PROCESSING ATTRIBUTES AND CHIPS QUALITY OF PROMISING POTATO CLONES UNDER DIFFERENT SLICE TREATMENTS IN BHAKTAPUR, NEPAL

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ABSTRACT

A study was conducted to evaluate processing attributes of different potato clones (genotype) and their effect in chips quality in combination with different potato slice treatments in Bhaktapur, Nepal from January to April 2018. Six potato clones (PRP 35861.18, CIP 384866.5, PRP 226267.11, CIP 388676.1, PRP 858676.1 and Desiree) were allocated in Randomized Complete Block Design with four replications. Significant variation among the potato clones was found with respect to dry matter and reducing sugar content. PRP 858676.1 showed the highest dry matter whereas the lowest reducing sugar content was with CIP 384866.5. Variation in specific gravity and total soluble solidwas not found statistically significant. Chips were prepared in two factorial design with 3 replications, following the protocol of National Potato Research Program. First factor was potato clones and the second factor was slice treatments viz; cold water, 0.5% NaCl solution and warm water at 45ºC. This study revealed significant variation in chips colour, taste & flavour, crispiness, overall acceptability and recovery percent. Clone CIP 388676.1 with slices treated with cold water produced best quality chips while highest recovery percent was given by PRP 858676.1 treated with warm water at 45ºC. Superior quality of chips was obtained with CIP 388676.1 followed by Desiree, CIP 384866.5 and PRP 858676.1. Thus, potato clones CIP 388676.1, Desiree, CIP 384866.5 and PRP 858676.1 needs further evaluation for chips quality and slice treatment with cold water should be recommended for good quality chips production.

Keywords: *potato clones, chips quality, slice treatment, processing, quality*

INTRODUCTION

Processing is an important technique of postharvest management for increasing the shelf life of product and making diverse products. Simply, it is a value addition function of marketing which is a good source of income and employment. Major portion of potato production is utilized in processing in many developed and developing countries. Processed products have high demand (Khurana, 2005) and high market value which is far better than value of raw products (Abbas, 2011). Potato is processed into different products like chips, french fry, flakes, flour and frozen products. Potato chips are gaining popularity among the Nepalese consumers due to the change in food habits, rapid urbanization, and attitude of new generations for easy to prepare and ready to serve fast food (Gautam, Sharma & Khatri, 2016). However, the domestic chips production is not able to fulfil the increasing demand of consumers towards chips.

Chips production in Nepal is still in an infant stage. Large amount of national currency is spent for the import of chips every year. It is reported that approximately 48% chips market of Nepal is contributed from Indian products. Chaudhary group contributes 32% and local cottage industries 20% (MoAC, 2011). Lack of appropriate potato varieties with processing attributes especially for chips making is one of the major reason for low production of domestic produce (NPRP, 2017). For chips making purpose, potato should have certain quality attributes like round to oval tubers, preferably 74 mm length, shallow eyes, higher

dry matter (>20%) and low reducing sugars (<0.1% on fresh weight basis) so as to yield chips of excellent quality (Kaur & Aggarwal, 2014 and Kaur, Sandhu & Aggarwal, 2012). Currently, varieties recommended for table purpose are used for chips making resulting in lower and inferior grade chips production. Most of the farmers and local entrepreneurs lack the information regarding the effect of different slice treatments on chips quality parameters. Thus, this study was conducted with aim of finding an appropriate potato varieties and an effective slice treatment method for production of superior chips.

MATERIALS AND METHODS

A field trial of five promising potato clones namely PRP 35861.18, CIP 384866.5, PRP 226267.11, CIP 388676.1 and PRP 858676.1 obtained from NPRP along with Desiree as check variety was tested in Bhaktapur, Nepal from January to April 2018. The harvested potato tubers were evaluated for processing attributes like dry matter, specific gravity, reducing sugar and total soluble solid (TSS) in Randomized Complete Block Design (RCBD) with 4 replications. For each replication 25 healthy and freshly harvested potato tubers were allocated randomly. Dry matter content was determined by chopping and mixing offive randomly selected tubers into small pieces and drying of 100-gram sample in hot air oven at 80°C for first six hours and then at 65°C till constant weight was obtained (Kumar et al., 2006). The specific gravity was determined by weighing randomly selected ten tubers in Kern electric balance (0.1 - 6000 g) in air and water by using following formula:

$$\text{Sp. gravity} = \frac{\text{Wt in air}}{\text{Wt in air - Wt in water}} \text{Sp. Gravity of water at lab temp.}$$

The dry matter and specific gravity measurement was carried out at National Potato Research Program (NPRP), Khumaltar, Lalitpur under Nepal Agriculture Research Council (NARC). Similarly, reducing sugar content was measured following the protocol of di-nitrosalicyclic colorimetric method (Miller, 1959) at Himalayan College of Agricultural Sciences and Technology (HICAST), Kathmandu. Total Soluble Solid of potato tubers was also measured at HICAST by using refractometer.

The chips of harvested potato tubers were prepared in Libali, Bhaktapur to study the effect of clones (genotype) and slice treatments in chips quality. The experiment was set up in two factorial design with three replications. The first factor was potato clones and the second factor was different slice treatments viz; cold water, 0.5% NaCl solution and warm water at 45ºC. Five tubers of each potato clones suitable for chips making were selected randomly for each replication. The texture and colour of potato chips vary with slice thickness (Abong et. al, 2011). The tubers were peeled and cut into slices of 1.3 to 1.4 mm thickness with a hand operated slicer. Uniformed and undamaged slices were washed 3-4 times with cold water until clear water was obtained. The slices were dipped in cold water (water at room temperature), 0.5% NaCl solution and warm water at 45°C for 5 minutes. The chips were prepared following the protocol of NPRP (2017). The slices were fried in refined sunflower oil at 180°C for about 10 to 12 minutes. Hedonic ranking of chips for chips colour, taste and flavour, crispiness and overall acceptability was done by panel of 17 members. Prior to the assessment of chips quality the panalists were trained about the technique of hedonic ranking. Chips recovery percent was determined by measuring the weight of potato tubers and its chips produced. Chips colour was scored by panel on 1-9 scale based on visual observation and comparing chips colour with standards references chart for potato

chip colour provided by Ezekiel et al. (2003). The colour scale 1 denoted the darkest chip colour and 9 scale denotes lightest chip colour. Similarly, taste and overall acceptability was measured by using 1 - 9 scale. The chips crispiness was rated at 1-3 scales with 1-2 and 3, corresponding to more crispiness, ideal crispiness and not crispiness enough respectively.

MS Excel 2007 was used for data entry, management and descriptive analysis. ANOVA and DMRT were done using R 3.5.1 and R-Studio 1.1.453.0 version (R Core Team, 2017) and significance level was defined at 5%.

RESULTS AND DISCUSSIONS

Processing attributes

The processing attributes of the potato clones are furnished in Table 1. Significant variation was found in dry matter and reducing sugar content among the clones. PRP 858676.1(19.08%) showed the highest dry matter percent. The lowest reducing sugar content was noted with CIP 384866.5 while the highest with PRP 226267.11. The variation in specific gravity and TSS was found statistically non-significant. However, the highest specific gravity was recorded with PRP 858676.1 followed by CIP 388676.1 and the highest TSS with PRP 226267.11 followed by Desiree.

Table 1. Effect of genotypes on processing traits of potato clones in Bhaktapur, 2018

Treatment	Dry matter (%)	Specific gravity	Reducing sugar (mg/100g)	TSS (°Brix)
PRP 35861.18	15.76 ±0.78^{b}	1.0635±0.008	43.41±9.35^{b}	4.92±0.01
CIP 384866.5	16.55 ±0.86^{b}	1.0643±0.009	27.11±5.01^{c}	5.04±0.25
PRP 226267.11	16.56 ±0.60^{b}	1.0635±0.003	58.55±17.63^{a}	5.33±0.53
CIP 388676.1	15.78±1.25 ^{b}	1.0673±0.003	32.38±2.66^{bc}	5.085±0.35
PRP 858676.1	19.08±2.26^{a}	1.0735±0.001	44.15±2.08^{b}	5.00±0.41
Desiree	15.17±1.00^{b}	1.0648±0.002	33.62±6.18^{bc}	5.25±0.29
F test	*	NS	***	NS
P value	0.0128	0.227	0.000754	0.494
CV (%)	8.08	0.58	20.029	6.44
LSD	2.01	0.01	12.04	0.5

*Note: Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1, CV=coefficient of variation, LSD=least significant difference*

These results are similar with findings of Feltran et al. (2004) and Gautam et al. (2016) who indicated processing qualities of tubers such as dry matter, specific gravity and reducing sugars content varied according to genotypes. Dhakal et al. (2011) and NPRP (2016/17) also reported the significant effect of genotypes on dry matter, specific gravity and quality of chips. Gautam et al. (2016) reported that there is highly significant positive correlation of dry matter with specific gravity while reducing sugars showed negative correlation with dry matter and specific gravity but not at significant level which is similar to results obtained in this study. Roy and Mukhopadhvav (2010) and Marwaha et al. (2008) reported significant effect of genotypes in dry matter and hence the production of light colour chips by genotype containing 21-24% dry matter (DM).

For chips making purpose, potato should have dry matter greater than 20% and low reducing sugars (RS) (<0.1% on fresh weight basis) (Kaur & Aggarwal, 2014 and

Kaur, Sandhu & Aggarwal, 2012). In this study, potato clone CIP 388676.1 containing 15.78±1.25% DM and 32.38±2.66 mg per 100g RS produced superior chips with respect to colour, taste and flavour, crispiness and overall acceptability. The lower value of dry matter in tested clones than recommended for processing might be due to early harvest and prevailing climatic condition (Ezekiel et al., 2003) and the higher amount of reducing sugar than recommended might also be due to early harvesting of crops resulting from the wilting of plants by continuous heavy rainfall and flooding of field. Aggarwal, Kaur and Vashisht (2017) observed significant differences in physico-chemical parameters among genotypes which is in agreement with the results obtained in this study. Significant variation in recovery percent among the genotypes was observed which agrees with the findings of Dhakal et al. (2011).

Table 2. Effect of clones, slice treatments and their combination on qualities of chips prepared from fresh tubers of promising clones in Bhaktapur, 2018

Treatments	Colour	Taste and Flavour	Crispiness	Overall acceptability	Recovery (%)
Clones (G)					
PRP 35861.18	6.76±1.23^{bc}	6.47±1.57^{c}	2.31±0.68^{a}	5.84±1.67^{d}	28.43±2.96^{b}
CIP 384866.5	6.57±0.92^{c}	7.29±1.03^{b}	1.9±0.81^{b}	6.55±1.06^{bc}	24.38±3.13^{c}
PRP 226267.11	6.96±1.08^{bc}	6.59±1.89^{c}	1.96±0.87^{b}	6.37±1.55^{c}	23.80±3.25^{cd}
CIP 388676.1	7.84±1.12^{a}	7.73±1.09^{a}	1.57±0.7^{c}	7.62±1.03^{a}	22.55±4.92^{d}
PRP 858676.1	7.06±1.53^{b}	6.71±1.57^{c}	1.86±0.78^{b}	6.76±1.66^{bc}	28.69±2.60^{b}
Desiree	7.22±1.08^{b}	6.71±1.6^{c}	1.78±0.76^{bc}	6.84±1.54^{b}	30.87±7.29^{a}
F value	***	***	***	***	***
P value	1.28e-07	1.40e-10	8.07e-09	1.30e-13	5.12e-14
CV %	15.18	14.51	29.07	15.86	7.96
LSD	0.42	0.39	0.22	0.41	1.73
Slices treatment with different water types (W)					
Cold water	7.43±1.21^{a}	7.21±1.34^{a}	1.82±0.74^{b}	7.00±1.53^{a}	26.29±3.91^{b}
0.5%Salt water	6.90±1.25^{b}	7.29±1.26^{a}	1.56±0.66^{c}	7.13±0.98^{a}	27.60±6.92^{c}
Warm water	6.87±1.16^{b}	6.25±1.75^{b}	2.31±0.8^{a}	5.87±1.68^{b}	25.47±4.15^{b}
F test	***	****	***	***	**
P value	0.000205	5.18e-14	<2e-16	<2e-16	0.00376
CV %	15.18	14.51	29.07	15.86	7.96
LSD	0.3	0.28	0.15	0.29	1.22
Effect of clones and different slice treatment interaction (G*W)					
W1G1	7.76±1.09^{ab}	7.05±1.02^{bcd}	2.35±0.49^{abcd}	6.06±1.82^{ghi}	27.14±3.48^{cdef}
W1G2	6.59±1.00^{def}	7.59±0.62^{abc}	2.05±0.66^{bcd}	6.53±0.94^{defg}	28.24±1.28^{bcd}
W1G3	7.24±1.09^{bcd}	7.17±1.88^{bc}	1.35±0.70^{hi}	7.35±1.5^{bcde}	29.92±3.63^{bc}
W1G4	8.29±0.99^{a}	8.12±0.93^{a}	1.29±0.59^{i}	8.32±0.81^{a}	22.78±5.25^{ghi}
W1G5	7.35±1.32^{bcd}	6.12±1.41^{de}	2.29±0.59^{abcd}	6.29±1.61^{fgh}	24.39±1.01^{efgh}
W1G6	7.35±1.22^{bcd}	7.18±1.13^{bc}	1.59±0.62^{fghi}	7.41±1.08^{bcd}	25.98±0.79^{defg}
W2G1	6.06±1.09^{f}	6.88±1.05^{bcd}	1.88±0.6d^{efg}	6.53±0.75^{efg}	23.89±0.93fghi
W2G2	6.29±0.69^{ef}	7.12±1.11^{abc}	1.18±0.39^{i}	7.06±0.75^{cdef}	27.08±1.47cdef
W2G3	7.06±1.25^{bcd}	6.88±1.73^{bcd}	1.82±0.73^{efgh}	6.59±0.87^{defg}	20.43±2.48^{ij}

W2G4	7.59±1.00^{abc}	7.12±1.11^{bcd}	2±0.61^{cdef}	6.89±0.78^{ij}	28.20±1.29^{bcd}
W2G5	6.77±1.64^{def}	7.88±0.93^{ab}	1.12±0.49^{i}	8.06±0.93^{ab}	18.42±3.12^{j}
W2G6	7.64±0.87^{ab}	7.35±1.32^{abc}	1.35±0.49^{i}	7.65±0.93^{abc}	21.02±3h^{ij}
W3G1	6.471. ±0.60^{def}	5.47±1.97^{e}	2.71±0.69^{a}	4.94±1.78^{j}	31.41±1.99^{b}
W3G2	6.82±1.01^{cdef}	6.65±1.00^{bcd}	2.47±0.72^{ab}	6.06±1.25^{ghi}	27.02±2.16^{cdef}
W3G3	6.59±0.6^{def}	5.71±1.83^{e}	2.71±0.59^{a}	5.18±1.38^{ij}	27.63±2.16^{cde}
W3G4	7.64±1.27^{ab}	7.94±0.97^{ab}	1.41±0.71^{ghi}	7.65±0.98^{abc}	24.30±0.96^{fgh}
W3G5	7.05±1.64^{bcde}	6.12±1.62^{de}	2.18±0.64^{bcde}	5.94±1.68^{ghi}	40.47±0.37^{a}
W3G6	6.65±0.93^{def}	5.59±1.7^{e}	2.41±0.71^{abc}	5.47±1.55^{hij}	27.87±1.08^{bcde}
F test	**	***	***	***	***
P value	0.004761	5.99e-09	<2e-16	8.76e-11	1.95e-14
CV%	15.89	19.56	32.58	18.60	8.803568
LSD	0.76	0.91	0.42	0.84	3.301657

*Note: Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*
W1=Treatment with cold water, W2=Treatment with 0.5% NaCl, W3=Treatment with water at 45ºC, G1=PRP 35861.18, G2=CIP 384866.5, G3=PRP 226267.11, G4=CIP 388676.1, G5=PRP 858676.1,G6=Desiree, CV=coefficient of variation, LSD=least significant difference

Chips quality parameters

The chips quality parameters of the potato clones under different slice treatments are shown in Table 2. Statistically significant variation was obtained in chips colour, taste and flavour, crispiness, overall acceptability and recovery percent. CIP 388676.1 and its slice treatment with cold water produced better chips colour.CIP 388676.1 was found to have good taste and flavour followed by CIP 384866.5. Statistically, both slices treatment with cold water and 0.5 % salt water were superior for taste and flavour of chips while inferior result for taste and flavor was found with warm water treatment at 45ºC.

Significantly higher crispiness was found in CIP 388676.1 and lower in PRP 35861.18. The slice treatment with 0.5 % salt water produced the highest crispness and the lowest by warm water. In aggregate the better quality chips having superior colour, taste and flavour and crispiness is produced by slices of CIP 388676.1 treated with cold water. Further, significant higher overall acceptability was also observed by the combination of CIP 388676.1 and slice treatment with cold water. Among the clones, Desiree (30.87%) showed the highest recovery percent and among the slice treatments, slice treatment with salt water at 0.5% (27.60%) showed the highest recovery percent. Similarly, for combination of clones and water treatment, slices of PRP 858676.1 treated with warm water at 45ºC (40.47%) gave the highest recovery percent.

Gautam et al. (2016) stated that the chips prepared with different slice treatments influenced the overall acceptability. The slices treated with fresh water were statistically superior and had the highest score of overall acceptability while slices treated with 0.5% NaCl solution for 15 min has the lowest score of overall acceptability which was far below than the acceptable score range which agrees with our result. The interaction of genotypes and slices treatment also influenced the overall acceptability of chips. The slices of genotypes treated with water produced superior chips with higher value of overall acceptability whereas slices of same genotypes treated with 0.5% NaCl produced inferior chips with below acceptable range of overall acceptability. Over concentration of NaCl might result soft and brown coloured slices before frying and exo-osmosis resulted by prolonged dipping of slices might result

unacceptable colour, taste and overall acceptability of chips after frying. Although the slices were dipped in 0.5% NaCl solution just for 5 min in this study, the inferior type of chips were produced with respect to colour, crispiness and overall acceptability. Kapadiyal, Makavana & Kathiria (2018) studied the effect of hot water blanching treatment on quality of dried potato slices. Among the potato slices subjected to blanching in hot water at temperature, i.e., 60, 70, 80, 90 and 100˚C and blanching time, i.e., 2.0, 3.0, 4.0 and 5.0 min., slices treated with 70˚ C for 2.0 min. was found to be best among all the treatment with optimum recovery of potato slice, shrinkage percentage, rehydration ratio, reducing sugar, sucrose and total phenol. Variation in quality of chips with water with different temperature was observed and it is in agreement with findings of Kapadiyal, Makavana & Kathiria (2018).

CONCLUSION

From the study it can be concluded that the processing traits vary with genotype and the different slice treatments in combination with genotypes also affect the quality of potato chips. The highest dry matter percent and specific gravity was found in clone PRP 858676.1. Reducing sugar was the least in CIP 384866.5 followed by CIP 388676.1 and Desiree. However, the superior quality of chips was obtained from CIP 388676.1 followed by Desiree. Slice treatment with cold water produced the best quality chips while slice treatment with 0.5% NaCl solution and warm water at 45ºC produced inferior chips. CIP 388676.1 with slices treated with cold water produced the best quality chips among all combinations. Regarding the recovery percent, the combination of PRP 858676.1 and slice treatment with warm water at 45ºC produced the highest value. Thus, clones CIP 388676.1, Desiree, CIP 384866.5 and PRP 858676.1 should be further evaluated for their chips quality. Slice treatment with cold water is the most effective among these slice treatments and should be recommended for good quality chips making. The effect of pre drying, postharvest treatments and storage method and period on the chips quality of these clones should be studied. Besides, the quality of French fries produced by these promising clones should be evaluated in future.

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REFERENCES

Abbas, G. (2011). *Evaluation and selection of potato genotypes for better yield, storage and processing attributes* (Doctoral Dissertation). Retrieved from http://prr.hec.gov.pk/jspui/bitstream/123456789/870/2/1084S.pdf

Abong, G., Okoth, M., Imungi, J.K., & Kabira, J.N. (2011). Effect of Slice Thickness and Frying Temperature on Color, Texture and Sensory Properties of Crisps made from Four Kenyan Potato Cultivars.*American Journal of Food Technology 6*(9),753-762. DOI: 10.3923/ajft.2011.753.762

Aggarwal, P., Kaur, S., & Vashisht, V. K. (2017). Processing quality traits of different potato (*Solanum tuberosum* L.) genotypes in India. *The Pharma Innovation Journal, 6*(3), 27-30. Retrieved from http://www.thepharmajournal.com/archives/2017/vol6issue3/PartA/4-6-17-850.pdf.

Dhakal, R., Shah, S. K., Shakya, S. M., & Basnet, K. B. (2011). Tuber yield and quality of potato chips as affected by mulch, variety, and potash levels under western Terai, Nepal**.** *Agronomy Journal of Nepal, 2*. 121-132. DOI: http://dx.doi.org/10.3126/ajn.v2i0.7527

Ezekiel, R., Singh, B., & Kumar, D. (2003). A reference chart for potato chip colour for use in India. *Journal of Indian Potato Association, 30*(3-4), 259–265. Retrieved from https://www.researchgate.net/publication/321348534

Feltran, J. C., Lemos, L. B., & Vieites, R. L. (2004). Technological quality and utilization of potato tubers. *Science of Agricutural, 61*, 598-603.

Gautam, I.P., Sharma, M.D., & Khatri, B.B. (2016). Yield, storability and processing quality of potato. LAMBERT Academic Publishing.

Kapadiya1, D. C., Makavana, J. M., & Kathiria, M. K. (2018).Effect of Hot Water Blanching Treatment on Quality of Dried Potato Slices. *International Journal of Current Microbiology and Applied Sciences*, ISSN: 2319-7706,7, 07.DOI: 10.20546/ijcmas.2018.707.322

Kaur S., Sandhu, K. S., & Aggarwal, P. (2012). Chlorpropham affects processing quality of potato during storage. *International Journal of Vegetatable Science,* 18,323-345.

Kaur, S.,& Aggarwal, P. (2014). Chipping and nutritional quality of potato cultivars grown in north Indian plains. *Hort Flora Research Spectrum*, 3 (3), 218-224.

Khurana, S. M. P. (2006). Indian potato exports: An overview. *Journal of Indian Potato Association, 33* (1-2), 1-10.

Kumar, D., Singh B. P., & Khurana, S. M. P. (2006). Processing quality of potato hybrid HT/92-621during storage at intermediate temperatures along with sprout suppressant treatment. *Potato Journal, 33*(1-2), 90-93.

Marwaha R. S., Kumar, D., Singh, S. V., & Pandey, S. K. (2008). Nutritional and qualitative changes in potatoes during storage and processing. *Processing Food Industries,11*(3), 22-30.

Miller, G. L. (1959). Use of dinitrosalicyclic acid reagent for determination of reducing sugars. *Analytical Chemistry, 31*(3), 426. DOI: 10.1021/ac60147a030

MoAC. (2011). Ministry of Agriculture and Cooperatives. Agri-Business Promotion and Statistics Division, Singha Durbar, Kathmandu, Nepal.

NPRP. (2016/17). Annual Report. National Potato Research Program, Khumaltar, Lalitpur, Nepal. NPSN, 00581-394/2017/18

Roy, M., & Mukhopadhvav, S. K. (2010). Studies on productivity and quality of tuber for processing of potato in alluvial zone of West Bengal. *Journal of Crop and Weed,6*(2), 15-18. Retrieved from https://www.cabdirect.org/cabdirect/abstract/20113063826