Ann. Bangladesh Agric. (2017) 21 (1 & 2) : 99-109 *ISSN 1025-482X (Print)*
2521-5477 (Online)

EVALUATION OF POTATO GENOTYPES FOR PROCESSING QUALITY ATTRIBUTES

S. M. Zubair Al-Meraj[1], M. Mohi-Ud-Din[1], A. K. M. A. Islam and T. K. Ghosh[1*]

Abstract

Sixteen potato genotypes including both yellow and purple flesh collected from different sources were investigated to know the processing quality in terms of dry matter content, brix index (total soluble solids), starch, glucose, sucrose and reducing sugar content and evaluation of consumer acceptability test. The genotypes showed a great variation in the parameters mentioned above and among them, Lady Rosetta, Rosa Gold, Cardinal, Courage, Diamant, Jam Alu, KAC 10064, and KAC 10069 showed better processing quality as they contained higher dry matter (≥ 20%), brix% (≥ 6.0) and starch content (≥ 90 mg g^{-1}) and lower glucose (≤ 0.4 mg g^{-1}), sucrose (≤2.5 mg g^{-1}) and reducing sugar (about 4 mg g^{-1}) content. The yellow flesh potato genotypes had superior processing quality and showed good score in consumer acceptability test than that of purple flesh genotypes. Among the yellow flesh genotypes having good processing quality, the Diamant and Lady Rosetta achieved very good score in acceptability test (≥7.5 out of 9.0 scale) suggesting their suitability in the preparation of potato chips.

Keywords: Dry matter, glucose, sucrose, starch, sensory, acceptability.

Introduction

Potato, an important food crop throughout the world has been primarily consumed as the considerable source of carbohydrate but biochemical analyses reported that it is also enriched with proteins, iron, phosphorus, calcium, carotene, thiamine, riboflavin, and vitamin-C (Navarre *et al*., 2009). It is the third most consumed staple food after rice and maize (FAO, 2013) and providing basic nutrition to millions of people globally which could have a positive impact on their health issues (Valcarcel *et al*., 2015). The Food and Agriculture Organization (FAO) reported that the world production of potato in 2014 was about 381.68 million tons and it was much higher than that of the year 2010. The organization also stated that the potato production has been greatly increased by 0.11, 13.18, and 65.46 million tons, respectively, in America, Africa, and Asia (FAOSTAT, 2017) during the year 2000 to 2010. Due to having lot of demand and popularities, the global potato consumption has been changed from fresh potatoes to processed food products indicating the rising demand of potato processing varieties.

Many investigations have been made considering the yield potential of potato varieties but very few researches were made on the processing quality of potato. For consumers and industrial demand, potato tuber quality is of utmost importance (Brown,

[1]Dept. of Crop Botany, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706. [2]Dept. of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706. [*]Corresponding Author: totan@bsmrau.edu.bd

2005.) Good processing quality of potato tubers is attributed by the presence of high dry matter with high specific gravity and starch content and low sucrose and reducing sugar, flavonoids and phenol contents (Abong *et al*., 2009) though the attributes are influenced by different factors, such as soil type, fertilizers application, dates of planting and harvesting in addition to their genetic factor (Burton, 1966; Smith, 1968). The dry matter content and reducing sugars are the most influential factors in frying and baking process because high dry matter content increases chip yield, crispy-consistency, and reduces oil absorption during cooking (Rommens *et al*., 2010) and low reducing sugars such as glucose, fructose are required to avoid dark color and bitter taste of processed products, which negatively affect consumers' acceptance (Wang-Pruski and Nowak, 2004). A good number of research works conducted on the processing quality and phytochemicals in potato across the world, whereas, very few observations are made in Bangladesh in spite of having increasing demands of potato consumption as both vegetables and processed products. So far, 87 potato varieties have been released by Bangladesh Agricultural Research Institute (BARI) but emphasis was given mostly on yield parameter (BARI, 2017). However, potato processors prefer cultivars that will ensure constant and regular supply and maintain superior processing quality. Besides, consumers also prefer the local potato cultivars, because of having good taste, flavor and color. Thus, the suitable potato genotypes should be identified to meet up the huge and increasing demands for industrial uses. Considering the above facts, the present research was carried out to investigate the processing quality of sixteen potato genotypes and find out their suitability in preparation of chips.

Materials and Methods

Plant materials

Sixteen potato genotypes were collected from Bangladesh Agricultural Research Institute (BARI), Bangladesh Agricultural Development Corporation (BADC) and local markets to investigate their processing quality (Table 1). Genotypes were grown in the field of Crop Botany department of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. Tubers were harvested at 90 DAP (Days after Planting) and kept in room temperature for curing. All chemical analyses were performed in the Crop Botany laboratory, BSMRAU.

Determination of dry matter content

Uniform tubers were taken from each genotype, and after making slices, samples were weighed and kept for oven dry (SANYO Drying Oven, MOV202) at 80°C for 72 hours. Dry weight of those samples was taken by using electric balance (AGN220C). Dry matter content was calculated as the ratio between dry and fresh mass and expressed as a percentage (Barton, 1989).

Determination of Brix % (Total Soluble Solids)

Brix% was measured with the help of Hand Refractometer [Model: ATAGO, Type N1 (0-32%, made in Japan] from the juice of potato flesh. According to the instructions, the readings were corrected by adding the required value from the correction table supplied with the machine.

Extraction and determination of sugar contents

For the analysis of sugar content like glucose, sucrose and reducing sugars, potato flesh was extracted. It was a slight modification of the

Table 1. List of potato genotypes

Genotype	Flesh Color	Tuber size/ shape	Sources
Forza	Yellow	Large/oval-elongated	BADC
Courage	Yellow	Medium/round	BADC
Laura	Yellow	Medium/oval	BADC
Rosa Gold	Golden yellow	Medium/round	BADC
Lady Rosetta	Light Yellow	Medium/round	BADC
Cumbica	Yellow	Large/oval	BADC
Asterix	Light Yellow	Large/oval-elongated	BARI
Coronada	Light Yellow	Medium/oval	BADC
Granola	Yellow	Medium/round	BADC
Cardinal	Light Yellow	Medium/ oval	BARI
Diamant	Light Yellow	Large/oval	BARI
Jam Alu	Yellow + Purple	Small/distinguished	Local
KAC 10063	Deep purple	Medium/round	BADC
KAC 10064	Purple + yellowish centre	Medium/oval	BADC
KAC 10069	Yellow + light purple ring	Large/elongated	BADC
KAC 10097	Yellow + light purple	Medium/oval-elongated	BADC

extraction procedure of Xue (1985). For each extraction, fresh sample of chopped potato was taken from uniform tuber samples. Sugar was extracted using 80% ethanol at 80° C for 30 min and the extracts were centrifuged at 5000 g for 10 min. After collection of the supernatant, the remains were subjected to the same procedure. Then the total supernatant was collected into a 50 ml beaker and supposed to evaporation using sand bath (80-85°C) to remove alcohol. The extract was transferred into a volumetric flask by 2-3 times washing with distilled water and 10 ml volume was made. Reducing sugar was estimated by the DNS (Dinitrosalicylic Acid) reagent colorimetric method following the procedure of Miller (1959) with some modifications. DNS reagent, Rochelle salt solution and standard glucose solution (400 $\mu g\ ml^{-1}$) were used here. Glucose Oxidase Enzyme Reagent kit and standard glucose (2000 $\mu g\ ml^{-1}$) solution were used for glucose determination. The procedure attached with the kit pack (Linear chemical, Spain) was followed here. Anthrone reagent, 2M KOH and standard sucrose solution (1500 $\mu g\ ml^{-1}$) were used for determination of sucrose content by following anthrone colorimetric method provided by Kang *et al*. (2009).

Extraction and determination of starch content

The residue remained after extraction for sugar was washed for several times with distilled water to ensure that there was no more soluble sugar in the residues. After that, following the procedure of Kang *et al*. (2009), it was dried overnight at 80° C. Then 2 ml distilled water was added and heated for 30 min in boiling water bath. 2 ml of 52% perchloric acid was added to hydrolyze starch into soluble sugars. 6 ml of distilled water was added and centrifuged at 4000 g for 20 min. The supernatant was collected in a test tube and the methodology was repeated for once. In a volumetric flask, volume of the combined supernatant was made up to 50 ml with distilled water. 1 ml of extract was mixed with 1 ml of distilled water and 5 ml of Anthrone reagent and poured into a test tube. After 15 min boiling, the test tubes were cooled in the dark, the absorbance was read at 620 nm. Stock solution (10,000 µg ml^{-1}) was prepared and standards were treated in the same way.

Sensory Evaluation

Chips, crackers, and french fry are major processed products of potato in food and beverage industries. Sensory evaluation is the general test in assessing acceptability of processed food products. It was done on prepared potato chips in this study. Potato chips were produced according to Kita *et al.* (2015) with slide modifications. After washing and peeling, the potatoes were cut into slices of 2 ± 0.1 mm thickness with a potato slicer. These slices were dipped into cold saline water (10 g NaCl per litre H_2O) for 10 min. Then the slices were dried superficially and fried in refined soybean oil (180^{o}C measured by infrared thermometer) for about 4 min until the bubbling ceases. Prepared chips were subjected to consumer acceptability. Consumer acceptability test also called affective test which indicates the participants in the study always should be untrained and representatives of the consuming population. In the present study, potato chips were produced from each genotype and tested by a 7-member panel. The members in the affective test were regular customer of potato chips available in the consumer shops made their marking out of 5.00 point scale for color, texture, crispiness, sweetness, sourness and bitterness and 9.00 point scale for flavor and overall acceptability.

Data analysis

Statistical analysis was performed using MSTAT-C software (Russell, 1994). Data were subjected to one way analysis of variance for mean comparison and significant differences were calculated according to Duncan's multiple range test (DMRT). Data were reported as mean ± standard error. Differences at $p<0.05$ were considered to be statistically significant.

Results and Discussion

Dry matter content

The results of present experiment showed a great variation in dry matter content among the genotypes studied and ranged from 14.40 to 26.22% (Table 2). The maximum dry matter was found in yellow flesh potato Lady Rosetta (26.22%) followed by that if Courage (24.34%) and Cardinal (23.84%). Forza, Diamant and Rosa Gold showed more or less similar dry matter content which were 21.74%, 21.68%, and 21.54%, respectively. For purple flesh potato genotypes, the highest dry matter content was found in Jam Alu (22.47 %) followed by that in KAC 10069 (19.37 %), KAC 10097 (18.59 %), and KAC 10063 (17.67 %) (Table 2). Dry matter content of the genotypes ranged from 20 to 26% and is suitable for chips production. High dry matter in potatoes results into lower content of fat and sugar suitable for maintaining good crispiness in chips and other fried products (Brody, 1969; Burton, 1966). Suitable proportion of dry matter content in the potato tubers results in less frying time as well as lesser oil absorption (Pavlista and Ojala, 1997). The results was supported by other findings of Kita *et al*. (2009); Lisinska and Eszczynski (1989); Talburt and Smith (1987). In respect of dry matter content, the potato genotypes Lady Rosetta, Courage, Cardinal, Forza, Diamant, Rosa Gold and Jam Alu having higher dry matter content are better for processing industry.

Brix% (Total Soluble Solid)

The brix% of yellow fleshed potato genotypes ranged from 4.92 to 6.63%. Rosa Gold was found to contain 6.63%, which was the highest value of brix% (Table 2). Courage and Cumbica both had the same brix% that is 6.43%. Granola and Cardinal contained TSS 6.39% and 5.93%, respectively. Forza, Laura, Lady Rosetta, and Diamant all gained 5.42 brix%. The lowest value 4.92% was found in Asterix and Coronada. In purple flesh genotypes highest brix% value 6.63 was gained by Jam Alu, following KAC 10063 (6.43%), KAC 10069 (5.93%). The lowest value 5.42% was found in both KAC 10064 and KAC 10097 (Table 2). The content of total soluble solid is also a good indicator for maintaining quality in processed potato products. The genotype with high total soluble solid (brix %) maintained thick juice and indicated as suitable one for the preparation of juice, malt and flavors (Sohail *et al*., 2013). So, the genotypes containing high percentages of total soluble solid would be suitable for making potato juice that was supported by Solaiman *et al*. (2015) who claimed the ranges from 7.5 to 8.1% is appropriate for juice preparation.

Starch content (mg g^{-1} FW)

The amount of starch in different potato genotype was found to be varied between 82.90 and 101 mg g^{-1} FW, harvested at 90

Table 2. Dry matter %, starch content and brix % of different potato genotypes

Genotype	Dry Matter (%)	Starch (mg g^{-1} FW)	Brix (%)
Yellow Flesh Genotypes			
Forza	21.74 ± 0.31 ^{c}	91.12 ± 1.57 ^{bc}	5.42 ± 0.0015 ^{d}
Courage	24.36 ± 0.54 ^{b}	91.71 ± 1.27 ^{bc}	6.43 ± 0.0026 ^{b}
Laura	18.82 ± 0.37 ^{fg}	84.12 ± 2.35 ^{d}	5.42 ± 0.0018 ^{d}
Rosa Gold	21.54 ± 0.46 ^{cd}	90.76 ± 1.06 ^{bc}	6.63 ± 0.0022 ^{a}
Lady Rosetta	26.22 ± 0.25 ^{a}	93.13 ± 1.05 ^{b}	5.42 ± 0.0012 ^{d}
Cumbica	19.72 ± 0.54 ^{ef}	86.23 ± 1.33 ^{cd}	6.43 ± 0.0026 ^{b}
Asterix	20.34 ± 0.13 ^{de}	86.92 ± 2.50 ^{cd}	4.92 ± 0.006 ^{e}
Coronada	14.40 ± 0.55 ^{i}	85.88 ± 0.86 ^{cd}	4.92 ± 0.0026^{e}
Granula	16.74 ± 0.84 ^{h}	82.90 ± 0.50 ^{d}	6.40 ± 0.033 ^{b}
Cardinal	23.84 ± 0.22 ^{b}	86.53 ± 1.44 ^{cd}	5.93 ± 0.001 ^{c}
Diamant	21.68 ± 0.21 ^{c}	101.00 ± 4.45 ^{a}	5.42 ± 0.001 ^{d}
Purple Flesh Genotypes			
Jam Alu	22.47 ± 0.26 ^{c}	87.28 ± 0.63 $^{b-d}$	6.63 ± 0.0062 ^{a}
KAC 10063	17.67 ± 0.37 ^{gh}	86.67 ± 1.06 ^{cd}	6.43 ± 0.0017 ^{b}
KAC 10064	17.02 ± 0.20 ^{h}	88.80 ± 1.52 $^{b-d}$	5.42 ± 0.009 ^{d}
KAC 10069	19.37 ± 0.40 ^{ef}	88.55 ± 0.35 $^{b-d}$	5.93 ± 0.0019 ^{c}
KAC 10097	18.59 ± 0.43 ^{fg}	88.31 ± 1.73 $^{b-d}$	5.42 ± 0.002 ^{d}

Means followed by same letters in a column are not significantly different at 5% level of significance by DMRT

DAP. Among the yellow flesh potato, Diamant achieved the highest starch content 101 mg g^{-1} fresh potato sample followed by Lady Rosetta 93.13, Courge 93.13, Forza 91.12, and Rosa Gold 90.76 mg g^{-1} (Table 2). Purple flesh potato genotypes contained slightly lower starch content compared to the yellow flesh potatoes ranging from 86.67 – 88.80 mg g^{-1} FW (Table 2). Starch content is very much essential factor for processing purpose since dry matter of potatoes is mostly dependent on starch content (Dean and Thornton, 1992; Uppal, 1999). Since starch content has direct influence on processed tuber products (Kadam *et al*., 1991), genotypes with high starch content and very low sugar percentage are desirable for industrial purposes. The present finding is consistent to the findings of others (Karim *et al*., 2008; Nielsen *et al.,* 1997) who found varied starch content in their genotypes ranged from 7.05% to 12.43% equivalent to 70 – 120 mg g^{-1} FW of potato at harvesting. Considering the high amount of starch content (about 100 mg g^{-1} FW), Diamant, Lady Rosetta, Courage, Forza, Rosa Gold, Asterix, Jam Alu and KAC 10069 likely to be selected candidate for better processing quality.

Glucose content (mg g^{-1} FW)

In this study, glucose content found to be ranged between 0.12 and 1.82 mg g^{-1} FW in yellow flesh potato genotypes and 0.41 to 0.78 mg g^{-1} FW in purple flesh potatoes. Yellow flesh genotype Rosa gold contained the least amount of glucose content, 0.127 mg g^{-1} FW. Diamant, Cardinal, Lady Rosetta, KAC 10064, and Jam Alu were found to contain 0.173, 0.260, 0.303, 0.410, and 0.430 mg glucose g^{-1} FW of potatoes, respectively (Fig. 1). As a reducing sugar, glucose content significantly determines the quality attributes of fried products, especially color (Cottrell *et al*., 1995; Brown *et al*., 1990). Glucose concentrations of 0.15–1.5% have been predicted to maintain good processing quality in potato (Storey, 2007). Murniece *et al*. (2010) found glucose content between 0.52 – 5.16 mg g^{-1} in freshly harvested potatoes and 0.2 to 3.4 mg g^{-1} glucose content was observed by Finotti *et al*. (2006). As lesser amount of glucose content is suitable for maintaining consumer acceptable color and taste of processed potato products, the genotypes Rosa Gold, Diamant, Cardinal, Lady Rosetta, KAC 10064, KAC 10069, and Jam Alu should be suitable in this context.

Sucrose content (mg g^{-1} FW)

Among the yellow flesh genotypes sucrose content was found lower in Rosa Gold, Lady Rosetta, Courage, and Laura e.i., 2.79, 3.18, 3.79, and 4.08 mg g^{-1} FW, respectively. It was also lower in the purple flesh genotypes KAC 10064, KAC 10097, KAC 10063, and KAC 10069 contained 2.09, 2.19, 2.50, and 3.64 mg sucrose g^{-1} FW, respectively (Fig. 1). As an early product of photosynthetic reaction, sucrose is the most abundant soluble sugar in potatoes (Burton, 1966; Karim *et al*., 2008) and responsible for dark color development in potato chips. High sucrose content in potatoes during harvesting has great influence as it results in greater accumulation of reducing sugars making the potatoes unfit for industrial use (Uppal, 1999). So, genotypes with low sucrose content are important for better potato product color during processing. Sandhu *et al*. (2014) reported 0.1 to 1.92 mg g^{-1} sucrose content in four potato genotypes including Lady Rosetta which was lower than that of the genotypes studied here. The results of this study also correlate the findings of others (Karim *et al*., 2008; Kumar *et al*., 2013).

Reducing sugars content (mg g^{-1} FW)

Reducing sugars is the most important influencing factor for the quality of processed potato products as it controls the ultimate color of the finished fried products, such as chips and French fries (Weaver *et al*., 1972). According to Elfnesh *et al*. (2011), low reducing sugars content of potato makes commercially acceptable processed food color. Here, Cardinal, Rosa Gold, Lady Rosetta, Diamant, Courage, and KAC 10064 showed lower amount of reducing sugars which is desired for industrial purposes (Fig. 1). The reducing sugar content was found 3.61, 3.68, 3.79, 3.93, 4.35, and 3.82 mg g^{-1} FW, respectively, to the above genotypes. According to Karim *et al*. (2008), the reducing sugars contents were found to be varied between 0.05 and 0.21% (0.5 – 2.1 mg g^{-1}) just after harvesting. Murniece *et al*. (2010) found a range of 0.6 – 6.9 mg reducing sugar content g^{-1} FW of freshly harvested potatoes. Result of this experiment showed slightly increased amount of reducing sugar at that stage which can be justified by several findings (Uppal and Verma, 1990). According to their studies , reducing sugar content of the potato is affected by several factors like variety, growing conditions of the potatoes, and maturity at harvest. Kita *et al*. (2015) found that reducing sugar content ranged between 0.14 and1.04 g 100 g^{-1} (1.4 – 10.4 mg g^{-1}) FW, which is also consistent with the present findings.

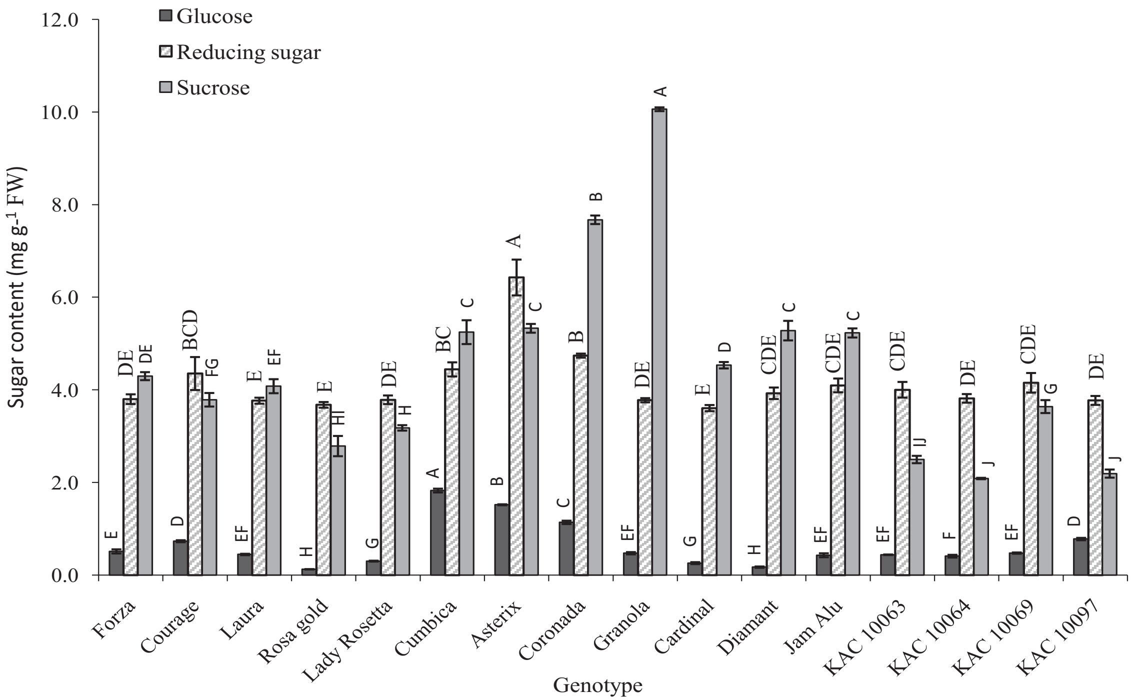

Fig. 1. Glucose, sucrose and reducing sugar contents in sixteen potato genotypes. Vertical bars represent±SE values calculated from three replications; values in the same colored columns with different letter(s) are significantly different at $p \leq 0.05$ by DMRT.

Sensory attributes

The sensory characteristics like color, texture, crispiness, sweetness, sourness, bitterness, flavor and overall acceptability are very good indicator for the preparation of good quality chips (Elfnesh *et al*., 2011; Walingo *et al*., 2007). For instance, consumer preference is predominately going for an attractive light brown potato chip. The affective analysis, also called acceptance tests or preference tests or hedonic tests, are used to quantify the consumer preference or degree of liking/disliking of a product (Lawless and Heymann, 2010; Lawless and Claassen, 1993). Among the genotypes tested in this study, the yellow flesh genotypes, such as Diamant, Lady Rosetta, Asterix, and Courage made high score (>7.00 out of 9) in overall acceptability test what were very consistent with the marking for other criteria such as color, texture, crispiness, sweetness, sourness and bitterness (Table 3, 4).

Conclusion

The comparative analysis of genotypes for good processing quality resulted that the genotypes Lady Rosetta, Rosa Gold, Cardinal, Courage, Diamant, Jam Alu, KAC 10064, and KAC 10069 contained high amount of dry matter (≥ 20%), starch (≥90 mg g^{-1}), Brix% (≥ 6.0) and more or less low amount of reducing sugar (≤4 mg g^{-1}), glucose (≤0.4 mg g^{-1}), and sucrose (≤2.5 mg g^{-1}) indicating good potentials for processing, but the results of sensory attributes suggested Diamant, Lady Rosetta and Asterix got top level of acceptability

Table 3. Sensory evaluation (score: 1-5) of potato chips prepared from different potato genotypes

Genotype	Color (score:1-5)	Texture (score:1-5)	Crispiness (score:1-5)	Sweetness (score:1-5)
Yellow Flesh Genotypes				
Forza	4.57 ± 0.30^{a-d}	3.29 ± 0.29 $^{a-d}$	3.14 ± 0.26^{b-d}	3.57 ± 0.20^{a-c}
Courage	5.00 ± 0.00^{a}	3.29 ± 0.36^{a-d}	4.00 ± 0.44^{a-c}	4.00 ± 0.31^{ab}
Laura	3.57 ± 0.30^{a-f}	3.14 ± 0.26^{a-d}	3.00 ± 0.31^{b-d}	3.57 ± 0.20^{a-c}
Rosa Gold	4.29 ± 0.29^{b-e}	4.29 ± 0.29^{a-c}	4.86 ± 0.14^{a}	2.57 ± 0.20^{c-e}
Lady Rosetta	4.86 ± 0.14^{ab}	4.43 ± 0.20^{ab}	4.43 ± 0.20^{ab}	3.57 ± 0.20^{bc}
Cumbica	3.71 ± 0.36^{a-e}	2.29 ± 0.42^{d}	1.86 ± 0.34^{de}	3.29 ± 0.29^{b-d}
Asterix	4.14 ± 0.26^{a-e}	3.29 ± 0.29^{a-d}	2.57 ± 0.37^{e}	3.86 ± 0.14^{ab}
Coronada	3.00 ± 0.22^{d-g}	3.00 ± 0.44^{a-d}	2.71 ± 0.42^{cd}	2.29 ± 0.29^{de}
Granola	3.43 ± 0.43^{a-g}	2.86 ± 0.46^{a-d}	1.86 ± 0.26^{de}	4.71 ± 0.18^{a}
Cardinal	4.57 ± 0.20^{a-d}	2.57 ± 0.57^{b-d}	1.14 ± 0.14^{e}	3.57 ± 0.30^{bc}
Diamant	4.71 ± 0.18^{a-c}	4.57 ± 0.20^{a}	4.86 ± 0.14^{a}	3.57 ± 0.43^{a-c}
Purple flesh Genotypes				
Jam Alu	2.00 ± 0.44^{g}	3.71 ± 0.42^{a-d}	4.43 ± 0.43^{ab}	1.86 ± 0.26^{e}
KAC 10063	2.14 ± 0.34^{fg}	2.43 ± 0.37^{cd}	2.86 ± 0.34^{cd}	2.57 ± 0.30^{c-e}
KAC 10064	3.14 ± 0.46^{c-g}	3.00 ± 0.44^{a-d}	3.14 ± 0.46^{cd}	3.43 ± 0.30^{b-d}
KAC 10069	2.71 ± 0.29^{e-g}	3.71 ± 0.42^{a-d}	4.86 ± 0.14^{a}	2.86 ±0.2^{b-e}
KAC 10097	3.29 ± 0.42^{b-g}	2.86 ± 0.34^{a-d}	2.71 ± 0.36^{cd}	3.00 ±0.22^{b-e}

Means followed by same letters in a column are not significantly different at 5% level of significance by DMRT

Table 4. Sourness, bitterness, flavor and overall acceptability of potato chips

Genotype	Sourness (score:1-5)	Bitterness (score:1-5)	Flavor (score:1-9)	Consumer acceptability (score:1-9)
Yellow Flesh Genotypes				
Forza	$3.29 \pm 0.29^{a-c}$	$3.00 \pm 0.31^{b-d}$	7.00 ± 0.62^{b}	$5.29 \pm 0.57^{b-f}$
Courage	$3.29 \pm 0.29^{a-c}$	$3.29 \pm 0.18^{a-d}$	7.00 ± 0.62^{ab}	$6.71 \pm 1.04^{a-d}$
Laura	3.71 ± 0.47^{ab}	4.00 ± 0.38^{a}	7.00 ± 0.53^{ab}	$6.00 \pm 0.53^{a-e}$
Rosa Gold	$2.57 \pm 0.30^{a-c}$	2.00 ± 0.22^{cd}	6.29 ± 0.68^{ab}	$4.71 \pm 0.42^{d-f}$
Lady Rosetta	3.57 ± 0.30^{ab}	$3.29 \pm 0.29^{a-d}$	8.00 ± 0.31^{a}	7.57 ± 0.20^{ab}
Cumbica	3.57 ± 0.37^{ab}	3.71 ± 0.29^{ab}	7.29 ± 0.68^{a}	$4.86 \pm 0.51^{c-f}$
Asterix	3.57 ± 0.37^{ab}	3.57 ± 0.30^{ab}	7.57 ± 0.37^{a}	$7.14 \pm 0.34^{a-c}$
Coronada	$2.71 \pm 0.36^{a-c}$	$2.57 \pm 0.37^{a-d}$	6.29 ± 0.18^{ab}	$4.71 \pm 0.42^{d-f}$
Granola	3.86 ± 0.46^{a}	$3.43 \pm 0.48^{a-c}$	7.86 ± 0.46^{a}	4.14 ± 0.59^{ef}
Cardinal	$2.86 \pm 0.40^{a-c}$	3.71 ± 0.42^{ab}	8.14 ± 0.34^{a}	3.14 ± 0.26^{f}
Diamant	3.71 ± 0.29^{ab}	4.00 ± 0.22^{a}	7.43 ± 0.81^{a}	7.86 ± 0.34^{a}
Purple flesh Genotypes				
Jam Alu	2.29 ± 0.36^{bc}	1.86 ± 0.40^{d}	4.71 ± 0.18^{b}	4.00 ± 0.49^{ef}
KAC 10063	$3.00 \pm 0.44^{a-c}$	$2.71 \pm 0.29^{a-d}$	7.29 ± 0.64^{a}	$5.71 \pm 0.36^{a-e}$
KAC 10064	$3.29 \pm 0.29^{a-c}$	$3.00 \pm 0.38^{a-d}$	7.57 ± 0.48^{a}	$5.57 \pm 0.37^{a-e}$
KAC 10069	1.86 ± 0.34^{c}	$2.43 \pm 0.37^{b-d}$	6.14 ± 0.55^{ab}	$5.29 \pm 0.29^{b-f}$
KAC 10097	$3.14 \pm 0.26^{a-c}$	$3.14 \pm 0.26^{a-d}$	6.86 ± 0.51^{ab}	$4.71 \pm 0.36^{d-f}$

Means followed by same letters in a column are not significantly different at 5% level of significance by DMRT

(> 7 point out of 9). Though Asterix got top level of acceptability but the genotype is not consistent with the results of processing quality where it showed low performance. In addition to the highest level of acceptability, the yellow flesh genotypes Diamant and Lady Rosetta showed better processing qualities in all the criteria examined compared to other genotypes, suggesting that they might be suitable for chips preparation in industry. As purple flesh KAC 10064 have good processing quality and got moderate level of acceptability (about 6 point out of 9), the genotype can also be considered for industrial uses. Though the genotypes Cardinal, Rosa Gold, and Jam Alu had good biochemical properties, but they got low consumer acceptability due to having of high bitterness and sourness in sensory test.

References

Abong, G. O., M. W. Okoth, E. G. Karuri, J. N. Kabira and F. M. Mathooko. 2009. Evaluation of selected Kenyan potato cultivars for processing into French fries. *J. Anim. Plant Sci*. 2: 141-147.

BARI. 2017. Developed Crop Varieties of Potato. Cited from browsing: http://baritechnology.org/en/home/tech_commodity#result.

Barton, W. G. 1989. The potato. p. 599-601. 3rd edition. Longman Scientific and Technical.

Brody, J. 1969. Pointers on potatoes. *Food Eng.* 41:124-132.

Brown, C. R. 2005. Antioxidants in potato. *American J. Potato Res.*, 82: 163-172.

Brown, J., G. R. Mackay, H. Bain, D. W. Griffith and M. J. Allison. 1990. The processing potential of tubers of the cultivated potato, *Solanum tuberosum* L., after storage at low temperatures. 2. Sugar concentration. *Potato Research* 33: 219-227.

Burton, W. G. 1966. The potato. A survey of its history and of factors influencing its yield, nutritive value, quality and storage. 2nd ed. The Netherlands, Pp. 128-130.

Cottrell, J. E., C. M. Duffus, L. Paterson and G. R. Mackay. 1995. Properties of potato starch: effects of genotype and growing conditions. *Phytochemistry* 40: 1057-1064.

Dean, B. B. and R. E. Thornton. 1992. The specific gravity of potatoes. Extension Bullentin, Washington State University, Cooperative Extension, Pullman, WA. P.. 1541.

Elfnesh, F., T. Tekalign and W. Solomon. 2011. Processing quality of improved potato (*Solanum tuberosum* L.) cultivars as influenced by growing environment and blanching. *African J. Food Sci.* 5: 324-332.

FAO. 2013. International Year of the Potato. *Journal of Food Composition and Analysis* 22: 494-502.

FAOSTAT. 2017. Food and Agriculture Organization of the United Nations, Statistics Division. Available at www.potatopro.com/world/potato-stastics.

Finotti, E., A. Bertone and V. Vivanti. 2006. Balance between nutrients and anti-nutrients in nine Italian potato cultivars. *Food Chemistry* 99: 698-701.

Kadam, S. S., B. N., Wankier, N.R. Adsule. 1991. Processing. Pp. 111-154. In: SALUNKHE, D. K., S. S. Kadam, S. J. Jadhav (ed.) Potato production, processing and products. Boca Raton, CRC press.

Kang, Y. Y., S. R. Guo, J. Li and J. J. Duan. 2009. Effect of root applied 24-epibrassinolide on carbohydrate status and fermentative enzyme activities in cucumber (*Cucumis sativus* L.) seedlings under hypoxia. *Plant Growth Regul.* 57: 259-269.

Karim, M. R., M. M. H. Khan, M. S. Uddin, N. K. Sana, F. Nikkon and M. H. Rahman. 2008. Studies on the sugar accumulation and carbohydrate splitting enzyme levels in post harvested and cold stored potatoes. *J. Bio. Sci*., 16: 95-99.

Kita, A., A. Bąkowska-Barczak, G. Lisińska, K. Hamouz and K. Kułakowska. 2015. Antioxidant activity and quality of red and purple flesh potato chips. *LWT-Food Sci. and Tech.* 62: 525-531.

Kita, A., G. Lisińska, A. Tajner-Czopek, A. Pęksa and E. Rytel. 2009. The properties of potato snacks influenced by the frying medium. *Potato IV. Food* 3: 93-98.

Kumar, P., B. P. Singh, R. Kumar and N. Kumar. 2013. Effect of maturity days on yield and processing quality of potato varieties. *Research and Reviews: J. Agri. Sci. and Tech.* 1: 1-9.

Lawless, H. T. and M. R. Claassen. 1993. Application of the central dogma in sensory evaluation. *Food Tech.* 47: 139-146.

Lawless, H. T. and H. Heymann. 2010. Sensory evaluation of food: principles and practices. Springer Science and Business Media, New York.

Lisinska, G. and W. L. Eszczynski. 1989. Potato Science and Technology*. Elsevier Applied Science,* Springer Science and Business Media, New York.

Miller, G. L. 1959. Use of dinitrosalicylic acid reagent for determination of reducing sugar. *Analytical Chemistry* 31: 426-428.

Murniece, I., D. Karklina, R. Galoburda and M. Sabovics. 2010. Reducing sugar content and colour intensity of fried Latvian potato varieties. *Latvijas Lauksaimnieci bas Universita te-Raksti* 24: 20-30.

Navarre, D. A., A. Goyer and R. Shakya. 2009. Nutritional value of potatoes. Vitamin, phytonutrient and mineral content. *Advances in Potato Chem. and Tech.* 395-424.

Nielsen, T. H., U. Deiting and M. Stitt. 1997. A [beta]-amylase in potato tubers is induced by storage at low temperature. *Plant Physiol.* 113: 503-510.

Pavlista, A. D. and J. C. Ojala. 1997. Potatoes: Chip and French fry processing. *Processing Vegetables, Sci. and Tech.,* Lancaster: Technomic Publishing, Inc. Pp. 237-284.

Rommens, C. M., R. Shakya, M. Heap and K. Fessenden. 2010. Tastier and healthier alternatives to French Fries. *J. Food Sci.* 4: 75.

Russell, O. F. 1994. MSTAT-C v. 2.1 (a computer based data analysis software). *Crop and Soil Science Department, Michigan State University, USA*.

Sandhu, K. S., R. S. Marwaha and P. Kumar. 2014. Processing attributes of potato varieties stored at ambient conditions of north-western plains. *Potato J.* 1: 41.

Storey, M. 2007. The Harvested Crop. Pp. 441-470. In: D. Vreugdenhil (ed.). Potato Biology and Biotechnology Advances and Perspectives. *Elsevier*, Oxford.

Smith, O. 1968. Potatoes: production, storing, processing. *Potatoes: production, storing, processing.* Avi Publishing Co., Inc. Westport, Connecticut, USA.

Sohail, M., R. U. Khan, S. R. Afridi, M. Imad and B. Mehrin. 2013. Preparation and quality evaluation of sweet potato ready to drink beverage. *ARPN J. Agri. and Biol. Sci.* 8: 279-282.

Solaiman, A. H. M., T. Nishizawa, T. S. Roy, M. Rahman, R. Chakraborty, J. Choudhury and M. Hasanuzzama. 2015. Yield, Dry Matter, Specific Gravity and Color of Three Bangladeshi Local Potato Cultivars as Influenced by Stage of Maturity. *J. Plant Sci.* 10: 108.

Talburt, W. F. and O. Smith. 1987. Potato processing 4th ed. Avi Van Nostrand Reinhold Company, New York, USA.

Uppal, D. S. 1999. Quality traits and chipping performance of newly released potato varieties. *J. Indian Potato Assoc.* 26: 139-142.

Uppal, D. S. and S. C. Verma. 1990. Changes in sugar content and invertase activity in tubers of some Indian potato varieties stored at low temperature. *Potato Res.* 33: 119-123.

Valcarcel, J., K. Reilly, M. Gaffney and N. O'Brien. 2015. Total carotenoids and l-ascorbic acid content in 60 varieties of potato (*Solanum tuberosum* L.) grown in Ireland. *Potato Res.* 58: 29-41.

Walingo, A. M., C. Lung'aho and J. N. Kabira. 2007. Pp. 408-416. Requirements and characteristics of potato varieties in the Kenyan potato processing agricultural sub-sector. Proceedings of the 13th ISTRC Symposium.

Wang-Pruski, G. and J. Nowak. 2004. Potato after-cooking darkening. *American J. Potato Research* 81: 7-16.

Weaver, M. L., E. Hautala, M. Nonaka and W. Iritani. 1972. Sugar-end in Russet Burbank potatoes. *American J. Potato Research* 49: 376-382.

Xue, Y. L. 1985. A handbook of experiments for plant physiology. Shanghai Science and Technology, Shanghai.