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Full Length Research Paper

Physico-chemical, functional and processing attributes of some potato varieties grown in Pakistan

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A study was generated from six commercial potato varieties and studied for their physical, chemical, functional and processing attributes. Lady Rosetta followed by Hermes was the most appreciable varieties concerning their physical attributes. A positive correlation (R = 0.765) existed between tuber firmness and specific gravity. Lady Rosetta and Atlantic attained maximum dry matter and starch contents. Agria contained lesser amount of sugar and Desi contained maximum fat and fiber contents. Highly significant correlation was estimated between dry matter and starch contents (R = 0.967). Hermes and Agria were preferred over all other varieties for their mineral contents, but its functional attributes were found maximum in Desi followed by Hermes. A promising correlation was reported between most of these functional parameters with distinctive correlation between total phenolic contents and radical scavenging activity (R = 0.903). Post processing parameters in Lady Rosetta indicated its preference over all other varieties followed by Hermes and Atlantic.

Key words: Potato varieties, physico-chemical, functional attributes, processing.

INTRODUCTION

Potato is native to South America and was introduced to the Indo-Pak subcontinent by the British right in the 19th century. It is expected that annually about 320.67 million tons of potatoes are produced world over, China being the major producer of this crop with an annual yield of 72 million tons (FAO, 2007). In Pakistan, the total area under potato farming is 149.1 thousand hectares with the total production of 2.5 million tons (GOP, 2009). Therefore, the available crop size is less than 1% of the world potato production. The averaged annual export of potato is about 50,000 tons contributing only 0.5% of total world export (PHDEB, 2008).

Potatoes are best studied for their carbohydrate content. Starch is the predominant form of carbohydrate found in potatoes. Out of the six vitamins included in the recommended daily dietary allowance of food, four are present in potato, namely: ascorbic acid, thiamin, riboflavin and niacin. However, the principal vitamin is ascorbic acid, an important antioxidant that is susceptible to heat and light, and is also the index of quality change in the potato tubers during storage (Burlingame et al., 2009). Polyphenols, in addition, are the most common dietary antioxidant (Lachmann et al., 2008) being efficient as reducing agents, metal chelators and reactive oxygen species quenchers in biological systems.

Exposure of tubers to light at some stages during the commercial processing and marketing chain is generally inevitable and results in adverse physiological changes within the tuber. These changes include ‘greening’ due to the increase level of chlorophyll, and synthesis of toxic steroidal glycoalkaloids (predominantly found as α-solanine and α-chaconine) within the marginal tuber layers. Accumulation of both compounds can result in significant financial and food security threats. Contrary to glycoalkaloids, chlorophyll is safe and tasteless but green potatoes are highly tasteless and considered harmful for consumption. Sweetening is an important physiological change in potato tubers, particularly associated to low temperature storage. The quality of potatoes continues to change as a result of physiological activity owing to the accumulation of reducing sugars and running down of starch (Nourian et al., 2003).

Potatoes utilized for making crisps, French fries and other fried products, require low sugar level since they decide the quality of the processed product. The most important among the snack products are potato crisps

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discovered back in 1853 by George Crum, an American Chef, and which gained tremendous popularity in the processed food industry. Currently, potato chips contribute major share in the snack food market of the world and generated total revenues of US$16.4 billion in 2005 (www.Potatopro.com). However, the existence of preprocessing toxins like glycoalkaloids in tubers and post processing toxins like acrylamide in chips have been the major subject of food security concerns. Excessive amounts of sugars in potato tuber have caused an undesirable brown color and poor taste for the fried products. Maillard reaction has been associated to acrylamide formation at elevated temperature in fried potato products, which has been incorporated in the list of potentially toxic chemicals (Tareke et al., 2002). Acryl amide appears to be produced as a by-product of the maillard reaction involving sugars and the amino acid asparagines (Mottram et al., 2002).

Several varieties of potato have been developed and released to the farmers in Pakistan. Even though these varieties exhibit appreciable tuber characteristics, the comprehensive data regarding their proximate composition, mineral contents, functional potential and processing performance under local ecological condition (weather, soil and irrigation) were mainly unknown. This study explains the important physical, chemical, functional and sensory parameters of profit-making potato varieties to reveal their differential characteristics. The varieties were also analyzed for their processing potential in order to determine their suitability for industrial use in compliance with food safety standards.

MATERIALS AND METHODS

Six processing varieties of potatoes (*Solanum tuberosum* L.) were harvested from District Okara (Punjab, Pakistan) and were shifted to the Department of Food Technology, Pir Mehr Ali Shah (PMAS) Arid Agriculture University, Rawalpindi (Punjab, Pakistan), where the trials were carried out. Four varieties namely: Agria (AGR), Atlantic (ATL), Desi (DES) and Hermes (HER) had yellow-white skin, while the other two: Courage (COU) and Lady Rosetta (LR), had reddish skin. These were selected because of the current increase in their production and their contribution to the processing industry in Pakistan. The tubers were graded into homogenous lots of > 50 mm length, sorted out for the removal of diseased, scratched, wounded and sunburned tubers and were placed between 15 and 20°C for suberization for one week.

Physical analysis

The size of the potato in terms of linear dimensions (that is, length) was measured by a digital caliper (0 to 150 mm, China) with an accuracy of 0.01 mm. The geometric mean diameter (D_g) was calculated by using the following equation:

$$Dg = (LWT)^{0.333}$$

Where, L is the length; W is the width and T is thickness of the fruit. Sphericity of the fruit was determined by the following formula described by Ahmadi et al. (2008):

$$\Phi = (D_g / L) \times 100$$

Surface area (S) was determined according to Baryeh (2001) by the following formula:

$$S = \pi D_g^2$$

Where, D_g is the geometric mean diameter of the potato. Tuber counts (TC)/25 Kg packaging were counted manually for each variety. Firmness of the tubers was determined by Wagner fruit firmness tester model FT-327 with an 11 mm plunger. Values expressed were converted to Kilopascals (Kpa). Specific gravity was determined by taking the weight of the tuber in air and water according to AOAC (1990) method no. 936.13:

$$\text{Specific gravity} = \frac{\text{Weight in air}}{\text{Weight in air} - \text{Weight in water}}$$

Total soluble solid (TSS as °Brix) was determined in the pulp of each sample using a digital refractometer PAL-3 (ATAGO, Japan) at 29±1°C and temperature correction was made accordingly as described by AOAC (1990) method no. 932.12. The pH values were recorded by using a pH-meter (Inolab. WTW Series, Germany) as illustrated in AOAC (1990) method no. 981.12. Sprouting (SPRT) in different varieties was determined as the percentage of sprouted eyes as described by Ranganna et al. (1998):

$$\text{Eyes sprouted (\%)} = \frac{\text{No. of eyes sprouted}}{\text{Total no. of eyes}} \times 100$$

Proximate analysis

The proximate compositions of different potato varieties were carried out with different analytical methods and the results were expressed on a dry weight basis to record the appropriate comparison between them.

Dry matter (DM) was determined by oven drying method at 102°C till constant weight was achieved as described by AOAC (1990) method no. 934.06. Starch estimation was carried out by making the tuber sugar free by the repeated extraction with 80% iso-propanol. Tubers were dried at 70°C and then the starch was hydrolyzed by 60% perchloric acid. The glucose was estimated spectrophotometerically by using anthrone reagent as described by Kumar et al. (2005). Crude protein estimation was carried out by multiplying the total nitrogen contents with conversion factor 6.25 using the Kjeldhal apparatus as described by AOAC (1990) method no. 920.10. As such, crude fat was determined according to the AOAC (1990) method no. 983.23. Reducing sugar, non reducing sugar (NRS) and total sugar contents were determined by Lane and Eynon titration using Fehling's solution as described by AOAC (1990) method no. 925.35. However, the crude fiber was estimated by AOAC (1999) method no.920.86, while the ash content was determined by AOAC method no. 940.26 (1990).

Functional properties

Ascorbic acid (AA) was determined by titrametric method using 2, 6 dichlorophenol indophenol dye as described by AOAC (1990) method no. 967.21.

The total glycoalkaloids (TGA) determination was carried out by the method described by Grunenfelder et al. (2006). Chlorophyll

Table 1. Physical analysis of potato varieties.

Variety	Size (mm)	GMD (mm)	Sphericity (%)	Surface area (mm^2)	TC/25 kg	Firmness (Kpa)	Specific gravity	TSS (0Brix)	pH	SPRT (%)
AGR	76.27 ± 2.955^{c}	66.93 ± 1.537^{c}	87.75 ± 2.577^{b}	14075.25 ± 9.716^{d}	160.0 ± 1.125^{c}	799 ± 7.887^{f}	1.081±0.09^{efg}	5.440 ± 1.18^{f}	6.170 ± 1.12^{c}	47.50 ±2.12c
ATL	64.99 ± 1.732^{d}	61.99 ± 2.173^{d}	95.38 ± 2.381^{a}	12077.79 ± 8.812^{e}	186.3 ± 0.982^{a}	925 ± 5.196^{b}	1.092 ± 0.06^{b}	5.540 ± 1.12^{d}	6.210 ± 1.16^{b}	42.33 ±1.38d
COU	78.43 ± 3.882^{c}	71.50 ± 2.289^{b}	91.16 ± 3.339^{ab}	16067.80 ± 8.312^{b}	154.3 ± 0.812^{d}	885 ± 5.487^{c}	1.090 ± 0.09^{bc}	5.690 ± 1.11^{b}	6.270 ± 1.16^{a}	53.75 ±2.15b
DESI	91.20 ± 3.155^{b}	70.92 ± 2.577^{b}	77.76 ± 1.814^{cd}	15808.17 ± 9.726^{c}	131.0 ± 0.527^{e}	845 ± 8.774^{d}	1.086 ± 0.05^{cde}	5.880 ± 1.39^{a}	6.250 ± 1.12^{ab}	90.66 ±3.15a
HER	94.25 ± 3.577^{a}	75.70 ± 2.173^{a}	80.31 ± 2.287^{c}	18010.93± 11.889^{a}	125.7 ± 1.202^{f}	829 ± 9.732^{e}	1.084 ± 0.04^{def}	5.620 ± 1.19^{c}	6.130 ± 1.11^{d}	36.00 ±1.27e
LR	75.49 ± 2.877^{c}	71.18 ± 2.231^{b}	94.29 ± 3.377^{a}	15924.29 ± 9.431^{b}	165.7 ± 0.333^{b}	948 ± 6.928^{a}	1.101 ± 0.02^{a}	5.550 ± 1.49^{e}	6.180 ± 1.09^{bc}	46.25 ±1.96c

Different letters in one column indicate significant difference (p<0.05). AGR, Agria; ATL, atlantic; COU, courage; DESI, desi; HER, hermes; LR, lady Rosetta.

(CHL) extraction was carried out by acetone and quantification was carried out by spectrophotometer as described by AOAC (1990) method no. 942.04.

Total phenolic contents (TPC) in terms of gallic acid equivalent (GAE) were determined by Folin-Ciocalteu (FC) assay as described by Lachmann et al. (2008) with some modifications. Tubers randomly selected from each variety were freeze dried and then extracted with 80% ethanol, after which 2 gm extract was quantitatively converted to 100 ml volumetric flask and adjusted with 80% ethanol. In 5 ml of the sample, slightly diluted with distilled water, 2.5 ml of FC and 7.5 ml of 20% sodium carbonate solution was added. The contents were allowed to settle for 2 h and absorbance was measured at 765 nm using a CE-2021 Spectrophotometer (CECIL Instruments Cambridge, England). Total phenolics were estimated by standard calibration curve obtained from measuring the absorbance of the known gallic acid concentration (10 to 100 ppm). The results were expressed as mg gallic acid equivalents (GAE) per 100 g of dry matter.

Radical scavenging activity (RSA), as a measure of antioxidant activity, was carried out using the method described by Singh and Rajini (2004), which involves the use of the free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH). Subsequently, 5 mg of lyophilized potato extract was incubated with 1.5 ml of DPPH solution (0.1 mM in 95% ethanol), after which the reaction mixture was properly shaken and allowed to stand for 20 min under room temperature. The absorbance of the resulting mixture was determined at 517 nm against blank. The antioxidant activity was determined as a decrease in the absorbance of DPPH using the following equation:

$$\text{Radical scavenging activity (\%)} = 1 - \frac{A_{\text{sample 517 nm}}}{A_{\text{Control 517nm}}} \times 100$$

Mineral analysis

The mineral contents in potato tubers were determined as described by AOAC (1999) method no. 923-07. Briefly, 5 g of the sample was digested with 10 ml of nitric acid: perchloric acid (7:3) mixtures at a temperature between 180 and 200°C, till transparent contents were obtained. The contents were diluted to a volume of 100 ml with bi-distilled water. The mineral contents, that is, Fe, Ca and Mg of tubers, were determined in an Atomic Absorption Spectrophotometer (GBC-932 Australlia), whereas Na and K were determined by Flame Photometer (Model PFP 7 Jenway, England) and Phosphorus by using a Spectro-photometer (CE-2021, 2000 series CECIL Instruments Cambridge, England).

Evaluation of potato chips

The potato tubers of the selected varieties were processed into potato chips. Peeled tubers were sliced (1.2 to 1.5 mm thick) and blanched in 1.5% NaCl solution at 85°C for 2 min. After pre-drying, the chips were fried in electric fryer at 180 to 185°C temperatures for 3 min using palm oil. The fried chips were cooled and placed in dry oven at 105°C till the constant weight of moisture contents (MC) was estimated. The fat absorption (FAB) in different chip samples was determined by Soxhlet Extraction apparatus as described by AOAC (1990) method no. 983.23. The estimation of Glycoalkaloids as Solanine (SOL) in potato chips was carried out by the same method described in the foregoing. Twenty five (25) students, including the faculty members of the Department of Food Technology, who were the habitual consumers of the potato chips, were selected as judges for the sensory evaluation. The judges were requested to record their degree of preferences for crispiness (CRP), flavor (FLV) and taste (TAS) according to the five point hedonic scale as described by Kita (2002). The color (COL) of the chips was correlated with the British Potato Council (BPC) frying color chart and the values were expressed as approximate L-values.

Statistical analysis

Results were subjected to statistical analysis by considering the varieties as variation source, using one-way analysis of variance (ANOVA). Statistical differences with P-values under 0.05 were considered significant and the means were compared by Duncan Multiple Range test (Steel et al., 1997).

RESULTS AND DISCUSSION

Table 1 summarizes the mean values obtained for

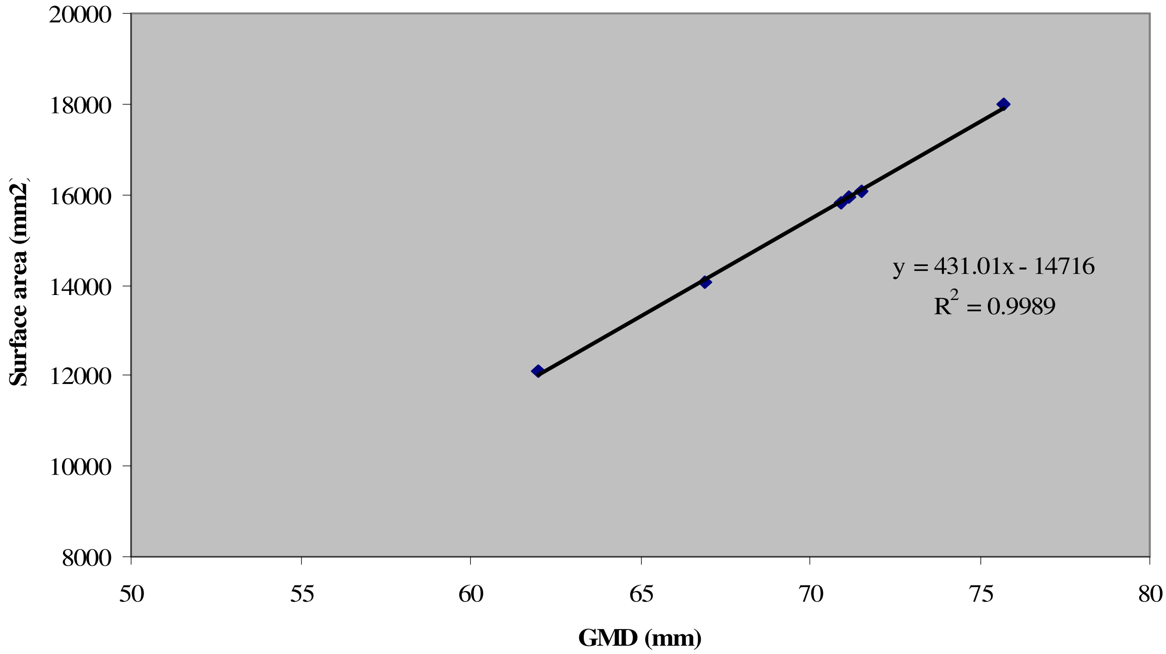

Figure 1. Correlation between surface area (mm^2) and GDM (mm).

each of the varietal physical attributes like, size, geometric mean diameter (GMD), sphericity, Surface area, tubercounts/25 Kg, firmness, specific gravity, TSS, pH and sprouting potential. The results of one way ANOVA in comparing the means for different varieties were also incorporated. The significant differences were recorded between varieties for their parameters like: sizes, GMD and surface area which were positively inter correlated (Figure 1). Hermes yielded maximum tuber size (94.25 mm) followed by Desi (90.10 mm) and is inversely related to the tuber counts/25 Kg packaging. Hermes exhibited maximum surface area (18010.93 mm^2), followed by Courage (16067.80 mm^2) and Lady Rosetta (15924.29 mm^2). However, Atlantic had maximum sphericity (95.38%), followed by Lady Rosetta (94.29%). These parameters discussed in the foregoing play a vital role in defining the processing yield of different varieties as recommended in British Quality Chip Charter by British Potato Council (BPC). The sugar contents were significantly higher in small sized tubers, so the tubers < 50 mm sizes were eliminated during the frying process, which confirmed the results of Mirsa and Chand (1990). Tubers of Lady Rosetta followed by Atlantic attained maximum specific gravity (Table1) and were extremely associated with their firmness (Figure 2). Variety difference on the basis of their specific gravity was also reported by preceding researchers (Kumar et al., 2003). A significant range was experiential in the pH values of different tested varieties (6.13 to 6.27); however, non significant difference was recorded between Agria and Lady Rosetta ($P<0.05$). The minimal variations between the pH in different varieties have also been reported by Gomez et al. (1997). Desi attained maximum TSS (5.880 °Brix) followed by Courage. At ambient temperature (25±2°C) under 45 days storage, Desi showed maximum sprouting percentage (90.66%), followed by Courage (53.75%) and Agria (47.50%); however, longer dormancy and lowest sprouting was experienced in Hermes and Atlantic (Table 1).

Expressing proximate composition on dry weight basis (Table 2), Lady Rosetta formed the tubers with maximum dry matter (25.85%) and starch contents (77.39%) amongst all the tested varieties, while the lowest dry matter (22.95%) and starch contents (74.42%) were observed in Agria, followed by Hermes. Highly significant correlation was recorded between these two parameters in all the varieties (Figure 3), which confirmed the earlier findings (Casanas et al., 2002). A narrow range was estimated in the fat contents of all the tested varieties (0.803 to 1.293%) with the maximum content observed in Desi. The proximate analysis revealed that the mean protein contents in potato varieties were significantly different as it was also mentioned with the maximum protein contents (11.86%) determined in Agria. Evaluation of the total sugar of potato varieties indicated that Agria attained the least sugar contents (0.81%) followed by Lady Rosetta (0.93%). Reducing sugars and protein contents in the tuber varieties at elevated temperature cause the formation of neurotoxin, that is, acrylamides and thus, of grave food safety concerns. The formation of this carcinogen (Tareke et al., 2002) in potato chips during processing is directly linked with the Maillard reaction (Mottram et al., 2002). Therefore, the right selection of potatoes for processing, with respect to low reducing

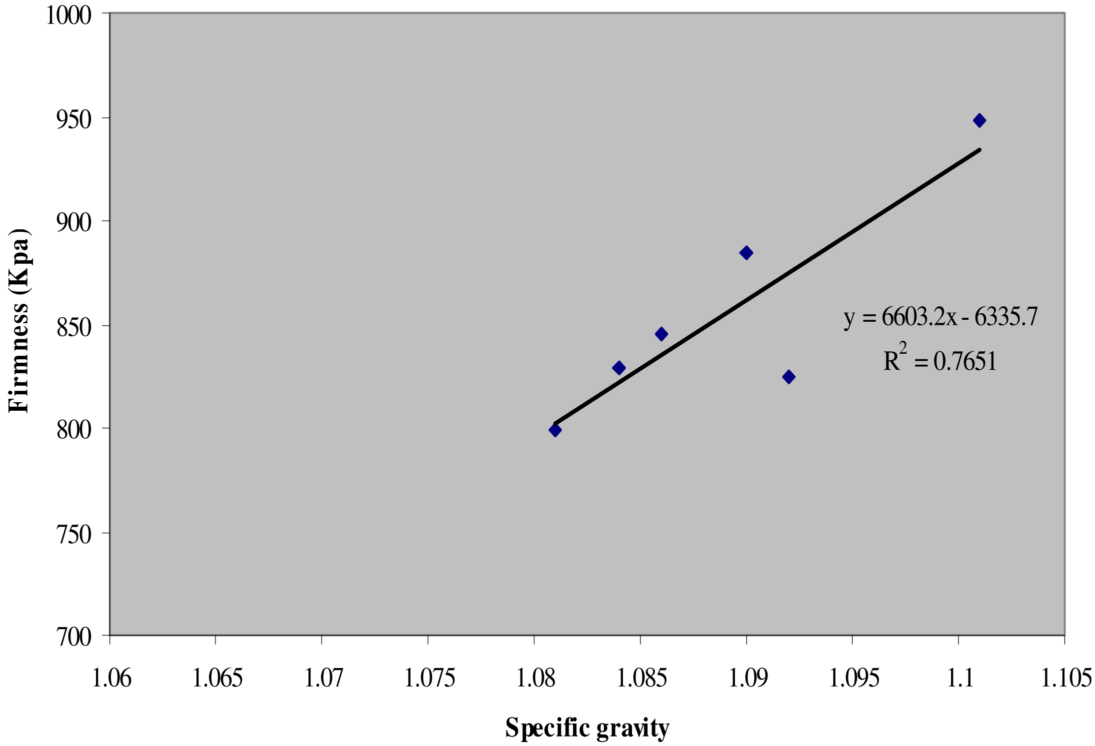

Figure 2. Correlation between specific gravity and firmness (Kpa).

sugar contents, will be an important mitigation strategy against the formation of this lethal compound.

Table 2 reveals non starchy polysaccharides (as fibers) on dry weight basis in different potato varieties. Desi accumulated the maximum fibre contents (7.83%) with the least contents recorded in Hermes (6.43%). The ash contents in the tuber varieties were well differentiated and they ranged from 3.30% in Agria to 1.89% in Atlantic, and were highly correlated with the total mineral contents (Figure 4). Hermes (598 mg/100 g) and Agria (577 mg/100 g) were preferred over all other varieties for their mineral composition, followed by Lady Rosetta (546 mg/100 g) and Courage (536 mg/100 g) (Table 3); however, individual mineral contents dominance exhibited slight deviation from the general trend.

Table 4 expresses results on a dry matter basis pertaining to the functional characteristics of different potato varieties which are of major food safety concerns with positive correlation recorded in most of them. A close range of ascorbic acid contents (80.50 /100 to 115.0 mg/100 g), mostly with non significant difference ($P<0.05$), was recorded in the evaluated varieties. Nonetheless, maximum ascorbic acid contents were recorded in Desi followed by Hermes and Agria. Radical scavenging activity in different tuber varieties were positively correlated (Figure 5) with other functional parameters like glycoalkaloids, total phenolic contents and ascorbic acid. It was seen that the results partly coincided (Hejtmankova et al., 2009). The maximum glycoalkaloids which were estimated as α-solanine were observed in Desi (22.35 mg/100 g) followed by Hermes (19.24 mg/100 g). Agria accumulated the maximum chlorophyll contents (that is, 1.374 mg/100 g), followed by Desi and Courage (Table 4). Glycoalkaloids have been considered as one of the toxins related to the human diet with upper safe limit of 20 mg/100 g on fresh weight basis (Papathanasiou et al., 1999). However, it is also believed to act as a natural defense mechanism in plants against some pathogens and insects (Rodriguez-Saona et al., 1999). In all the tested varieties, the amount of glycoalkaloids was found to be lower than the permissible limit considered safe for human intake. The significant correlation (Figure 5) between the radical scavenging activity and glycoalkaloids in potato might be attributed to their anti malignant properties. Amongst all the tested varieties, Desi followed by Agria and Lady Rosetta attained maximum total phenolic contents and radical scavenging activity (Table 4), with significant correlation (Figure 5) observed between them. This significant correlation was also reported by Lachmann et al. (2008).

Table 5 expresses the quality parameters of chips like: Moisture contents, fat absorption and sensory evaluation after the processing of different potato varieties. The mean moisture contents (%) range between maximum (1.513%) in Desi and minimum (1.203%) in Lady Rosetta.

However, a non significant difference ($P<0.05$) was

Table 2. Proximate analysis of potato varieties.

Variety	DM %	Starch (g/100g)	Protein (g/100g)	Fat (g/100g)	Total sugar (%)	Reducing sugar (%)	N. R. S (%)	Fibre (g/100g)	Ash (%)
AGR	22.95 ± 1.22[f]	74.42 ± 2.30[d]	11.86 ± 1.27[a]	0.970 ± 0.012[b]	0.810 ± 0.017[f]	0.110 ± 0.023[e]	0.700 ± 0.012[e]	7.250 ± 0.416[d]	3.300 ± 0.581[a]
ATL	24.99 ± 2.91[b]	76.69 ± 2.67[b]	10.89 ± 2.39[b]	1.000 ± 0.085[b]	1.170 ± 0.058[d]	0.320 ± 0.017[c]	0.850 ± 0.023[d]	7.440 ± 0.613[c]	1.890 ± 0.292[e]
COU	24.75 ± 2.60[c]	76.52 ± 2.50[b]	9.937 ± 2.35[e]	0.810 ± 0.012[c]	1.380 ± 0.017[c]	0.400 ± 0.029[b]	0.980 ± 0.006[c]	7.580 ± 0.528[b]	2.820 ± 0.581[c]
DESI	23.89 ± 1.29[d]	75.45 ± 1.73[c]	9.880 ± 1.28[d]	1.293 ± 0.030[a]	2.590 ± 0.035[a]	0.900 ± 0.055[a]	1.690 ± 0.058[a]	7.830 ± 0.582[a]	1.990 ± 0.237[e]
HER	23.35 ± 5.87[e]	75.36 ± 1.75[c]	11.79 ± 2.33[a]	0.997 ± 0.013[b]	1.555 ± 0.035[b]	0.383 ± 0.015[b]	1.170 ± 0.017[b]	6.430 ± 0.751[e]	3.110 ± 0.292[b]
LR	25.85 ± 4.82[a]	77.39 ± 1.32[a]	10.50 ± 1.20[c]	0.803± 0.026[c]	0.935 ± 0.023[e]	0.220 ± 0.012[d]	0.710 ± 0.023[e]	7.192 ± 0.581[d]	2.560 ± 0.351[d]

Different letters in one column indicate significant difference ($p < 0.05$). DM, Dry matter; NRS, non reducing sugar.

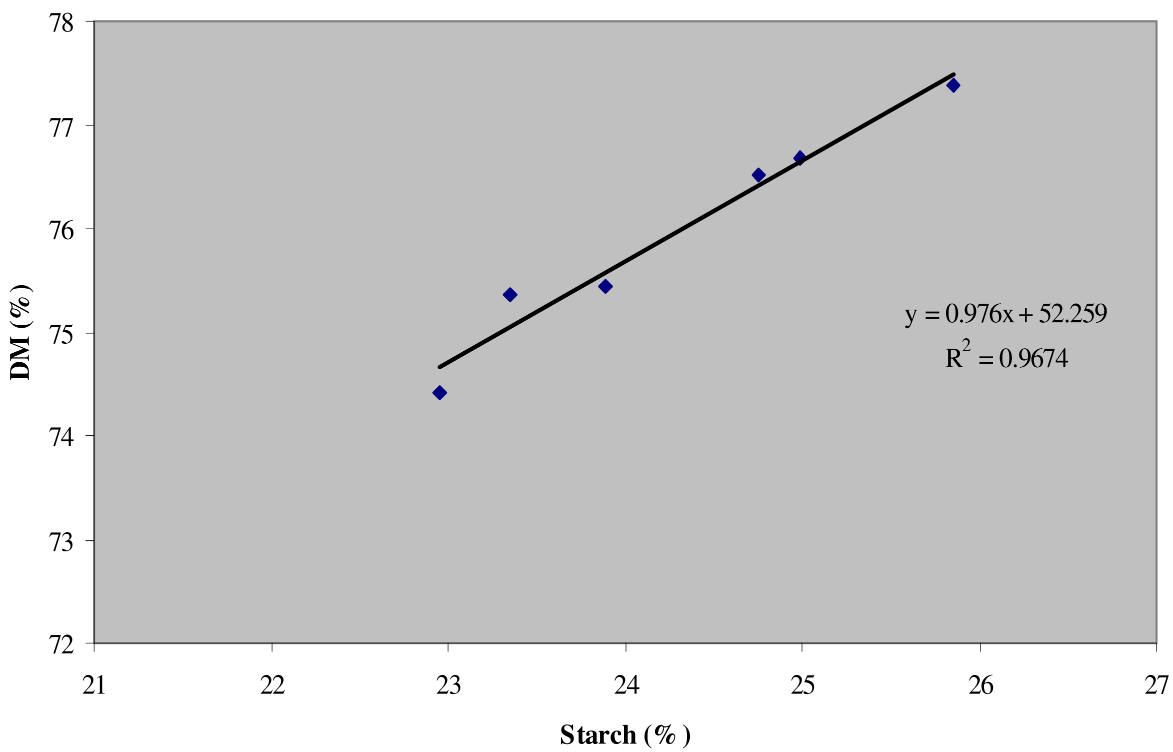

Figure 3. Correlation between dry matter (%) and starch (%).

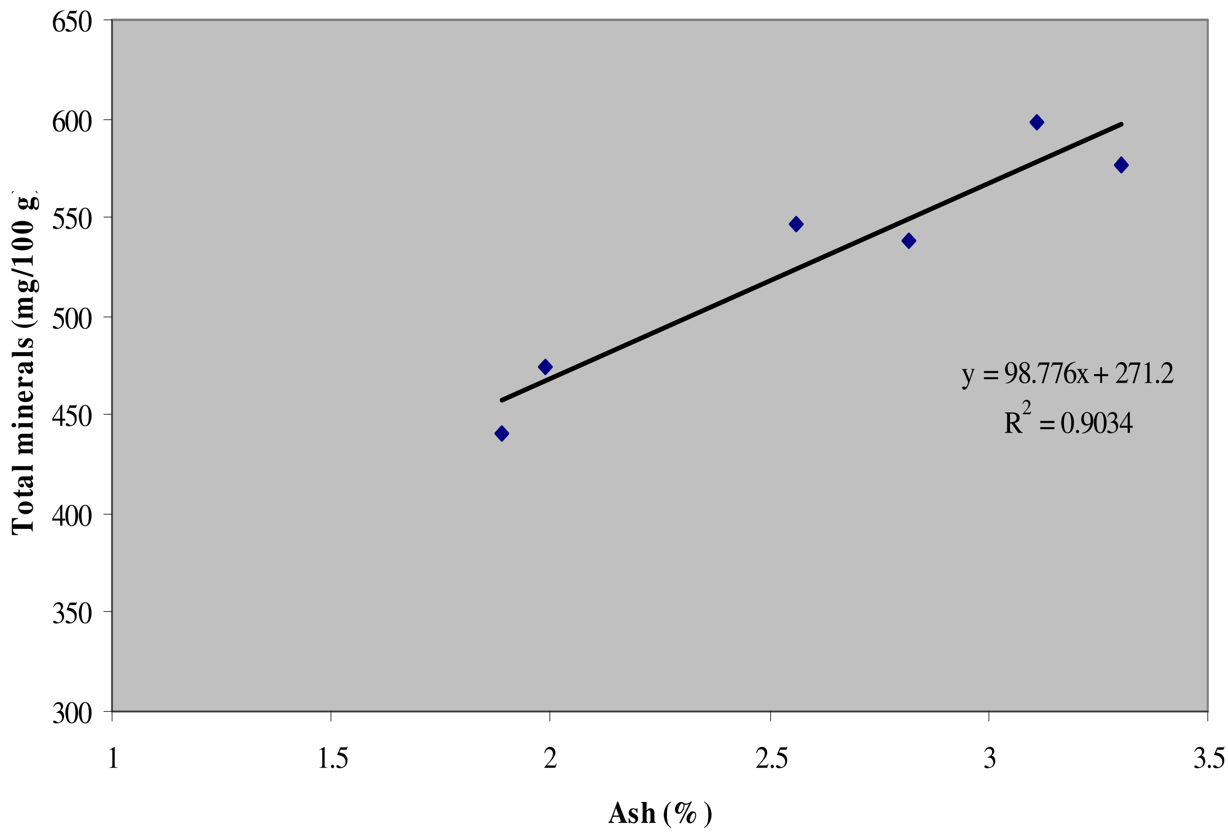

Figure 4. Correlation between ash (%) and total minerals (mg/100 g).

Table 3. Mineral composition of potato varieties.

Variety	Na (mg/100g)	K (mg/100g)	Fe (mg/100g)	Ca (mg/100g)	P (mg/100g)	Mg (mg/100g)	Total mineral (mg/100g)
AGR	6.827 ±0.15[f]	465.7 ±9.66[a]	1.760 ±0.12[d]	18.03 ±2.8[a]	63.83 ±2.61[b]	21.00 ±1.86[d]	577±16.20[b]
ATL	9.550 ±0.29[a]	347.3 ±7.66[e]	2.277 ±0.19[a]	16.53±1.45[c]	40.67 ±2.14[e]	25.00±1.57[b]	441±12.30[f]
COU	7.423 ±0.15[e]	437.0 ±5.15[c]	1.823 ±0.18[c]	14.32 ±1.30[d]	51.43 ±4.56[d]	24.83±1.16[b]	536±11.64[d]
DESI	8.550 ±0.29[d]	434.7 ±11.18[c]	1.450 ±0.12[f]	13.63 ±1.69[e]	57.00 ±2.57[c]	26.00 ±1.28[a]	475±15.13[e]
HER	8.730 ±0.21[c]	453.7 ±7.85[b]	1.627 ±0.15[e]	17.40 ±1.73[b]	62.00 ±3.57[b]	25.53±1.06[ab]	598±13.57[a]
LR	9.273 ±0.15[b]	423.0 ±11.52[d]	1.843 ±0.18[b]	17.93 ±1.45[a]	71.33 ±5.14[a]	23.47 ±2.14[c]	546±18.58[c]

Different letters in one column indicate significant difference ($p < 0.05$).

Table 4. Functional properties of potato varieties.

Variety	AA (mg/100g)	TGA (mg/100g)	CHL (mg/100g)	TPC (mgGAE/100g)	RSA (%)
AGR	94.40 ±2.23[b]	17.29±2.17[c]	1.374±0.29[a]	189.21± 8.66[b]	59.92 ±0.73[b]
ATL	80.50 ±1.15[c]	15.34±2.02[d]	1.037±0.23[c]	129.47± 9.82[e]	38.90 ±0.17[e]
COU	83.00 ±1.55[c]	14.17± 3.08[e]	1.274±0.17[abc]	93.58± 5.77[f]	37.59 ±0.17[f]
DESI	115.00 ±4.66[a]	22.35±2.20[a]	1.292±0.11[ab]	253.24± 7.32[a]	68.12 ±0.64[a]
HER	110.00 ±3.88[a]	19.24±4.06[b]	1.089±0.52[bc]	150.33±10.55[d]	52.50 ±0.58[d]
LR	86.00 ±2.73[bc]	17.52±5.03[c]	0.904±0.23[d]	171.55± 6.32[c]	56.90 ±0.16[c]

Different letters in one column indicate significant difference ($p < 0.05$). AA, Ascorbic acid; TGA, total glycoalkaloids; CHL, chlorophyll; TPC, total phenolic content; RSA, radical scavenging activity.

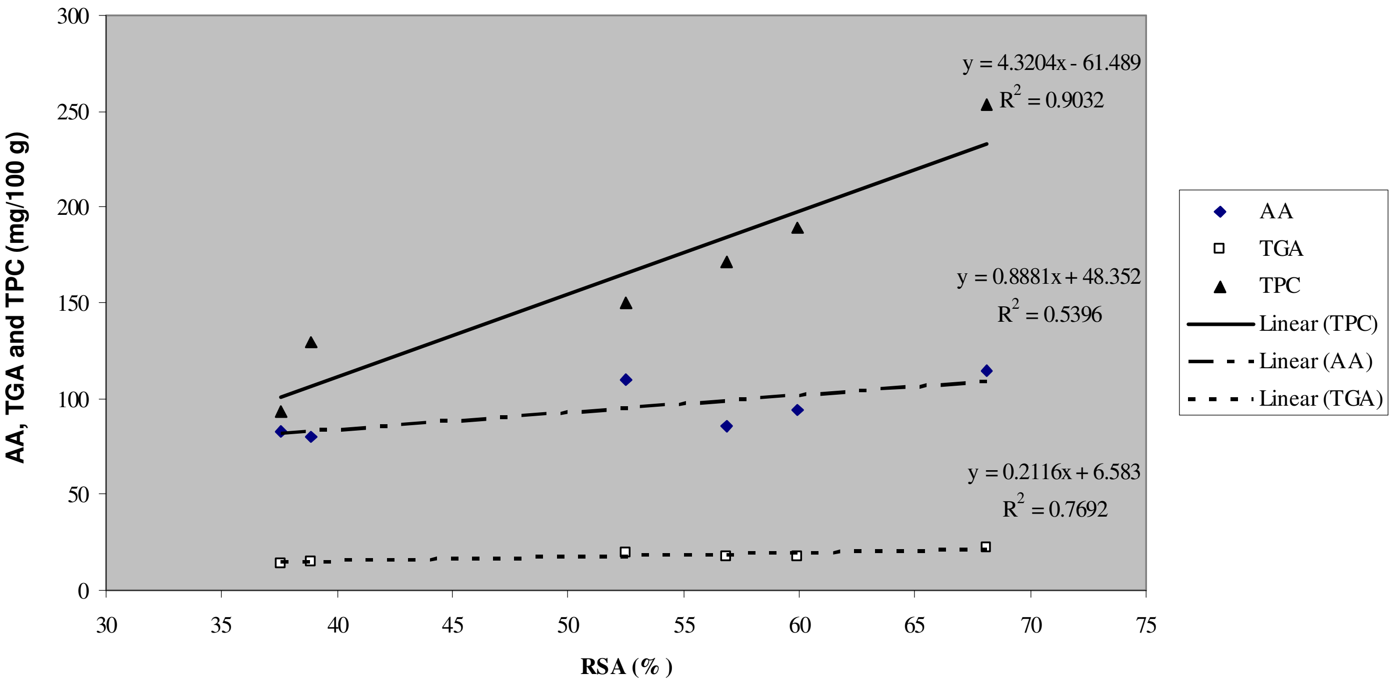

Figure 5. Correlation between RSA (%) and AA, TGA and TPC (mg/100 g).

Table 5. Evaluation of potato chips.

Variety	MC (%)	FAB (%)	TGA (mg/100g)	COL (L-value)	CRP Scores	FLV Scores	TAS Scores
AGR	1.285 ±0.21[c]	30.75 ±1.17[b]	3.80 ± 0.34[b]	63.80 ± 1.32[b]	4.250 ±0.58[c]	4.100 ±0.57[c]	4.350 ±0.33[c]
ATL	1.318 ±0.44[b]	27.48 ±2.30[e]	2.80 ±0.41[e]	63.20 ±1.84[c]	4.300 ±0.44[c]	4.117 ±0.60[c]	4.330 ±0.10[c]
COU	1.327 ±0.19[b]	32.40 ±3.15[d]	2.87 ±0.18[d]	63.00 ±1.50[c]	4.200 ±0.58[d]	4.217 ±0.44[bc]	4.000 ±0.23[d]
DESI	1.513 ±0.11[a]	35.97 ±1.88[a]	5.20 ±0.26[a]	62.50 ±1.99[d]	4.000±0.74[e]	4.033 ±0.33[c]	3.500±0.58[e]
HER	1.240±0.22[d]	30.05±2.94[c]	4.04 ±0.30[b]	63.10 ±1.71[c]	4.4500 ±0.62[b]	4.367 ±0.19[b]	4.500 ±0.57[b]
LR	1.203 ±0.19[e]	27.77±1.80d[e]	3.15 ±0.24[c]	64.80 ±0.91[a]	4.750 ±0.28[a]	4.850 ±0.12[a]	4.800 ±0.19[a]

Different letters in one column indicate significant difference ($p < 0.05$). MC, Moisture content; FAB, fat absorption; TGA, total glycoalkaloids; COL, colour; CRP, crispiness; FLV, flavor; TAS, taste.

recorded between Atlantic and Courage. In general, fat absorption (%) in chips was positively correlated to the moisture contents (Figure 6) and inversely proportional to dry matter, as minimum fat absorption was recorded in varieties like Atlantic and Lady Rosetta. The results are in close washing and frying caused considerable reduction (82% in Lady Rosetta and 76.73% in Desi) in glyco-alkaloids in all the tested varieties. Consequently, glyco-alkaloids decreased during potato processing (Peksa et al., 2006).

In general, close scores were observed between all the sensory attributes recorded by the judges (Table 5). The response of judges regarding the chip color correlated with the British Potato Council (BPC) chip chart agreement with the findings of Kita (2002). Different steps in chip processing like peeling, cutting, slicing, used to calculate the approximate L-values. The best chip color was displayed by Lady Rosetta (L-64.80), followed by Agria (L-63.80) > Atlantic (L-63.20) > Hermes (L-63.10) > Courage (L-63.0). A positive correlation was like crispiness, flavour and taste (Figure 7). Crispiness is an important quality feature in chip which is mostly attributed to high dry matter and starch contents. Potatoes with high specific gravity possessed appreciable starch contents along with higher molecular weight and non starch polysaccharides which gave stable, compact and thin configuration as reported also by Kita (2002). Lady Rosetta secured maximum crispiness scores (4.75) followed by Hermes (4.50) > Atlantic (4.33) > Agria (4.25) > Courage (4.233). Almost the same trend was followed in the taste and flavor scores recorded by the panel of judges in Table 5a. Lady Rosetta maintained its

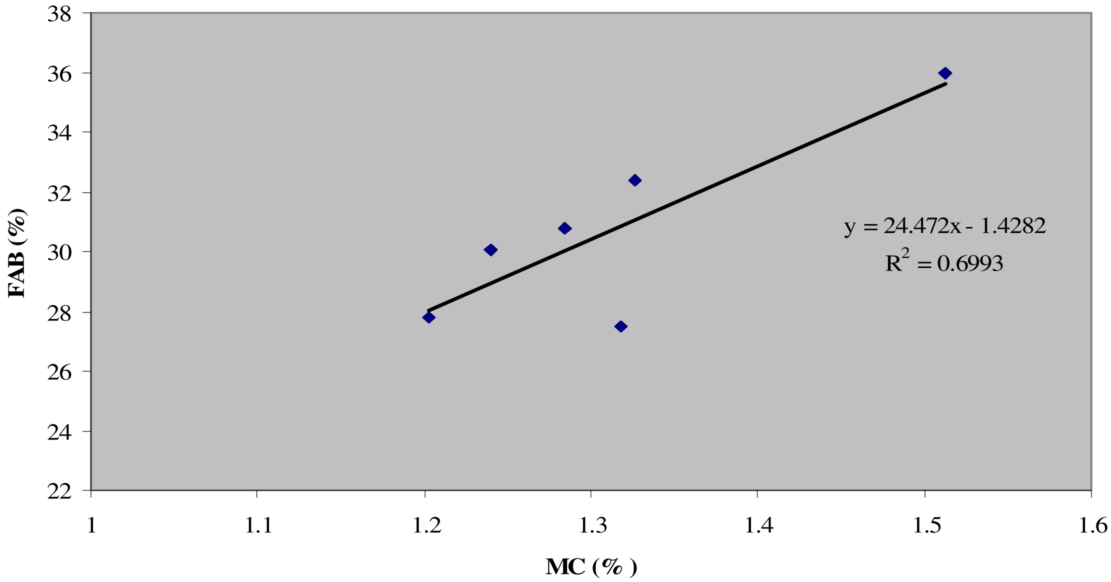

Figure 6. Correlation between MC (%) and FAB (%).

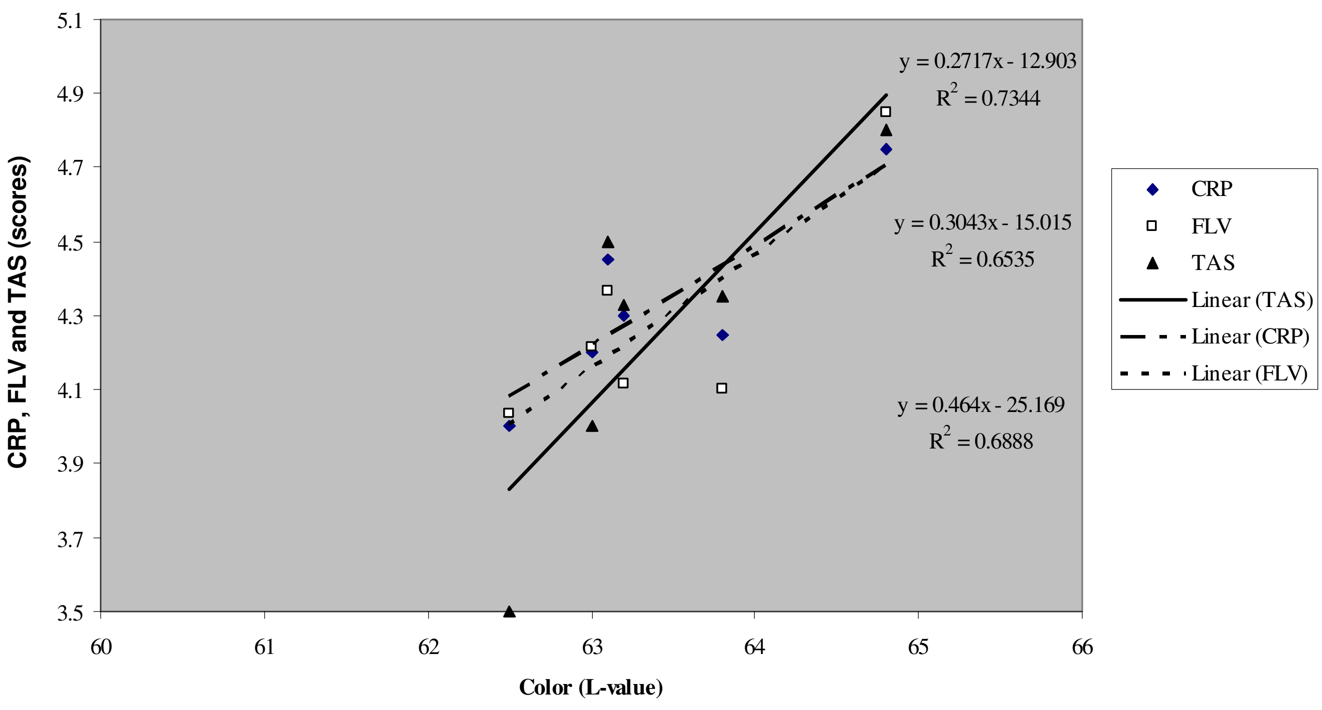

Figure 7. Correlation between color (L-value) and CRP, FLV and TAS (scores).

supremacy over all other varieties with maximum flavor (4.85) and taste (4.80). This was followed by the scores of Hermes.

Conclusion

Lady Rosetta showed the best overall performance in all the tested varieties accounting for its suitable size and sphericity, low sprout (%), high dry matter, low fats and reducing sugars, significant mineral contents, significant functional potential and above all remarkable processing performance. Atlantic and Hermes were also impressive owing to their high dry matter contents, long dormancy period and impressive processing performance. An outstanding functional potential has been identified in

Desi variety, but it proved inferior to Lady Rosetta in other physico-chemical and processing attributes. The development of the potato variety with significant functional potential, along with other quality attributes, may be the point of great attention for the breeders. The significant correlation between different quality attributes may be helpful in the selection of the best variety for the industry in compliance with food safety standard.

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