Effect of Chemical Treatments and Storage on Quality of Potato Chips

Ishwori P. Gautam[1], Moha D. Sharma[2], Bhim B. Khatri[1], Resham B. Thapa[2] and Kanti Shrestha[3]

ABSTRACT

Experiments were conducted at National Potato Research Programme (NPRP), Khumaltar (1350 m asl) during the year of 2011 to study the effect of slices treatments with different chemicals before the preparation of chips and effect of different storage methods and days for preparation of chips. Potato cultivars Kufri Chipsona-2 and PRP 25861.1 were used for experimentation to assess the effect of chemicals on chips and chips qualities before storage. Same cultivars were used for different conditions and durations of storage to assess chips quality. Undamaged and apparently healthy tubers of more than 60 gram weight were stored in ordinary room temperature under dark (26.9 ±1.16 o C) and cold store conditions at Balaju for 90 days. Temperature and relative humidity of ordinary storage room was recorded daily during the storage period. Observation was recorded on chips quality parameters like dry matter percentage, specific gravity and reducing sugars and freshly prepared chips qualities (colour, crispness, taste and over all acceptability). The results indicated that slices washed and dipped for 15 minutes in fresh water was found as effective as slice treatment with potassium meta bisulphate (slices dipped for 15 minutes in 0.25%) for preparation of fresh chips before storage. On the other hand, cold stored potatoes for 30 days and on-wards were not suitable for preparation of chips due to the browning of chips as a result of higher reducing sugars. Chips prepared from 75 and 90 days stored potatoes under dark at ambient temperature of genotype respectively Kufri Chipsona-2 and PRP 25861.1 had acceptable chips colour and qualities.

Key words: Genotypes, effect of storage on chips quality, potato, slice treatment

INTRODUCTION

The area, production and productivity of potato have been increasing steadily over the last two decades in Nepal. Now it produces 25, 17,693t of potatoes from about 18,53,42ha of land with an average productivity of 13.58 t/ha (ABPSD, 2010). The increasing trend of potato production cannot be sustained without adequate processing supports. Potatoes can be processed for varieties of products viz: potato chips, French-fry, potato flakes, potato flour and frozen potato etc. Among them, potato chips are most important and gaining popularity among Nepalese consumers also, which is mainly due to the changing food habits of the people and urbanization. This is likely to increase further more in the future. The high demand of potato chips was presently fulfilled by exporting large quantity of chips especially from India. It is estimated that the share of potato chips is about 48% from Indian product, 32% from Chaudhary group and remaining 20% from local cottage industries (ABPSD, 2011). The imported quantity and value of potato chips was about 885.38 tons and NRs 336.5 million during the year 2010/11 (ABPSD, 2011). Commercial production of chips was first started in Nepal by Chaudhary Group, CG foods (Pvt.) Ltd., Nawalparashi in 2003 by using sophisticated plant (Sah, 2010). Besides this, large numbers of cottage industries for preparation of

[1] Sen. Scientists, Nat. Pot. Res. Prog. (NPRP), Khumaltar, Lalitpur. Email: ishworigautam@gmail.com
[2] Prof. Institute of agriculture and Animal Science (IAAS), Rampur , Chitwan
[3] Sen. Scientific Officer. National Academy of Science and Technology(NAST), Khumaltar, Nepal.

chips in different part of country are established. This clearly indicated that there is a great scope of potato chip industries in Nepal.

For chips preparation, potato should have high dry matter (DM) and specific gravity (SG) and low reducing sugars. The dry matter content of about 18-20 % and reducing sugar content up to 250mg/100g fresh weight is considered acceptable for chips making (Ezekiel and Shekhawat, 1999). The DM content determines the yield of chips, oil uptake and crispness of fried product where as reducing sugars determine the colour of chip. It is reported that the cold stored potatoes at low temperature turn brown and not suitable for chips due to the reaction of reducing sugars and amino acids while frying at high temperature (Ezekiel *et al.*, 2007; Thapa *et al*., 2004; Gautam and Bhattarai, 2006; Singth *et al.,* 2008). The preliminary results conducted at Khumaltar showed that chips prepared after 90 cold stored potato varieties Kufri Jyoti, Janak Dev, Desiree and Khumal Rato-2 were found unacceptable as a result of dark brown color; which might be due to presence of high reducing sugar (Thapa *et al*., 2004). There are many conflicting results on suitability of potato for processing with respect to methods and duration of storage. Moreover, the potato varieties behave differently for producing acceptable quality chips. Singh *et. al.* (2008) reported that reducing sugars and chips colour varied among varieties, when potatoes were stored for 100 days at 20^{o}C at Modipuram, India. After 210 days storage at 4, 8, 12, 16 and 20^{o}C all tested cultivars produced unacceptable chips colour. Different chemicals like potassium meta bisulphate, calcium chloride and many acids have been recommended for treating the potato slices for improvement of chips colour. However, it is not clear whether these chemical treatments are necessary or not for the preparation of chips from fresh slices; therefore experiments were conducted to find out the effect of slices treatments with different chemicals and storage conditions on the quality of chips before and after the storage at different days, respectively.

MATERIALS AND METHODS

Potato genotypes viz; Kufri Chipsona-2 (recommended variety for chips making in north Indian plains) and PRP 25861.1 (new promising genotype of Nepal) were used to assess the effect of chemical treatments on chips qualities. Storage experiment was conducted under dark conditions at NPRP Khumaltar and cold store at Balaju. Five kg of healthy potato tubers with more than 60g weight were stored from 20 June to 17 September (90 days). First experiment was conducted before storage of potatoes to identify the effect of slice treatment with different chemicals. A total of eight treatments comprised with two genotypes viz; Kufri-Chipsona-2 and PRP 25861.1and four treatment methods viz: farmers' practices (slices washed and dipped 15 minutes in cold water; slices washed and dipped 15 minutes in 0.5% solution of NaCl; slices washed and dipped 15 minutes in 0.25% solution of potassium meta bisulphate and slices washed and dipped 15 minutes in 0.25% of calcium chloride). After this, slices were spread over the paper towel for removing the surface water and fried in palm oil at 180^{o}C till stopping the bubbles.

Second experiment was carried out to assess the chips quality prepared before storage and at 15 days intervals after 30 days storage. Randomly selected 10 potato tubers were peeled and cut into slices of 1.4 mm thickness with a hand operated slicer. Good and undamaged slices were washed with cold water and were spread over the paper towel to remove surface water and then fried immediately in palm oil at 180°C following above mentioned methodologies. Chips qualities were evaluated on the basis of hedonic rating by group of scientists for colour, taste and overall acceptability using

1-9 scale and crispness; 1-3 scale (higher the number better the colour, taste and acceptability). Observations recorded were temperature and relative humidity of storage. Similarly, observations were made on dry matter, specific gravity and reducing sugars and fresh chips qualities at 15 days intervals. Temperature was recorded at half an hour's interval by using temperature data logger (Hobo). Relative humidity was calculated by using wet and dry bulb thermometer daily at 9.30AM. Dry matter content was determined by chopping and mixing of tubers in to 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). Specific gravity was determined by weighing of randomly selected 10 tubers in Kern electric balance (0.1- 6000g) in air and water before and after storage by using following formula:

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

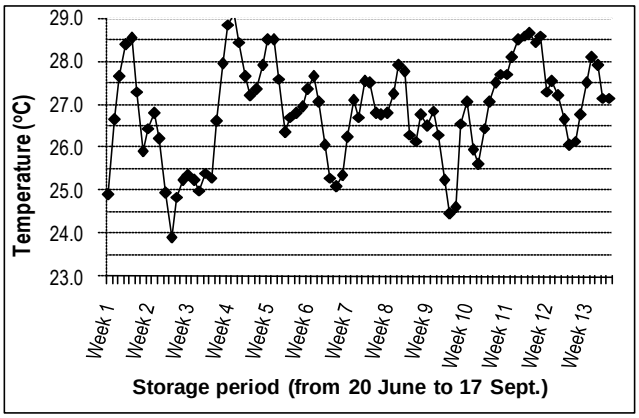

Fig.1: Average temperature of dark storage room during storage period at Khumaltar, 2011

Reducing sugars was determined by using di-nitrosalicyclic colorimetric method (Miller, 1959) by recording the absorbance reading in spectrophotometer at 575 nm. To calculate reducing sugars per 100g fresh weight of potato, a standard curve was plotted with different concentration of glucose (0.00125, 0.0025, 0.05, 0.01, 0.02 and 0.04mg glucose /ml water on X-axis and absorbent reading on Y-axis. The absorbent reading of samples was recorded and calibrated on the basis of standard curve and presented as milligram reducing sugars per 100 gram fresh weight of potato. Data were statistically analyzed using Genstat-3.2, while MSTAT C was used to separate treatment means.

RESULTS AND DISCUSSION

Storage Environment

The average storage dark room temperature ranged from 23.9 to 29.1 ^{o}C with mean 26.9 ± 1.16 ^{o}C during the storage period **(**Fig.1). The relative humidity on storage remained consistently high and ranged from 80 to 88 % with mean 86.53 ±3.21 percentage (Fig.2).

Dry matter, specific gravity and reducing sugars

The dry matter content, specific gravity and reducing sugar content in the tubers increased in all the treatments after storage (Table 1). The variation of increment in reducing sugars was significantly higher in cold stored potatoes.

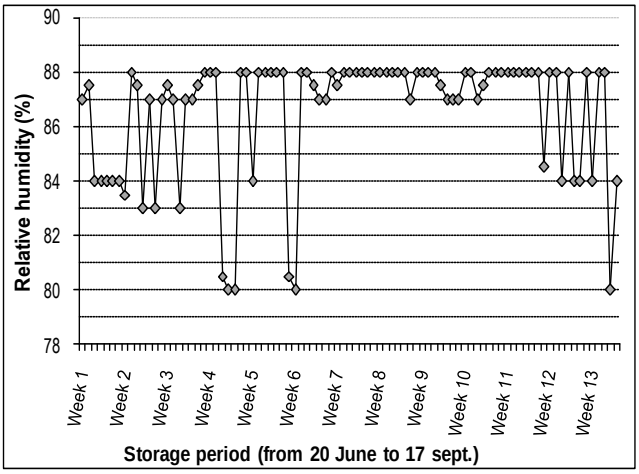

Fig.2: Relative humidity (%) of dark storage room during storage period at Khumaltar,2011

Table 1: Effect of varieties and storage condition on dry matter, specific gravity and reducing sugars content of potato before and after storage (DAS), 2011

Treatments	D A S					
	Before storage	30	45	60	75	90
Dry matter Content (%)						
K.Chipsona-2 Cold Storage	15.4	16.3	15.8	15.02	15.9	17.5
K.Chipsona-2 Dark Storage	16.6	16.9	17.4	17.23	17.1	17.5
PRP 25861.1 Cold storage	17.0	17.8	17.8	17.9	17.2	18.9
PRP 25861.1 Dark storage	18.1	18.8	18.6	18.40	18.6	18.9
Specific gravity (g/cc)						
K.Chipsona-2 Cold Storage	1.051	1.0542	1.0541	1.0568	1.0565	1.0697
K.Chipsona-2 Dark Storage	1.0541	1.0574	1.0611	1.0708	1.0584	1.0697
PRP 25861.1 Cold storage	1.0690	1.0706	1.0710	1.0727	1.0739	1.0723
PRP 25861.1 Dark storage	1.0700	1.0736	1.0726	1.0735	1.0741	1.0723
Reducing sugars (mg/100g fresh weight)						
K.Chipsona-2 Cold Storage	11.66	78.0	285.0	332.0	373.4	373.5
K.Chipsona-2 Dark Storage	11.66	47 .0	31.0	43.7	53.3	43.8
PRP 25861.1 Cold storage	15.33	184.7	311.3	361.3	508.8	591.6
PRP 25861.1 Dark storage	15.33	45.0	38.7	51.0	58.6	53.5

Table 2: Effect of genotype, chemical treatments and their interaction on color, crispness, taste and overall acceptability of chips, 2011

Treatments	Colour (1-9 scale)	Crispness (1-4 scale)	Taste (1-9 scale)	Overall Acceptability (1-9 scale)
A. Varieties				
1. PRP-25861.1	7.03	1.92	7.67	7.381
2. K. Chipsona-2	7.02	2.05	7.52	7.175
F-test	ns	ns	ns	ns
B. Chemicals				
1. No chemicals (Only water)	8.32 *b*	2.12	8.69 *a*	8.93 *a*
2. NaCl (0.5%)	3.11 *d*	1.73	4.96 *c*	3.33 *c*
3. $K_2S_2O_5$ (0.25%)	8.83 *a*	1.98	8.89 *a*	8.85 *a*
4. $CaCl_2$ (0.25 %)	7.84 *c*	2.11	7.83 *b*	8.00 *b*
F-test	***	ns	***	***
LSD	0. 3399	-	0.5222	0. 3404
Interaction (Ax B)				
1. PRP-25861.1 + water	8.26 *bc*	2.12	8.70	8.91 *a*
2. K. Chipsona-2 + water	8.39 *b*	2.12	8.68	8.96 *a*
3. PRP-25861.1 + NaCl	3.39 *d*	1.64	4.73	3.48 *d*
4. K. Chipsona-2 + NaCl	2.82 *e*	1.82	5.19	3.18 *d*
5. PRP-25861.1+ $K_2S_2O_5$	8.64 *ab*	1.86	9.06	8.77 *ab*
6. K. Chipsona-2 + $K_2S_2O_5$	9.00 *a*	2.1	8.72	8.93 *a*
7. PRP-25861.1+ $CaCl_2$	7.84 *c*	2.07	8.18	8.37 *b*
8. K. Chipsona-2 + $CaCl_2$	7.83 *c*	2.14	7.48	7.63 *c*
Mean	7.03	1.985	7.592	7.278
F-test	*	ns	ns	*
LSD	0.4807	-	-	0.4814
CV (%)	7.3	25.1	10.3	7.0

ns = No significantly different and *** highly significant at <0.001 levels.
[+] Same small letters are not significantly different by DMRT at 0.05 levels

The reducing sugars were over limit for chips preparation in both genotypes at 45 days of storage and on-ward. But the increased rate was very high on PRP 25861.1 than Kufri Chipsona-2. It could be due to the higher dry matter content on PRP 25861.1 than K. Chipsona-2, which can be due to close association of starch

conversion to reducing sugar. This result is in the agreement of earlier findings of Ezekiel *et al*. (2007), Singh *et al. (*2008) and Changai *et. al*. (2009). It was reported that acid invertase is main enzyme for sugar accumulation in cold storage stored potatoes because it directly catalyzes the formation of glucose and fructose in starch to sugar path ways (Changai *et al*., 2009).

Chips quality before storage

The chips prepared from fresh potato genotypes did not show any significant differences on chips color, texture, crispness, taste and over all acceptability and had acceptable range of chips in the colour and taste. However, chips prepared after chemical treatments had significant differences on all of these parameters. The interaction between potato genotypes with slice treatment methods differed significantly on the production of light color chips and overall acceptability. The slices of genotype K. Chipsona-2 treated with potassium metabisulphate produced light color chip (scaling 9.0 score) followed by genotype PRP 25861.1 (8.64 score), where as the minimum scores (2.82 score) was recorded on K. Chipsona-2 treated with sodium chloride and then PRP 25861.1 treated with sodium chloride (3.39 score). The trend of over all acceptability was same as colour of chips (Table 2). Potato slices treated with sodium chloride produced soft and brown colored slices before frying and unacceptable colour and overall acceptability of chips after frying. The soft and brown colour of slices due to treatments with sodium chloride might be due to it's over concentration and thereby exo-osmosis.

Chips quality after storage

Chips colour

Chips prepared from dark and cold stored potato tubers showed significant variation on chips color after 30 days of storage and on-wards. The chips prepared from dark stored potatoes showed acceptable chips color up to 75 days storage of both genotypes. At 90 days after storage the colour score was unacceptable on genotype Kufri Chipsona-2 while it was still acceptable up to 90 days storage on genotype PRP 25861.1. However, chips prepared from cold stored potatoes showed unacceptable chips colour after 30 days storage and onward (Fig.3). Similar finding was reported by Singh *et al*., (2008). He reported that cold storage potatoes at 2-4^{o}C were not suitable for chipping, whereas potatoes stored at 16^{o}C and 20^{o} C produced acceptable colour of chips.

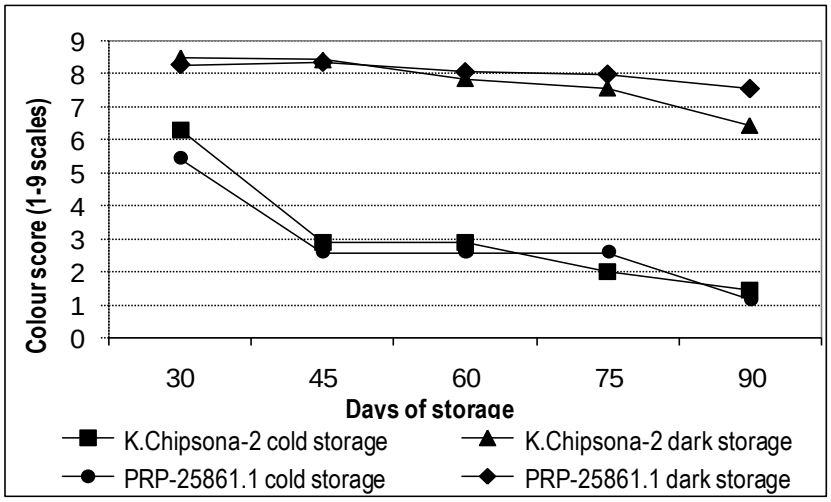

Fig.3: Colour of potato chips prepared from different genotypes stored at different condition and duration in Kathmandu, 2011.

Table 3: Effect of variety and storage conditions and duration on chips-crispness (1-3 scale), 2011

Treatments	DAS					
	Before Storage	30	45	60	75	90
K.Chipsona-2 cold storage	2.12	2.00	1.57	1.07 *c*	1.57 *ab*	1.57
K.Chipsona-2 dark storage	2.12	2.07	2.00	2.00 *ab*	1.89 *a*	2.00
PRP-25861.1 cold storage	2.12	2.14	2.29	1.71 *b*	1.29 *b*	2.00
PRP-25861.1 dark storage	2.12	2.0	2.07	2.07 a	2.00 *a*	2.00
Mean		2.054	2.893	1.714	1.679	21.893
F-test		NS	NS	***	*	NS
LSD		-	0.3561	0.3069	0.4504	-
CV (%)		17.1	20.8	16.2	24.3	20.8

Taste of Chips

The taste of potato chips prepared from 30 days stored potato and on-ward differed significantly among the treatments assessed. Chips prepared from dark stored potato of both genotypes had acceptable chips taste up to 90 days of storage despite the decreasing order of taste as days advanced. However, chips prepared from cold stored potatoes after 30 days and onward had no acceptable taste on PRP 25861.1 and 45 days and onward on K. Chipsona-2. The detail scores of chips taste prepared from stored potato in different conditions and duration is presented in Table 4.

Table 4: Effect of varieties and storage conditions and duration on chips-taste (1-9 scale), 2011

Treatments	DAS					
	Before Storage	30	45	60	75	90
K.Chipsona-2 cold storage	8.70	7.56 *bc*	2.71 *b*	2.29 *b*	2.71 *c*	2.57 *b*
K.Chipsona-2 dark storage	8.70	8.26 *ab*	7.93 *a*	7.71 *a*	7.43 *b*	7.00 *a*
PRP-25861.1 cold storage	8.78	6.86 *c*	3.50 *b*	3.00 *b*	3.29 *c*	2.14 *b*
PRP-25861.1 dark storage	8.78	8.57 *a*	8.57 *a*	8.43 *a*	8.14 *a*	7.57 *a*
Mean		7.56	5.670	5.36	5.39	4.52
F-test		***	***	***	***	***
LSD		0.808	0.794	1.009	0.691	0.722
CV (%)		9.7	12.7	17.1	11.6	13.6

Overall acceptability

The colour and overall acceptability are most important parameters for acceptance of chips. Like as in colour, the treatments differed significantly on overall acceptability of chips prepared from 30 days and onward storage stored potatoes. Chips prepared from dark stored potato of both genotypes had acceptability up to 75 days storage with score of 8.29 and 7.50 scale respectively on chips prepared from PRP 25861.1 and K. Chipsona-2. Chips prepared from 90 days dark stored potato had

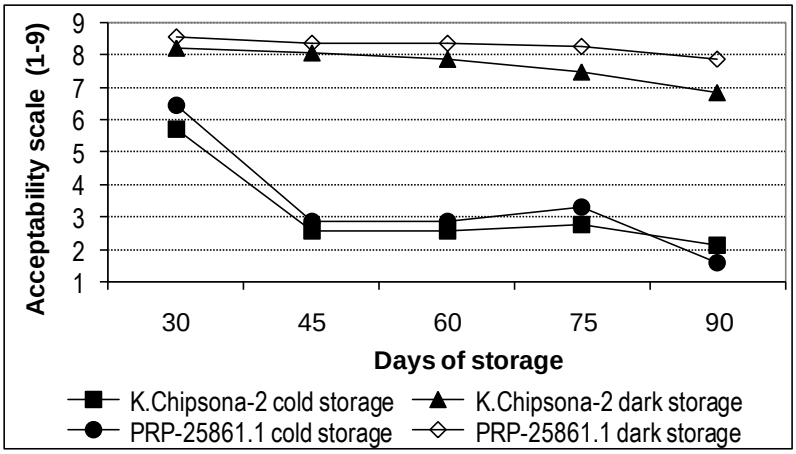

Fig.4: Overall acceptability of potato chips prepared from different t genotyp stored at different condition and duration in Kathmandu, 2011

acceptable scores (7.86 scale) on the PRP 25861.1but not acceptable scores (6.86 scale) on K.Chipsona-2. The detail is presented in fig.4.

CONCLUSIONS

Results showed that treatments of potato slices with chemicals for preparation of fresh chips from fresh potato is not necessary, if slices are washed and dipped for 15 minutes in fresh water before drying of outer surface of slices. Chips prepared at 75 and 90 days after storage potatoes under dark at ambient temperature of genotypes respectively Kufri Chiposona-2 and PRP 25861.1 were in accepted scale for commercial production. However, both genotypes were not suitable for preparation of chips after 30 days cold storage and thereafter due to dark brown chips colour as increased level of reducing sugars.

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