaked in 0.25 % Potassium Meta-bisulphite (KMS) solution for 10 minutes using 0.5 kg of solution per kg of potato slices) and (4) Sample of raw potato was cleaned with water, boiled at 80 °C for 15 minutes and smashed with hand.

These samples were subsequently used for the preparation of potato flours.

Preparation of potato flour

The pre-treated potato samples and control sample was dried in cabinet dryer. Air was blown by a fan passed over a heater and trays containing the sample to be dried. The slices were dried for about 8 hours at 65°C and then about 4 hours at 45°C. The potato flour was prepared by grinding the dried potato slices in a blender and kept in polyethylene bags for noodles manufacture. The color, flavor and overall acceptability of pretreated

potato flour (blanched + KMS) were significantly different from that of four pretreated potato flour samples. Finally pretreated samples (blanched + KMS) were used for this study. Potato slices spread on tray for drying on Cabinet dryer and potato flour prepared from potato after various pre-treatments are shown in Figure 1.

Figure 1: Potato slices spread on tray for drying on Cabinet dryer and potato flour prepared from potato after various pre-treatments.

Preparation of rice flour

The selected rice (BRRI Dhan 29) was collected from local market. Then the rice was washed and soaked for about 3-6 hours. The rice was drained in a fine mesh strainer for 10-15 minutes. The rice was spreaded out on a triple layer of paper towels to dry for an hour. Then, the rice flour was prepared by grinding rice in a blender and the flour was kept in polythene bag. Rice flour prepared from rice is shown in Figure 2.

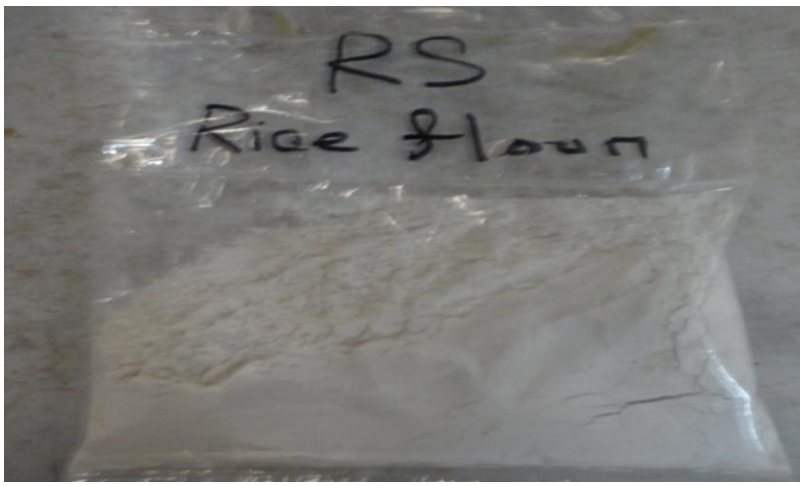


Figure 2: Rice flour prepared from rice

Product Development

Formulation of composite flour from wheat, rice and potato flour

The basic formulation of composite flour is shown in Table 1. 0, 10, 20, 30 and 40% of potato flour was substituted with wheat flour for the composite flour preparation.

Table 1: Basic formulations of composite flour on 100 gm flour basis

Ingredients	Sample CS1	Sample CS2	Sample CS3	Sample CS4	Sample CS5
Wheat flour	100	80	70	60	50
Rice flour	0	10	10	10	10

Potato flour	0	10	20	30	40

CS1= Composite flour sample 1(Control sample), CS2= Composite flour sample 2, CS3= Composite flour sample 3, CS4= Composite flour sample 4, CS5= Composite flour sample 5.

Formulation of rice and noodles for composite flour on 100 g basis

The basic formulations of noodles are shown in Table 2.

Table 2: Basic formulations of noodles for composite flour on 100 g basis

Ingredients	Sample S1	Sample S2	Sample S3	Sample S4	Sample S5
Composite flour	98 g of CS1	98 g of CS2	98 g of CS3	98 g of CS4	98 g of CS5
Starch powder	0.7 g	0	0	0	0
Salt	1.3 g	1.3 g	1.3 g	1.3 g	1.3 g
Sodium Benzoate	0.03g	0.03g	0.03g	0.03g	0.03g

Preparation of noodles

The dough was formulated by mixing 98% composite flour, 1.3% salt, 0.03% sodium benzoate and 35-40% distilled water. Starch powder (0.7%) was used only in sample 1. The mixer machine (blender) was operated for 1 min (at speed 1) and 4 min (at speed 3). The dough was made ruti for slicing to make sticks. Then the sticks were kept in cabinet dryer for drying. The temperature of dryer was maintained at 30-35^{0}C for 2 hours, then 45-50^{0}C for 2 hours, finally the sticks were dried at 70-75^{0}C for 50-60 min (until final moisture became 7-10% wb). Then it was kept for 15 min at ambient temperature. The sticks were packed in polythene bag for future use.

(Note: The procedure of making noodles from composite flour mentioned here was developed through trial and error following other procedures for similar products.)

Chemical Analysis

The fresh potato, potato flour, wheat, wheat flour, rice, rice flour, prepared rice and noodles were analyzed for their moisture, ash, fat, protein and total carbohydrate contents. All the determinations were done in triplicate and the results were expressed as average value. Proximate composition was determined using AOAC (2004) method.

Cooking of Prepared Noodles

Noodle was cooked in boiled water for 12 minutes. The cooked noodle was rinsed and washed with cold water. The form of noodle did not change (i.e. dissolve or disintegrate) after cooking. Then the boiled noodles were cooked with oil, taste maker, spices, egg etc. Noodles were served to panelist for sensory evaluation.

Sensory evaluation

A test panel evaluated the consumer's acceptability of developed products. The test panels (20) were selected from the students, officers and teachers of the Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. The panelists were requested to assign score for characteristics color, flavour, texture and overall acceptability of prepared noodles.

The scale was arranged such that: 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 and 1=Dislike extremely.

The results were evaluated by analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) procedures using MSTAT-C statistical software packages (MSTAT-C, 1991).

Data analysis

Analysis of variance (ANOVA) was carried out using MSTAT-C statistical software packages (MSTAT-C, 1991). Means were compared using least significant differences (LSD). Correlations between parameters were made when appropriate. As suggested by Watts et al. (1989), in analyzing the sensory data, the 5 point scale and the 9 point hedonic scales were used and the numerical values for each sample were tabulated and analyzed by ANOVA to determine whether significance differences in mean degree of scoring points exist among the samples or not.

III. RESULTS AND DISCUSSION

Composition of fresh potato, rice and wheat

The fresh potato, rice and wheat were analyzed for moisture, ash, protein, fat, and total carbohydrate. The results are presented in Table 3.

Table 3: Composition of fresh potato, rice, wheat

Components	Fresh potato	Rice	Wheat
Moisture (%)	80.5	12.9	12.0
Ash (%)	0.98	0.5	1.5
Protein (%)	2.04	6.8	13.0
Fat (%)	0.1	0.6	2.3
Total carbohydrate (%)	16.38	79.2	71.2

Kroner and Volksen (1950) showed that potato contained 77.5 %, 1%, 19.4%, 0.1% and 2% moisture, ash, carbohydrate, oil and protein respectively. These values were very close to those found in this study. The slight variation in composition of fresh potato might be due to varietal differences, variation in stage of maturity, time elapsed between harvesting and analysis and the growing conditions of the crop.

The composition of rice under study was more or less similar to those reported in USDA Nutrient Data Base (2007). The reported nutrient content of rice as follows: moisture 12%, ash 0.52%, fat 0.66%, protein 7.1%, and total carbohydrate 80%. USDA Nutrient Data Base (2007) showed that wheat contained moisture 11%, ash 1.83%, fat 2.47%, protein 13.7 % and total carbohydrate 71.0%.

Composition of potato flour, rice flour and wheat flour

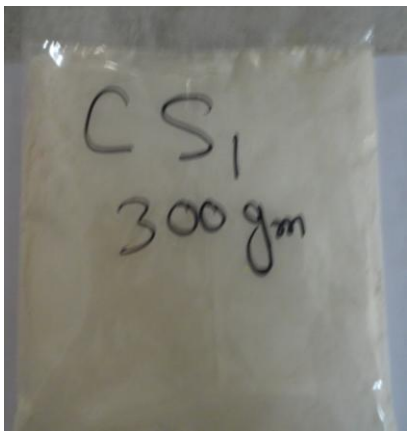
Potato flour, rice flour and wheat flour were analyzed for moisture, ash, protein, fat, and total carbohydrate. The results are presented in Table 4.

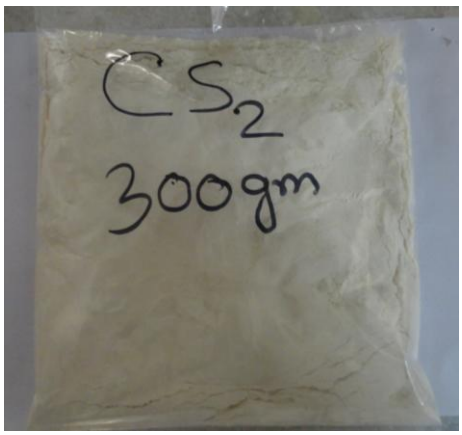
Table 4: Composition of potato flour, rice flour and wheat flour

Components	potato flour	rice flour	wheat flour
Moisture (%)	10.0	11.0	13.0
Ash (%)	2.5	0.7	0.70
Protein (%)	5.0	7.5	11.5
Fat (%)	0.86	0.8	1.0
Total carbohydrate (%)	81.64	80.0	73.80

Preparation of composite flour from potato, rice and wheat flour

Composite flour was prepared which include the ingredients potato, rice and wheat flour as shown in Figure 3. The proportion is mentioned in Table 1.





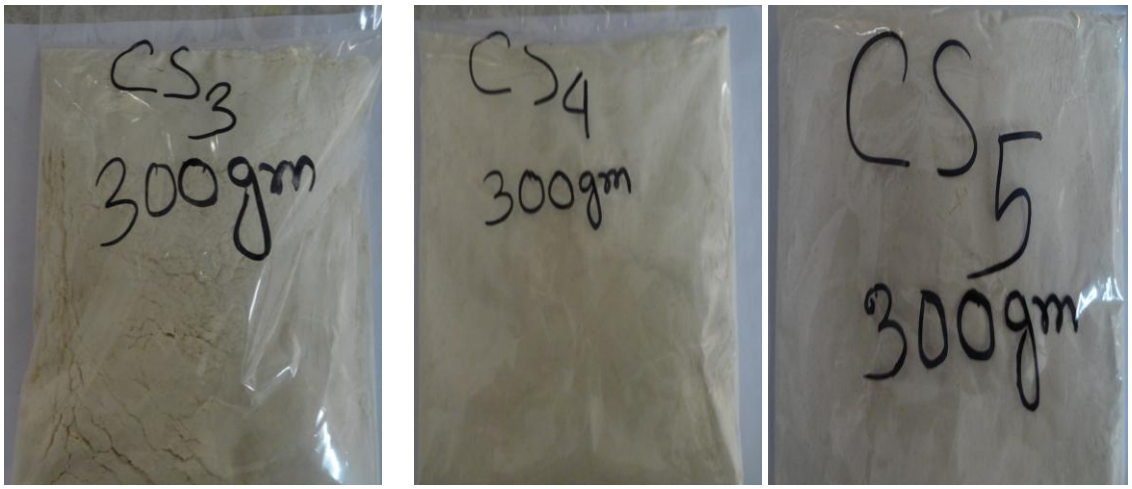


Figure 3: Composite flour prepared from various proportion of potato, rice and wheat flour.

Composition of prepared noodles

In the present study five samples of prepared noodles, one containing no potato flour and four samples with various levels of potato flour, were prepared and analyzed for their composition. The results are shown in Table 5.

Table 5: Composition of prepared Noodles

Type of products		Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Total carbohydrate (by difference) %
Prepared noodles	CS1 (0%)	10.57	0.71	10.50	0.90	77.32
	CS2 (10%)	11.25	0.89	10.05	0.85	76.96
	CS3 (20%)	11.70	1.07	9.60	0.82	76.81
	CS4 (30%)	11.25	1.27	9.25	0.92	77.38
	CS5 (40%)	11.00	1.40	9.01	0.82	76.77

The proportion is mentioned in table 1. CS1= Composite flour sample 1, CS2= Composite flour sample 2, CS3= Composite flour sample 3, CS4= Composite flour sample 4, CS5= Composite flour sample 5.

Moisture content of prepared noodles sample with different levels of potato flour was higher than that of controlled sample. But fat content of 30% potato flour was higher than different level of potato flour and noodles. With the increasing level of potato flour, the prepared rice and noodles had increasing level of ash and decreasing protein.

Sensory evaluation of noodles

The noodles substituted with 0, 10, 20, 30 and 40% potato flour were subjected to sensory evaluation by a panel of 20 panellists. The mean scores for colour, flavour, texture and overall acceptability of the noodles are presented in Table 6. A two way analysis of variance indicate that all these sensory attributes of different noodles were significantly ($P<0.05$) different and thus the noodles showed varied degrees of acceptability in terms of colour, flavour, texture and overall acceptability.

Table 6: Mean sensory scores of noodles Duncan's Multiple Range Test (DMRT) for colour, flavour, texture and overall acceptability of noodles

Product type	*Mean scores on sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
Noodles with wheat flour only (Control)	6.0^{c}	6.8^{ab}	6.7^{b}	7.0^{b}
Noodles with 10% rice and 10% potato flour	6.4^{bc}	6.7^{ab}	6.5^{b}	7.1^{ab}
Noodles with 10% rice and 20% potato flour	6.8^{abc}	7.8^{a}	7.8^{a}	7.8^{a}
Noodles with 10% rice and 30% potato flour	7.6^{a}	7.0^{ab}	6.2^{b}	6.4^{b}
Noodles with 10% rice and 40% potato flour	7.0^{ab}	6.4^{b}	7.0^{ab}	6.7^{b}
LSD (P <0.05)	0.8657	1.233	0.8951	0.7250

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

As shown in Table 6, the DMRT test revealed that the noodles containing 30% potato flour were most preferred for colour than the noodles containing various levels of potato flour and controlled noodles. Noodles with (control) 0% potato flour had least colour acceptability. The flavour, texture and overall acceptability of noodles containing 20% potato flour were significantly different from that of others and secured the highest scores in terms of all quality attributes and ranked as 'like moderately' to 'like very much'.

Figure 4: Noodles prepared from composite flour

IV. Conclusion

Five samples of noodles were prepared by the incorporation of various levels of potato flour (0-40%) in the standard formulations and the products were evaluated for their physico-chemical properties and sensory analysis.

Statistical analysis of noodles containing 30% of potato flour was mostly preferred for colour than the noodles containing various levels of potato flour and controlled noodles. The noodles containing 20% potato flour was mostly preferred for flavour, texture and overall acceptability than the noodles containing various levels of potato flour and control noodles. The flavour, texture and overall acceptability of noodles containing 20% potato flour were significantly different from that of others.

This study demonstrates that it is possible to prepare potato flour from potato and preserve as flour. The study also demonstrates that potato flour can be incorporated with rice and wheat flour to develop composite flour. The study also reveals that rice, wheat, potato composite flour can be used to prepare stick noodles that can be cooked as noodles and consumed. Then the study opens a bright area of using potato as flour and use of potato as a supplement to the products. This will ensure the good price of potato for the growers and supply of potato and preservation throughout the year.

The findings of the present study may help in developing commercial processing technology for effective utilization of potato flour, especially for manufacturing of noodles.

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Author's contribution

In this research, all authors contributed effectively.

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