

IDENTIFICATION OF PHYSICAL CHARACTERISTICS OF POTATO VARIETIES FOR PROCESSING INDUSTRY IN BANGLADESH

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Keywords: Colour, Potato, Specific gravity, Tuber shape

Abstract

A total of 40 potato varieties grown in Bangladesh were evaluated for different physical and other quality attributes for processing industry. Seventeen varieties were oval shaped and 12 varieties were round shaped tubers. Twenty nine varieties were white coloured and 11 varieties were red coloured skin. Sixteen potato varieties were cream colour flesh. Number of eyes was less in most of the cultivars with shallow eye depth, without scars and green tint. Omega showed the highest average tuber weight (138.6 g) and longest diameter (6.58 cm) while Steffi recorded significantly the highest volume (130.20 ml). The specific gravity was determined to clarify their processing quality. The specific gravity of different potato varieties ranged from 1.053 to 1.123 with the highest in Ludmila and Tomensa (1.123) and the lowest in Espirit, Almerah and Connect (1.053). As the potato varieties Diamant, Lady Rosetta, Dheera, Elgar, Cardinal, Ailsa, Multa, Tomensa, Meridian, Asterix, Rumba, Omega, Caruso, Amanda and Svenja showed better physical and other quality parameters studied in this experiment, these varieties may be used for processing industry in Bangladesh.

Introduction

Bangladesh is the eighth potato producing country in the world and it ranks second after rice in production (FAOSTAT 2013). The total area under potato crop, national average yield and total production in Bangladesh are 444,534.41 hectares, 19.35 t/ha and 8,603,000 metric tons, respectively (FAOSTAT 2013). Potato production is increasing day by day due to increasing processed potato consumption rate in Bangladesh (Rahman 2016). In the present year (2014-2015), about 9 million tons of potatoes are produced where consumption capacity is about 7 million tons and rest 2 million tons are surplus. This surplus amount of potato needs to use either in processing industries or to export in foreign countries.

The demand for processed potato products is increasing continuously in present days mainly due to improved living standards, urbanization growth, preference of new generation and expanding tourist trade. On an average, about 28% of total potato produced throughout the world is processed. Physical characteristics of agricultural products are the most important parameter in the design of grading, handling, processing and packaging system. Besides the shape and size of the tubers, eye depth, average weight, total potato defects and specific gravity of potatoes are the most important factors in determining their suitability for processing. Medium to large size tubers with shallow eyes are preferred for most of the processed products as these results in lower peeling losses. Colour is also an important quality attribute where golden yellow colour is considered to be the best for high quality potato chips (De Freitas *et al.* 2012). In Bangladesh, 40 potato varieties are grown in different growing areas but the processing characteristics such as optimum tuber

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shape, size, eye depth, number of eyes, colour, dry matter content, specific gravity, starch content, reducing sugar content, non-reducing sugar content are not assessed elsewhere. Therefore, the study was undertaken to evaluate the suitability for processing of different potato varieties grown in Bangladesh on the basis of their physical characteristics.

Materials and Methods

The experiment was conducted at the Agronomy Laboratory, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March to June, 2013. Forty varieties of potato tubers were used as treatments and arranged in a CRD with 3 replications. Physical characteristics, namely weight, volume, specific gravity, diameter, shape, colour, visual observation of skin and flesh colour of 40 potato varieties were recorded.

Tuber shape, evaluation of tuber eye depth, colour of flesh and skin was determined as mentioned by Wooster and Farooq (1995). Total potato defects (TPD) were examined externally in terms of presence of green tint, scars, natural depression, skin texture and number of eyes. Internally TPD of cut potatoes was visualized for presence of hollow hearts and black spots (Singh *et al.* 2005). Volume of potato tubers was calculated as described by Tabatabaefar (2002).

Data obtained for different characters were statistically analyzed following the analysis of variance by using MSTAT-C computer package programme and differences among the treatment means were compared by DMRT at 1% level of probability (Gomez and Gomez 1984).

Results and Discussion

Tuber characteristics include tuber shape, eye depth, tuber skin colour, flesh colour and general appearance. These are also called quality characteristics which are important for marketing as well as for processing. The varieties varied widely for these characteristics (Table 1).

Most of the varieties had oval shaped tubers. Seventeen varieties such as, Diamant, Binella, Elgar, Agila, Sagitta, Provento, Cardinal, Steffi, Felsina, Multa, Espirit, Meridian, Asterix, Omega, Amanda, Svenja, and Connect had oval shaped tubers. Twelve varieties such as, Granola, Lady Rosetta, Dheera, Saikat, Ailsa, Rumba, Endeavour, Caruso, Belarossa, Bat Pakri, BARI TPS-1, Tomensa had round shaped tubers. Potato tubers that are round and oval in shape are found to be suitable for making chips by most processors because they easily make the required crisp diameter (Pandey *et al.* 2009). Majority of the cultivars was oval shaped with brown coloured skin with cream flesh in the present study. Abong *et al.* (2010) reported that the most of Kenyan cultivars showed round shape with white, cream or red skin colour and white or cream flesh colour. General appearance was scored by giving number 9 for excellent to 1 for disliking. Out of forty varieties, Granola, Steffi, Cumbica, Omega, Forza, Amanda, Ludmila, Binella and BARI TPS-1 got maximum score of 8 and Lady Rosetta, Jerla, Elgar, Dura, Patrones, Cardinal, Felsina, Laura, Ailsa, Quincy, Meridian, Tomensa, Bat Pakri and Jam alu got minimum score of 6.

In the present trial only two varieties, Belarossa and Bat Pakri had very deep eyes whereas other six varieties such as, Dheera, Saikat, Meridian, Caruso, Tomensa and BARI TPS-1 had deep eyes; five varieties, namely Lady Rosetta, Sagitta, Ailsa, Multa, Rumba had medium eyes; and rest of the varieties, Svenja, Raja, Binella, Jerla, Elgar, Agila, Dura, Patrones, Provento, Cardinal, Steffi, Felsina, Laura, Espirit, Asterix, Almerah, Cumbica, Omega, Forza, Ludmila and Granola had shallow eyes (Table 1). Shallow to medium deep eyes were liked by consumers, which are suitable to reduce losses during trimming and peeling (Kabira and Lamega 2006).

Table 1. Salient tuber characteristics of different potato varieties.

Variety	Tuber shape	Eye depth	Colour of skin	Colour of flesh	General appearance
Granola	Round	Shallow	White	Yellow	8
Diamant	Oval	Deep to medium	White	Cream	7
Raja	Long oval	Shallow	Red	Cream	7
Lady rosetta	Round	Medium	Red	Cream	6
Binella	Oval	Shallow	White	White	8
Jerla	Long oval	Shallow	White	Yellow	6
Dheera	Round	Deep	White	Cream	7
Elgar	Oval	Shallow	White	Cream	6
Agila	Oval	Shallow	White	Yellow	7
Dura	Long oval	Shallow	Red	Yellow	6
Sagitta	Oval	Medium	White	White	7
Saikat	Round	Deep	Red	Cream	7
Patrones	Long oval	Shallow	White	White	6
Provento	Oval	Shallow	White	Yellow	7
Cardinal	Oval	Shallow	Red	Cream	6
Steffi	Oval	Shallow	White	Yellow	8
Felsina	Oval	Shallow	White	White	6
Laura	Long oval	Shallow	Red	Yellow	6
Ailsa	Round	Medium	White	White	6
Multa	Oval	Medium	White	White	7
Espirit	Oval	Shallow	White	Yellow	7
Quincy	Long oval	Deep to medium	White	White	6
Meridian	Oval	Deep	Red	White	6
Asterix	Oval	Shallow	Red	Cream	7
Almerah	Long oval	Shallow	White	Cream	7
Cumbica	Long oval	Shallow	White	Yellow	8
Rumba	Round	Medium	White	Cream	7
Omega	Oval	Shallow	White	Cream	8
Endeavour	Round	Deep to medium	White	Yellow	7
Caruso	Round	Deep	White	White	7
Forza	Long oval	Shallow	White	Yellow	8
Belarossa	Round	Very deep	Red	Yellow	7
Amanda	Oval	Deep to medium	White	Cream	8
Ludmila	Very long oval	Shallow	White	Cream	8
Connect	Oval	Deep to medium	White	Cream	7
Svenja	Oval	Shallow	White	Cream	7
Tomensa	Round	Deep	White	White	6
BARI TPS-1	Round	Deep	White	Yellow	8
Bat Pakri	Round	Very deep	Red	White	6
Jam Alu	Long oval	Deep to medium	Red	Cream	6

#Mean of 10 randomly selected potatoes.

In Bangladesh, Bhutan, Nepal, Pakistan and Philippines red skin potatoes are traditionally preferred. Thus characters such as tuber appearance, size, shape, colour, skin finish etc. which influence consumer choices, are considered as quality attributes in potato (Pandey *et al.* 2000). Results revealed that skin colour of 29 varieties such as, Granola, Diamant, Binella, Jerla, Dheera, Elgar, Agila, Sagitta, Patrones, Provento, Steffi, Felsina, Ailsa, Multa, Espirit, Quincy, Almerah, Cumbica, Rumba, Omega, Endeavour, Caruso, Forza, Amanda, Ludmila, Connect, Svenja, Tomensa and BARI TPS-1 had white colour contrary 11 varieties, namely Raja, Lady Rosetta, Dura, Saikat, Cardinal, Laura, Meridian, Asterix, Belarossa, Jam alu and Bat Pakri had red colour (Table 1). Many Kenyan consumers have attributed white or red skin coloured tubers to be of good quality for processing (Kabira 2000). The flesh of 16 potato varieties such as, Jam alu, Raja, Lady Rosetta, Dheera, Elgar, Saikat, Cardinal, Asterix, Almerah, Rumba, Omega, Amanda, Ludmila, Connect, Svenja and Diamant were creamy while white in case of 11 varieties, namely Binella, Sagitta, Patrones, Felsina, Ailsa, Multa, Quincy, Meridian, Caruso, Bat Pakri and Tomensa. On the other hand, rest thirteen varieties such as, Granola, Jerla, Agila, Dura, Provento, Steffi, Laura, Espirit, Cumbica, Endeavour, Forza, Belarossa and BARI TPS-1 had yellow flesh colour (Table 1).

Total potato defects based on external skin characteristics are presented in Table 2. External observation revealed absence of scars in most of the cultivars except for Dheera, Agila, Cardinal, Felsina, Ailsa, Quincy, Almerah, Omega, Forza and Bat Pakri. Green tint was absent in case of all the varieties. Skin for most of the cultivars was smooth except in Lady Rosetta, Agila, Ailsa, Endeavour, Ludmila, Connect and Tomensa which had rough skin. Mean number of eye ranged from 3.0 to 7.6 with least in Omega and highest in Bat Pakri. Natural depression was found in Dura, Sagitta, Patrones, Felsina, Ailsa, Espirit, Quincy, Rumba, Omega, Endeavour, Belarossa and Jam Alu. Considering skin characteristics, the visualized total potato defects on potato skin were found to be negligible. Besides the desirable morphological and biochemical characters, tubers of processing varieties should not have green tint more than 3% and the total tuber defects should not exceed 15% (Pandey *et al.* 2009). We observed that number of eyes was less in most of the cultivars with shallow eye depth, without scars and green tint. Highest number of natural depressions was found in Jam Alu. Deep eye depths lead to heavy losses during peeling, trimming and thus lowers overall yield of crisps (Kabira and Lamega 2006) which was absent in the tubers of present investigation (Table 2). Thus the tubers investigated in the present study were suitable for processing due to low TPD.

Table 3 shows average tuber weight of potato which ranged from 38.93 to 138.60 g. Maximum weight was found in Omega (138.6 g) followed by Diamant (138.10 g), Rumba (137.80 g), Ailsa (137.00 g), Laura (137.90 g) and Steffi (137.70 g) while Jam Alu had minimum tuber weight (38.93 g). The differences may be attributed due to genotypes and environment suitable for tuberization (Ravikant and Chandha 2009, Mehdi *et al.* 2008 and Patel *et al.* 2008).

The statistical analysis for volume of different potato varieties showed significant variation (Table 3). The highest volume was found in Steffi (130.20 ml) closely followed by Laura (129.10 ml). The minimum volume was observed in varieties Jam Alu (35.39 ml). The differences in volume among the varieties could be due to differences in range of diameter and mass (Abong *et al.* 2009). The results regarding diameter of different potato varieties differed significantly and highest diameter was found (6.58 cm) in Omega, followed by Rumba (6.56 cm) with no significant difference (Table 3). Varietal difference is one of the important factors that affect the physical parameters. Tuber size influences chips and post frying handling. Tubers of more than 60 mm diameter yield crisps which are fragile and break easily during packaging and transport (Abong *et al.* 2010). The processing varieties are graded into four different sizes such as, 20 - 40,

Table 2. Total potato defects of different potato varieties based on skin characteristics.

Variety	External (skin)			
	Scars	Type of skin	No. of eyes	Natural depression
Granola	Absent	Smooth	3.1	Absent
Diamant	Absent	Smooth	5.8	Absent
Raja	Absent	Smooth	4.2	Absent
Lady Rosetta	Absent	Rough	4	Absent
Binella	Absent	Smooth	6.4	Absent
Jerla	Absent	Smooth	4.6	Absent
Dheera	Present	Smooth	6.1	Absent
Elgar	Absent	Smooth	6.1	Absent
Agila	Present	Rough	6.3	Absent
Dura	Absent	Smooth	3.9	Present
Sagitta	Absent	Smooth	6	Present
Saikat	Absent	Smooth	5	Absent
Patrones	Absent	Smooth	5.2	Present
Provento	Absent	Smooth	6.1	Absent
Cardinal	Present	Smooth	5.4	Absent
Steffi	Absent	Smooth	6.7	Absent
Felsina	Present	Smooth	7	Present
Laura	Absent	Smooth	6.1	Absent
Ailsa	Present	Rough	5.2	Present
Multa	Absent	Smooth	5.9	Absent
Espirit	Absent	Smooth	6	Present
Quincy	Present	Smooth	7.2	Present
Meridian	Absent	Smooth	5.1	Absent
Asterix	Absent	Smooth	5.1	Absent
Almerah	Present	Smooth	5.6	Absent
Cumbica	Absent	Smooth	3.3	Absent
Rumba	Absent	Smooth	4.2	Present
Omega	Present	Smooth	3	Present
Endeavour	Absent	Rough	5.3	Present
Caruso	Absent	Smooth	4.4	Absent
Forza	Present	Smooth	3.8	Absent
Belarossa	Absent	Smooth	5.2	Present
Amanda	Absent	Smooth	4.1	Absent
Ludmila	Absent	Rough	3.5	Absent
Connect	Absent	Rough	3.2	Absent
Svenja	Absent	Smooth	4.8	Absent
Tomensa	Absent	Rough	4.2	Absent
BARI TPS-1	Absent	Smooth	3.7	Absent
Bat Pakri	Present	Smooth	7.6	Absent
Jam Alu	Absent	Smooth	4.3	Present

#Mean of 10 randomly selected potatoes.

Table 3. Average weight, volume, diameter and specific gravity of different potato varieties.

Variety	Average weight (g)	Volume (ml)	Diameter (cm)	Specific gravity
Granola	121.60a-d	113.80a-c	6.11d-f	1.063 b-e
Diamant	138.10a	126.70ab	6.20c-e	1.090a-c
Raja	73.14i	67.10jk	4.42 rs	1.093a-c
Lady Rosetta	72.84i	66.21jk	4.51q-s	1.093a-c
Binella	76.21hi	71.22h-k	4.44rs	1.067b-e
Jerla	79.21hi	75.43f-j	4.58p-r	1.057b-e
Dheera	81.34 g-i	74.62f-k	4.43 rs	1.087a-c
Elgar	82.87g-i	76.02 f-j	5.11mn	1.083a-c
Agila	123.10a-c	115.00a-c	6.01 e-g	1.067b-e
Dura	76.60hi	72.26 h-k	4.54 p-r	1.067b-e
Sagitta	91.00f-i	85.84e-h	5.12mn	1.057 b-e
Saikat	77.80hi	72.71g-k	4.75 op	1.077a-d
Patrones	91.97f-i	85.15 e-i	5.36kl	1.077a-d
Provento	95.24 f-h	90.70ef	5.65ij	1.057b-e
Cardinal	89.75f-i	82.34 e-j	5.37kl	1.087a-c
Steffi	136.70a	130.20a	6.32b-d	1.057 b-e
Felsina	87.53 f-i	81.80e-j	5.49jk	1.067 b-e
Laura	136.90a	129.10a	6.43 a-c	1.067 b-e
Ailsa	137.00a	125.70ab	6.52 ab	1.093 a-c
Multa	85.00g-i	77.98 f-j	5.23 lm	1.083a-c
Espirit	73.00i	69.52 h-k	4.91no	1.053 b-e
Quincy	84.44g-i	78.17 f-j	5.35 kl	1.073a-e
Meridian	74.00 i	68.52 i-k	4.31s	1.083a-c
Asterix	104.0 d-f	96.28de	5.78hi	1.073a-e
Almerah	79.30hi	58.16k	4.87o	1.053b-e
Cumbica	124.60a-c	115.4a-c	5.91f-h	1.073a-e
Rumba	137.80a	127.60ab	6.56 a	1.083a-c
Omega	138.60a	126.00ab	6.58 a	1.093a-c
Endeavour	120.90a-d	111.90bc	6.10 d-f	1.083a-c
Caruso	131.30a-c	118.30a-c	6.21 c-e	1.103ab
Forza	135.20ab	124.00ab	6.25 cd	1.093a-c
Belarossa	128.50a-c	119.00a-c	6.15 de	1.083a-c
Amanda	85.11g-i	78.09f-j	5.32 k-m	1.093a-c
Ludmila	98.85e-g	89.05 e-g	5.54jk	1.123a
Connect	113.20c-e	107.80cd	5.87 g-i	1.053b-e
Svenja	75.75 i	70.13 h-k	5.25 lm	1.073a-e
Tomensa	117.80b-d	106.10cd	5.79 g-i	1.123a
BARI TPS-1	74.31 i	68.81 i-k	4.69 o-q	1.073a-e
Bat Pakri	80.85 g-i	74.85 f-j	5.67 ij	1.073a-e
Jam Alu	38.93 j	35.39 l	3.86 t	1.093a-c
SE _{value}	5.36	4.92	0.07	0.01
CV (%)	9.83	9.32	2.32	2.41

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by DMRT at 0.01 level of probability.

40 - 60, 60 - 80 and > 80 mm diameter by (CPRI 2009) and has recommend that tuber size of 60 - 80 mm is most suitable for processing. In present investigation, the diameter of tubers ranged from 4.5 to 6.5 cm which was slightly lower than reported by (CPRI 2009) but was on par with those reported by Lisinska and Leszczynski (1989). Large size tubers (> 80 mm) generally showed hollow heart ranging between 33 - 100 per cent in different varieties. In contrast, the size preferred for processing is 40 - 60 mm diameter has been reported by Pandey *et al.* (2008). In the present study, size of most tubers except Jam Alu fall within the range of 40 - 60 mm and thus were suitable for processing.

Varieties varied with respect to specific gravity, which ranged from 1.053 to 1.123. It was observed that Ludmila and Tomensa had the highest specific gravity (1.123) with no significant difference, while the minimum value for specific gravity (1.053) was noted for Espirit, Almerah and Connect (Table 3). According to Abbas *et al.* (2011), genotypes varied with respect to specific gravity ranged from 1.0343 - 1.1443. The differences in specific gravity among the varieties could be due to differences in range of diameter and mass (Kabira and Lamega 2006). In general, tubers with high specific gravity are preferred for processing and Ludmila and Tomensa were found outstanding for this character.

This study revealed that 15 potato cultivars were suitable for processing in terms of physical parameters viz., tuber shape, eye depth, colour of skin and flesh, general appearance and diameter. Tuber size falls within the range of 40 - 60 mm which is the desirable size for processing. With absence of scars and green tints, those varieties were in oval or round in shape with shallow eye depths that were acceptable for processing. Specific gravity of most of the varieties exhibited more than 1.07 which demonstrated best in respect of processing qualities studied in this experiment. However, further experimentation may be needed by using the other biochemical parameters which affect the processing qualities of potato tubers.

Acknowledgements

This study was supported by Ministry of Science and Technology, Bangladesh; University Grants Commission of Bangladesh (UGC) and Japan Society for Promotion of Science (JSPS).

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(Manuscript received on 6 June, 2016; revised on 15 November, 2016)