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Assessment of Processing and Nutritional Quality of Potato Genotypes in Bangladesh

M. M. Ali[1], N. Akter[2*], D. D. Nath[3], M. L. Rahman[4] and M. S. Hossan[1]

[1]Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh.
[2]Department of Horticulture, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh.
[3]Department of Genetics and Plant Breeding, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh.
[4]Department of Agricultural Chemistry, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Authors MMA and NA designed the study, performed the statistical analysis, wrote the protocol. Author MMA wrote the first draft of the manuscript. Authors NA and MLR managed the chemical analyses of the study. Authors DDN and MSH managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This research was conducted to evaluate the processing as well as the nutritional quality of potato genotypes which was comprised of 30 potato genotypes obtained from Breeder Seed Production Centre (BSPC), Bangladesh Agricultural Research Institute (BARI). The experiment was RCBD with three replications having plot size 15 m^2. Uniform cultural practices were adopted for all treatments. Assessment of quality traits was made after harvest of the crop at 95 DAPs. Data were recorded for processing quality viz. specific gravity, dry matter, sugars and nutritional traits i.e. starch, protein and ash content. The significant differences in all the quality parameters were observed among the genotypes. The highest specific gravity was found in Lady Rossetta (1.081) while Almera had the lowest specific gravity (1.042). The highest dry matter was found in Courage (22.65%) while BARI

**Corresponding author: E-mail: nazminhstu143@gmail.com;*

Alu-41 had the lowest dry matter (16.41%).Maximum starch was observed in Destiny (14.01%) while it was minimum in Granola (9.34%). Reducing sugars ranged from 0.51% in BARI Alu 36 to 0.123% in Omega. Protein value was found to be the highest (3.21%) in Bari Alu 56 whereas the minimum value was recorded in BARI Alu 38 (Omega) 0.67% and ash content was highest in Diamant (1.61%) whereas the lowest was in BARI Alu-37(0.53%).

Keywords: Potato; genotype; processing; nutrition; Bangladesh; protein value.

1. INTRODUCTION

Potato is the 4th major food crop of the world next to rice, wheat and maize which is recognized as 'The king of vegetables' [1]. It is a balanced food containing high energy, quality protein, essential vitamins and minerals [2]. It is one of the most promising crops due to its high productivity, short duration and wide adaptability. Bangladesh is the seventh-largest potato producer in the world and third-biggest in Asia [3]. The total area, production and national average yield of potato in Bangladesh are 525698 hectares, 10.48 million metric tons and 19.93 t ha^{-1}, respectively [4]. The total potato production is surplus in the country and this overproduction is seen as a burden for the farmers due to glut situation in the market [5]. To solve this problem, processed food products may drive the proper utilization of these excess potatoes. Moreover, there is a huge demand of potato for the increasing number of potato industries and processed products. Despite the increasing demand for processing quality potato, the availability of suitable potatoes for processing industries is scanty [6]. The processing Potato must meet a number of requirements including high dry matter (> 20%), high starch, low reducing sugar, high firmness, high specific gravity, good fry color and shape. Bangladesh Agriculture Research Institute (BARI) has so far developed more than 90 potato varieties, but the majority is used for culinary consumption. The processing and nutritional qualities of these potato genotypes are largely unidentified. Therefore this study was undertaken to determine the processing and nutritional qualities of these genotypes.

2. MATERIALS AND METHODS

The study comprised of 30 potato genotypes, which are released for commercial cultivation in Bangladesh (Table 1). The selected potato genotypes were collected from Breeder Seed Production Centre (BSPC), Bangladesh Agriculture Research Institute (BARI), Debiganj, Panchagarh and planted in the research field of BSPC, BARI, Debiganj, Panchagarh. The experiment was a single factor RCBD with three replications having plot size 15 m^2. Uniform cultural practices were adopted for all treatments. Assessment of quality traits was made after harvest of the crop at 95 DAPs. After harvesting, healthy potato tubers were used for assessing the processing quality viz. specific gravity, dry matter, sugars and nutritional traits, i.e. starch, protein and ash content. The specific gravity of fresh potato tubers was determined by the standard water displacement method [7]. The dry matter content was determined by drying 5g of fresh tissue in hot air oven at 70±2°C till constant weight and was calculated on fresh weight basis % [8]. Reducing sugars of raw tubers were determined by the Nelson Somogyi method [9]. Starch content was analyzed by the method of [10]. Total nitrogen was estimated by the Micro-Kjeldahl method [11] and protein content was calculated using a nitrogen factor of 6.25.Ash content of tubers was determined according to Rahman et al. [12]. Finally all the data were analyzed by using statistical software STAT 10.

3. RESULTS AND DISCUSSION

3.1 General Feature of the Major Potato Genotype Grown in Bangladesh

Most of the genotype grown in Bangladesh is from exotic source mainly from Netherland, Some also developed in Bangladesh. The tuber characteristics include tuber skin color, tuber shape, eye depth, and flesh color is varied from genotype to genotype. These are called quality characteristics which are important for marketing as well as for processing. More importance was given to eye depth and tuber shape. Consumers like potatoes of attractive look, suitable shape, size and shallow to medium eyes to avoid peeling losses. Thus characters such as tuber size, shape, color, etc. which influence consumer choice, are considered as quality attributes in potato [13]. Generally Oval shape tubers are preferred for making chips and French fries. The genotypes had either shallow or medium eye depths, which are suitable for processing due to reduce losses during trimming and peeling [14] (Table 1).

3.2 Specific Gravity

Specific gravity of genotypes ranged from 1.042 to 1.081. It was observed that genotype Lady Rosetta had the highest specific gravity (1.081) followed by Courage and Alberta (1.080) with no significant difference, while the minimum value for specific gravity (1.042) was noted in Almera (Table 2). Specific gravity and dry matter content reflect the amount of starch present and tubers, with high specific gravity (>1.080) are preferred for processing [15]. The genotype Courage was outstanding for this character. These differences might be related to genetic variations among different cultivars. Similar observations were reported earlier for different cultivars of potatoes [16].

Table1. General feature of the major potato genotype grown in Bangladesh

Genotypes	Skin Color	Flesh Color	Shape	Eye depth	Origin
Bellarosa	Red	Yellow	Short oval to oval	Medium	Germany
BARI Alu 48	Yellow	Light yellow	Short oval to oval	Medium	Bangladesh
BARI Alu 49	Yellow	Cream	Round to short oval	Shallow	Bangladesh
Stiffy	Light yellow	Light yellow	Short oval to oval	Medium	Netherland
Musica	Yellow	Light yellow	Oval to long oval	Medium	Netherland
Metro	Yellow	Cream	Medium oval to long oval	Medium	Netherland
Diamond	Light yellow	Whitish yellow	Medium oval to long oval	Medium	Netherland
BARI Alu 47	Yellow	Light yellow	Short oval to oval	Medium	Bangladesh
Granola	Light bronze yellow	Pale yellow	Round to short oval	Shallow	Netherland
Almera	Yellow	Light yellow	Oval to long oval	Shallow	Netherland
BARI Alu 35	Yellow	Light cream	Oval	Shallow	Bangladesh
BARI Alu 37	Yellow	Light yellow	Oval to long oval	Shallow	Bangladesh
BARI Alu 40	Light yellow	Light yellow	Short oval	Medium shallow	Bangladesh
Belline	Light brown	Light cream	Long oval to medium	Medium shallow	Netherland
Omega	Light brown	Light cream	Long oval to medium	Medium shallow	Netherland
Elger	Yellow	Cream	Short oval to oval	Medium shallow	Netherland
BARI Alu 46	Light yellow	Cream	Round to short oval	Medium deep	Bangladesh
Laura	Red	Deep yellow	Long oval to medium	Light shallow	Germany
Alberta	Red	Yellow	Oval	Shallow	Germany
Lady Rossetta	Red	Yellow	Round to oval	Light shallow	Netherland
Courage	Red	Yellowish white	Round to oval	Light shallow	Netherland
Asterix	Red	Light yellow	Oval to long oval	Shallow	Netherland
Cardinal	Red	Light yellow	Oval	Shallow	Netherland
BARI Alu 41	Deep red	Light yellow	Round to flat round	Light shallow	Bangladesh
BARI Alu 56	Red (purple)	Yellow	Round to short oval	Deep	Bangladesh
BARI Alu 36	Red	Cream	Oval to long oval	Shallow	Bangladesh
Raja	Red	Light yellow	Oval to medium	Light shallow	Netherland
Destiny	Yellow	Yellow	Short oval to round	Medium	Netherland
BARI Alu 82	Pinkish	Light yellow	round	shallow	Bangladesh
BARI Alu 86	redish	Light yellow	Oval to long oval	shallow	Bangladesh

Table 2. Processing and nutritional quality of potato genotypes

Genotypes	Specific gravity	Dry matter	Starch	Reducing Sugar	Protein content	ASH
Bellarosa	1.057 e-i	16.867 k-m	9.633 l-m	0.163 f-g	0.867k	0.59 e
BARI Alu 48	1.055 f-i	17.403 i-l	10.473 i-m	0.380 a-f	1.303h-k	1.07 a-e
BARI Alu 49	1.056 e-i	17.070 j-m	9.970 j-m	0.240 c-g	2.360b-e	0.9067 b-e
Stiffy	1.051 h-j	18.007 g-j	11.530 f-i	0.403 a-e	2.073b-g	0.78 c-e
Musica	1.051 h-j	16.270 m	9.507 l-m	0.240 c-g	1.567f-k	0.75 c-e
Metro	1.064 c-g	18.400 f-i	12.603 c-f	0.473 a-b	1.867c-h	1.2767 a-c
Diamond	1.055 f-i	17.400 i-l	10.590 i-m	0.180 e-g	2.010b-h	1.61 a
BARI Alu 47	1.063 c-h	18.290 f-i	13.357 b-e	0.173 f-g	2.723a-b	0.94 b-e
Granola	1.053 g-j	16.907 m	9.343 m	0.403 a-e	1.847 d-h	0.66 d-e
Almera	1.042 j	16.957 m	9.367 m	0.413 a-d	1.910 c-h	1.1733 a-d
BARI Alu 35	1.060 e-h	17.143 j-m	10.327 i-m	0.277 b-g	1.980 c-h	1.2067 a-d
BARI Alu 37	1.054 f-j	17.067 j-m	10.267 i-m	0.430 a-d	2.117 b-f	0.53 e
BARI Alu 40	1.063 c-g	17.667 g-l	11.140 g-k	0.290 a-g	1.370 g-k	1.11 a-d
Belline	1.054 f-j	17.067 j-m	9.857 k-m	0.310 a-g	2.093 b-f	0.99 b-e
Omega	1.073 a-d	20.301 c-d	11.053 g-k	0.123 g	0.673 f-k	1.1667 a-d
Elger	1.054 f-j	17.607 g-l	11.407 f-i	0.387 a-f	1.0367 j-k	0.8733 b-e
BARI Alu 46	1.073 a-d	19.620 d-e	12.470 d-g	0.280 b-g	1.0633 i-k	1.09 a-e
Laura	1.061 d-h	17.787 g-k	10.820 h-l	0.403 a-e	1.67 e-j	0.9833 b-e
Alberta	1.080 a-b	21.517 a-b	14.517 a-b	0.273 b-g	2.1367 b-f	1.03b-e
Lady Rossetta	1.081 a	22.407 a-b	13.977 a-c	0.213 b-g	1.88 c-h	0.98 b-e
Courage	1.080 a-b	22.650a	13.637 a-d	0.167 f-g	2.3967 a-d	1.23 a-d
Asterix	1.063 c-g	18.320 f-i	11.317 f-j	0.457 a-c	1.7667 d-i	1.43a-b
Cardinal	1.074 a-c	20.400 c-d	13.330 b-e	0.227 d-g	2.09 b-f	0.7967 c-e
BARI Alu 41	1.047 i-j	16.300 m	11.200 f-k	0.437 a-d	2.58 a-c	0.8867b-e
BARI Alu 56	1.064 c-g	18.497 f-h	11.520 f-i	0.353 a-f	3.1 a	0.8567 b-e
BARI Alu 36	1.067 b-e	19.227 e-f	12.123 e-h	0.510 a	1.8433 d-h	1.25 a-c
Raja	1.066 c-f	18.593 e-g	11.613 f-i	0.407 a-d	2.38 b-e	1.1133 a-d
Destiny	1.077 a-b	21.420 a-b	14.011 a	0.180e-g	1.83 d-h	1.0567 a-e
BARI Alu 82	1.074 a-c	20.400 c-d	13.330 b-e	0.017 g	2.09 b-f	1.1567 a-d
BARI Alu 86	1.047 i-j	16.860 m	9.833 k-m	0.370 a-f	2.58 a-c	1.0633a-e
CV(%)	0.36	1.85	3.85	19.31	10.15	17.35

In a column, figure bearing same or no letter (S) do not differ significantly at 5% level of significant by DMRT

3.3 Dry Matter (%)

Dry matter is the most important parameter for processing of potato. The maximum dry matter was found in Courage (22.65%) followed by Lady Rosetta (22.407%) and Destiny (21.42%);BARI Alu-41 had the lowest dry matter (16.30%) but was not statistically different of sample (Table 2). For processing varieties for chips, French fries and dehydrated products tuber dry matter needs to be more than 20% [17]. Tuber dry matter content differs considerably between cultivars and is a strongly genetic based character [18]. The present works revealed that the genotypes Courage, Lady Rosetta, Cardinal, Destiny and BARI Alu- 82 had higher dry matter over 20% and hence are suitable for processing. Tubers with high dry matter content yield more chips while tuber with low dry matter content produces fewer chips with high absorption of oil. The possible reason for differences in dry matter content may be due to variation in genetic factors, several agro-climatic conditions and agronomic practices adopted for growing [19, 20, 21].

3.4 Starch Content (%)

Starch comprises 65-80% of the dry weight of tubers [21]. Maximum starch was observed in Destiny (14.01%) followed by Lady Rosetta (13.977) and Courage (13.637) while it was minimum in Granola (9.34%) (Table 2). Its percentage varied both with genotype and environment [22]; however, several other factors, including environmental conditions, and cultural practices during growth are also important 23].Differences in starch content is mainly attributed to the external tuber morphology while in some cases, internal distribution of nutrients also [24] resulting from different pattern of root absorption translocated to various organs and finally variation in metabolic activities [25]. This difference in starch content might be due to difference in dry matter content among various cultivars as starch and dry matter contents of potato are directly related to each other.

3.5 Reducing Sugars (%)

Significant difference was recorded among the genotypes with respect to the reducing sugar percentage. Maximum reducing sugar (0.51%) was recorded in BARI Alu-36 followed by Metro (0.47%). The reducing sugar was least (0.12%) in Omega (Table 2). A reducing sugar level of <100 mg per 100 g on fresh tuber weight is generally considered acceptable for producing light colored chips stated by Pandey et al. [26]. Therefore, due to the growing demand of the processed potato products, important parameter for the selection of raw material is reducing sugar content below 150 mg /100 g fresh tuber weight [27]. There were different statements regarding sugar limits for processing. Uppal [28] mentioned that the acceptable limit was 0.25% but can be acceptable up to 0.5%. Marwaha [29] stated that generally 0.33% tuber sugar content is suitable for product making. The acceptable limit was 150-250 mg/100 g on fresh weight [30,31]. Singh et al. [32] reported below 150 mg/100 g on fresh weight basis. The reducing sugar content, measured right after harvesting met the standard requirements (0.15%-0.31% on fresh weight basis) for all cultivars, except cv. Belousovsky [33]. Accumulation of reducing sugar is affected by a number of environmental factors, and are influenced by genotype or cultivar [34].

3.6 Protein Content (%)

The statistical analysis for protein content of different potato genotypes showed significant variation (Table 2).The highest value for protein content was found in BARI Alu 56(3.1%) whereas the minimum value was recorded in omega (0.67%). The average protein percentage in potato is 2% and range is 0.7 to 4.6% [35]. The difference in protein content may be due to genotype [36,37].

3.7 Ash Content (%)

The results regarding ash content of different potato varieties are given in (Table 2) which showed that the ash content of genotypes differed significantly. The ash content was found highest in Diamant (1.61%) whereas the lowest was in BARI Alu-37(0.53%).The average ash content in potato is 1% and range for ash percent is 0.53 to 1.9 [35].Variation in ash may be a varietal character as mentioned by earlier researchers [36,38].

4. CONCLUSION

The processing and nutritional qualities of these potato genotypes are largely unidentified. Therefore this study was undertaken to determine the processing and nutritional qualities of these genotypes. The genotypes had either shallow or medium eye depths, which are suitable for processing due to reduce losses during trimming and peeling. The genotype Alberta, Lady Rosetta, Courage, Destiny and BARI Alu– 82 is suitable for processing. Farmers will get more benefits by cultivating these varieties, that will ultimately improve their socio-economic condition. Moreover it will help in establishing processing industries by providing raw materials.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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