www.hortflorajournal.com
HortFlora Research Spectrum, 3(4): 315-322 (December 2014) ISSN : 2250-2823

DEVELOPMENT OF READY-TO-FRY FROZEN POTATO SNACK AND ITS QUALITY EVALUATION DURING STORAGE

Sukhpreet Kaur* and Poonam Aggarwal

*Department of Food Science and Technology, Punjab Agricultural University, Ludhiana-141 004, Punjab, *E mail: sukhpreetnagra1@gmail.com*

ABSTRACT : A simple technique for the preparation of ready-to-eat frozen potato snack was developed which do not require any costly machinery. Snacks were prepared using standardized formulation with 100 g mashed potato and 30 g boiled mashed peas. The prepared snacks were par-fried, packed in LDPE and stored under frozen (-20±2°C) storage for three months to study the shelf life and quality attributes of the product. All the nutritional parameters remained unaffected during storage upto three months within the cultivars studied Snacks prepared from 'K.Pukhraj' showed the highest total antioxidant activity. Snacks prepared from 'K.Chipsona-1' had lower oil uptake than from 'K.Pukhraj'. Rancidity parameters in terms of free fatty acids and peroxide value remained unaffected during the entire frozen storage period. The developed product from all the three cultivars were found to be highly acceptable for up to 3 months of storage without any change in sensory quality

Keywords: *Potato, frozen storage, deep fat frying, total phenolics, antioxidants.*

The demand for ready to eat convenient food items is increasing continuously in the present day liberalized economy mainly due to improved living standards, urbanization growth, preference of new generation for fast foods, rise in per capita income and increase in the number of working women preferring ready cooked food (Bhat and Pathak, 5). Snack foods have emerged as one of the main entries in the food market that can be adapted to consumer needs. However, maintenance of quality of this product is of key importance to the continued development of this sector. Quality and safety of frozen snack foods are the aspects affecting the overall consumer acceptability in terms of flavour, aroma, colour and appearance besides nutritional quality (Torres and Canet, 32). Generally frozen ready-to-eat snack food is consumed with no or little further processing except reheating. These frozen vegetable snacks can directly be fried in oil without thawing after frozen storage (Creed, 7).

Formulations of various non-vegetable kebabs are reported in literature (Bhat and Pathak, 5, Pandey *et al;* 20; Zeb and Ali, 33). However, there is no report available for the preparation of ready to fry frozen vegetable kebabs.

Potato is a nutritious vegetable containing significant amount of carbohydrates, superior quality protein, dietary fibre and some minerals. Potato also contains biologically active components including phenolic acids and ascorbic acid which are commonly described as antioxidants (Gumul *et al.,*10). Increased potato production has led to several post-harvest problems especially their storage (Marwaha and Sandhu, 19). Potato is a highly versatile and inexpensive raw material that can be incorporated either in fresh or dried form in various value added products such as bakery products and fabricated snacks (Singh *et al.,* 27). There is a need to find more diversified uses of potato and to develop new processed products in order to maximize its utilization and to cater the fast changing taste of the new generation as well as different sections of the society (Marwaha and Sandhu, 19). Keeping the above factors in view, a simple technique for the preparation of ready-to-fry frozen potato snack with vegetable stuffing was developed which does not require any costly machinery. The prepared snack was evaluated for storage stability in terms of rancidity parameters such as free fatty acids and peroxide value and phytochemical parameters such as total phenolic content and total antioxidant activity. Changes in organoleptic characteristics was also examined during storage.

MATERIALS AND METHODS

Three potato cultivars including two processing varieties Kufri Chipsona-1 and Kufri Chandramukhi, and one commonly cultivated variety 'Kufri Pukhraj' having low dry matter content and high reducing sugars were evaluated for the preparation of frozen potato snack. Healthy, fully cured tubers of the above cultivars were procured from Department of Vegetable Crops of the University. The tubers were washed under

Received : 04-09-2014 ***Accepted : 02-10-2014***

running tap water, surface dried and used for analysis of fresh tubers and preparation of frozen snack.

Preparation of raw material

Potatoes: Fresh potato tubers of all the three cultivars were peeled and cut into thick slices (10 mm) using a rotary hand slicer. The slices were cooked in a pressure cooker for 10-15 minutes. The boiled potato slices were cooled and mashed.

Peas : Fresh peas were depodded and blanched in hot water at 90±2°C for 3 minutes to inactivate polyphenol oxidase enzyme and to soften and enhance green color of the peas. Immediately after cooking, the peas were cooled under running tap water. The cooled peas were grinded in an electric grinder. The mashed material was then sauted in soybean oil in 1:10 ratio (w/v) to remove maximum moisture. The sauted cooled mashed peas were then used for product preparation.

Preparation of frozen potato snack

Formulation : Various proportions of raw ingredients were tried for the preparation of frozen potato snack. Proportion of ingredients which was liked best sensorily was selected for the development of final product. Based on the preliminary trials, following recipe (Table 1) was selected for the preparation of final product.

Table 1: Standardized recipe for frozen potato snacks of formulation of product.

Ingredients	Quantity (g)
Fresh potato mash	100
Boiled mashed peas	30
Ginger paste	3
Garlic paste	3
Cumin	0.8
Green chilli powder	1.5
Garam masala	0.4
Salt	1.2
Corn flour	3.0

Processing methods

Frozen potato vegetable snack was prepared using the standardized formulation (Table 1). Freshly boiled potato mash was blended with mashed peas, ginger, garlic and various spices and kneaded into a soft dough. Balls of 25 g from the prepared dough were made and flattened with hand. To get crispy texture in the final fried snack, balls were given an outer coating of bread crumbs. The prepared snacks were par-fried in a laboratory scale deep fat fryer maintained at 175±5°C for 40 sec. After frying, the snacks were drained and gently wiped with adsorbent paper to remove surface oil. After cooling the snacks were packed and sealed in polythene pouches of 200 gauge. Various steps in the preparation of vegetable snack are outlined in Fig. 1. The pre-cooled snacks were stored in

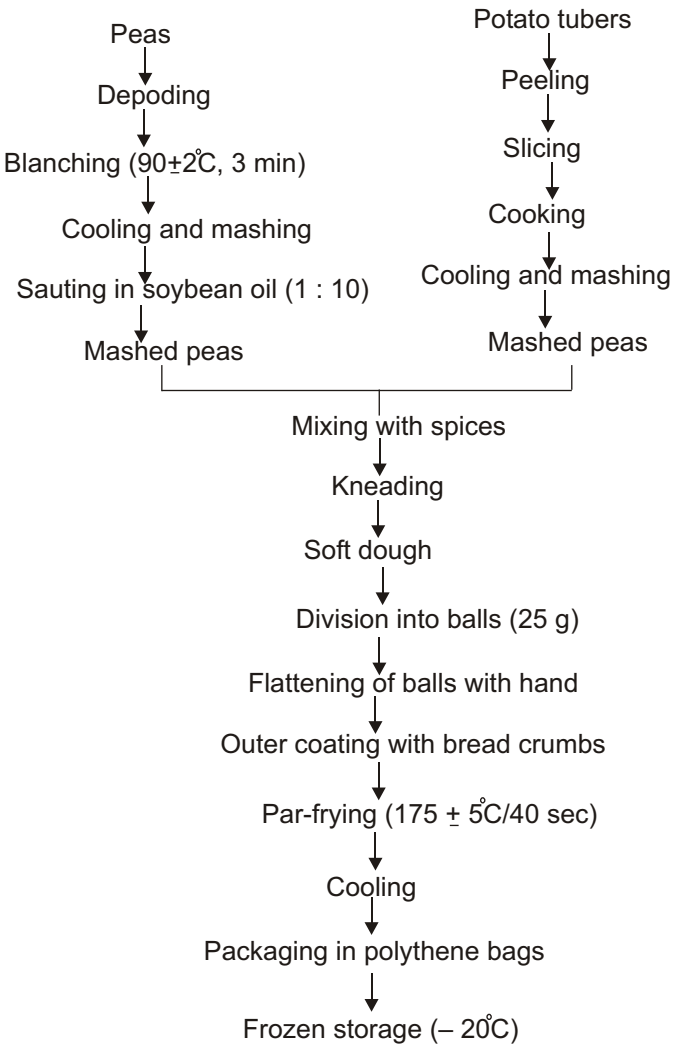

Fig. 1 : Flow chart for the preparation of frozen potato vegetable snack.

a deep freezer at -20°C until final frying.

Frying of snacks

Snacks were deep fat fried from the frozen state immediately after freezing and at an interval of 1 month up to the end of storage period.

Quality Analysis of Raw Material and Prepared Products

Proximate composition : The raw materials and prepared snacks were analyzed for proximate

components, *viz*; moisture, protein, fat, ash by using standard methods (AOAC, 2). All the analyses were carried out in triplicate.

Storage studies : Bioactive components including total phenolic content and total antioxidant activity and rancidity parameters including free fatty acids and peroxide value of the snack during storage at -20°C were analyzed.

Total phenolic content : Total phenols were estimated by the Folin-Ciocalteu's colorimetric method (Singleton and Rossi, 26). Total antioxidant activity of the raw tubers was estimated by DPPH (1, 1- diphenyl-2-picrylhydrazyl) as described by Shimada *et al.* (25) with some modifications. Methanolic extract of 5g sample was taken for antioxidant activity and calculated according to the following formula. BHT was taken as a standard at a fixed concentration of 5 mg/ml.

$$\text{Radical scavenging activity (\%)} = \frac{\text{Absorbance of control (0 minute)} - \text{Absorbance of sample (30 minute)}}{\text{Absorbance of control (0 minute)}} \times 100$$

During storage, the quality of prepared product was monitored by studying the changes in free fatty acids and peroxide value as per AOAC (2).

Sensory evaluation : The sensory evaluation of the product was carried for attributes namely appearance, flavor, texture and the overall acceptability by a panel of semi-trained members composed of scientists and research scholars of department based on a 9-point Hedonic scale, wherein 9 denoted "extremely liked" and 1 donated "disliked extremely" (Larmond, 17). Coded samples for sensory evaluation were prepared and served warm to panelists. Water was provided for oral rinsing between the samples.

Statistical analysis : All the measurements in this study were made in three replications. Statistical analysis was performed by analysis of variance (ANOVA) to calculate critical difference of the data to statistically predict the significance. Significance was established at $p < 0.05$ level.

RESULTS AND DISCUSSION

Proximate composition of raw materials :

Comparison of physicochemical parameters (Table 2) indicated varietal difference in moisture contents among different potato cultivars. 'Kufri Pukhraj' had a higher (84.69%) percentage of moisture content which is indicative of its lower dry matter content compared to 'Kufri Chipsona-1' and 'Kufri Chandramukhi' which contained a lower percentage of moisture. Protein and ash content was in the range of 3.90-5.42% and 0.98-2.18%, respectively and showed significant ($p < 0.05$) differences between the cultivars (Table 2). These differences might be related to the genetic variation and botanical origin among the different cultivars (Singh *et al.,* 28). Data for protein and ash content is in line with those reported by Sandhu and Parhawk (24) and Abbas et al. (1) for different potato cultivars.

Spice mix used in the preparation of frozen snack contained 3.10 per cent moisture, 0.10 per cent protein and 3.81 per cent ash, respectively (Table 2). Other ingredients used such as fresh peas, ginger and garlic had 75.42-80.12% moisture, 0.11-0.14% protein and 0.81-0.90% ash, respectively (Table 2).

Potatoes are considered significant source of antioxidants including total phenolics (Ezekiel *et al.,* 9). In the present study, total phenolics among different cultivars were found to be significantly ($p < 0.05$) higher in 'Kufri Pukhraj' (64.30 mg GAE/100g), followed by Kufri Chandramukhi (53.80 mg GAE/100g) and Kufri Chipsona-1 (40.20 mg GAE/100g) (Table 2). Findings with slight variations were reported earlier by Singh *et al* (28). Significant difference among cultivars may be attributed to genotypes and harvest location which influence the accumulation of phenolic compounds by synthesizing different quantities and/or types of phenolics (Hesam *et al.,* 11).

Antioxidant activity as measured by DPPH radical scavenging method was found to be in the range of 38.10-63.50% among various cultivars (Table 2). Maximum activity was observed in cultivar 'Kufri Pukhraj' (63.50%) and minimum in Kufri Chipsona-1 (38.10%). The high antioxidant activity in 'Kufri Pukhraj' might be due to presence of higher total phenolics in the cultivar. The relationship between the total phenolic content and antioxidant acidity of raw potato tubers is well established (Kaur and Kapoor, 14; Reyes *et al.,* 22, Ah-Hen *et al.,* 3).

Spice mix used in the preparation of frozen snack contained high levels of total phenolics (644.8 mg GAE/100g) and total antioxidant activity (85.43%) (Table 2). The present findings are in line with those reported by Shah *et al.* (23). Fresh peas, ginger and garlic had 37.80, 221.3 and 145.10 mg GAE/100g total phenolics and 57.0, 71.80 and 62.10 per cent total antioxidant activity (Table 2). Kaur and Kapoor (14) also reported similar observations during evaluation of antioxidant activity and total phenolic content of some Asian vegetables. The authors established a positive correlation between total phenolic content and antioxidant activity of vegetables.

Table 2 : Proximate composition of raw materials.

Raw material	Moisture (%)	Protein (%)	Ash (%)	Total phenolic content (mg GAE/100g)	Antioxidant activity (%)
Kufri Chipsona-1' tubers	75.69±0.90	5.42±0.25	0.98±0.29	40.20±0.29	38.10±0.25
Kufri Chandramukhi tubers	75.70±0.80	4.50±0.28	2.18±0.05	53.80±0.38	53.20±0.50
Kufri Pukhraj tubers	84.69±0.50	3.90±0.24	1.93±0.11	64.30±0.20	63.50±0.30
Peas	80.12±0.42	0.14±0.10	0.88±0.10	37.80±0.33	57.0±0.50
Ginger	80.14±0.40	0.12±0.10	0.81±0.12	221.3±1.40	71.80±0.61
Garlic	75.42±0.31	0.11±0.09	0.90±0.12	145.10±1.20	62.10±0.35
Spice mix	3.10±0.11	0.10±0.01	3.81±0.28	644.8±1.20	85.43±0.55
CD (P = 0.05)	0.87	0.25	0.17	0.28	0.78

Values are mean ±SD, n = 3

Table 3: Proximate composition of prepared frozen snacks from different cultivars

Cultivar	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Kufri Chipsona-1	53.89±0.39	4.80±0.20	6.10±0.10	2.89±0.08
Kufri Chandramukhi	53.80±0.31	4.82±0.18	6.53±0.12	2.80±0.10
Kufri Pukhraj	53.85±0.25	4.46±0.11	8.18±0.14	2.93±0.11
CD (P=0.05)	NS	NS	0.19	NS

Values are mean ±SD, n = 3; NS – Non Significant

Table 4: Organoleptic quality of fresh and stored frozen potato snack.

Cultivar	Storage (months)	Appearance	Flavour	Texture	Overall acceptability
Kufri Chipsona-1	0	8.66±0.03	8.30±0.04	8.35±0.02	8.44±0.04
	1	8.60±0.05	8.28±0.01	8.32±0.01	8.40±0.03
	2	8.68±0.06	8.30±0.02	8.31±0.02	8.43±0.03
	3	8.65±0.02	8.31±0.03	8.31±0.04	8.42±0.01
Kufri Chandramukhi	0	8.60±0.05	8.31±0.03	8.30±0.01	8.40±0.02
	1	8.61±0.03	8.29±0.06	8.33±0.02	8.41±0.08
	2	8.59±0.04	8.28±0.02	8.28±0.03	8.38±0.01
	3	8.58±0.04	8.28±0.04	8.28±0.03	8.38±0.02
Kufri Pukhraj	0	8.63±0.01	8.35±0.01	8.33±0.04	8.44±0.04
	1	8.60±0.05	8.31±0.02	8.31±0.08	8.40±0.03
	2	8.61±0.05	8.34±0.01	8.30±0.07	8.41±0.01
	3	8.60±0.04	8.30±0.01	8.29±0.07	8.40±0.01
CD (P=0.05)					
Cultivar (C)		0.02	0.02	0.02	0.02
Storage period (S)		NS	NS	NS	NS
C x S		NS	NS	NS	NS

Proximate composition of the prepared frozen snack

The moisture content variation in snack samples prepared from different potato cultivars was not significant ($p < 0.05$) (Table 3). Slight differences were observed in the protein and ash content of prepared snacks which ranged 4.46-4.82 and 2.80-2.89 per cent, respectively. These differences might be due to their compositional differences. Fat content of snack samples varied between 6.10-8.18% (Table 3). The fat content of prepared snacks was found to be positively correlated with the dry matter of tubers. Cultivars, which had higher tuber dry matter content, produced snacks with low oil uptake in comparison to cultivars with low tuber dry matter content (Fig. 2). Among the cultivars studied, 'Kufri Pukhraj' with lowest tuber dry

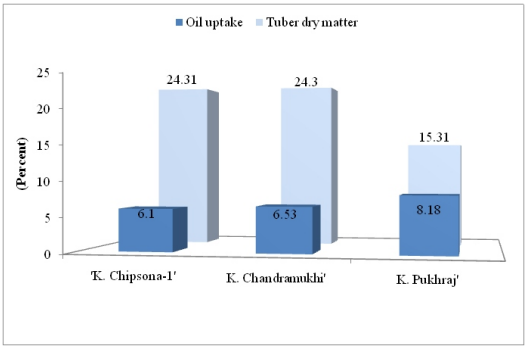

Fig. 2 : Tuber dry matter content and oil uptake of frozen potato snack prepared from different cultivars.

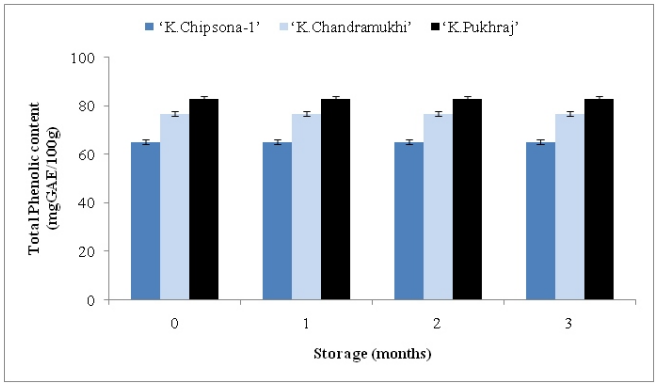

Fig. 3A : Effect of storage on total phenolic content of frozen potato snack prepared from different cultivars. Values are means ± SD, n=3. Error bars represents SD of the means.

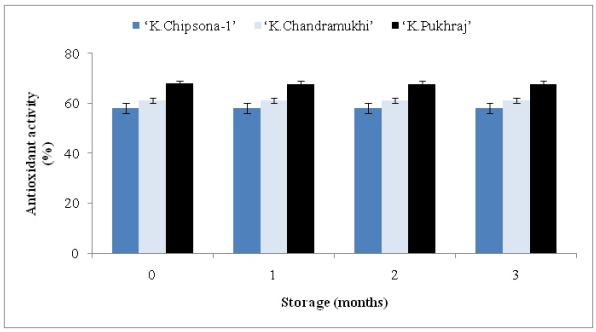

Fig. 3B : Effect of storage on total antioxidant acticvity of frozen potato snack prepared from different cultivars. Values are mean ± SD. m = 3. Error bars represents SD of the means.

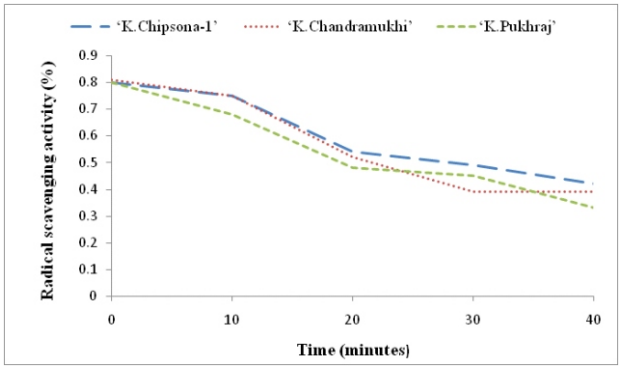

Fig. 3C : Radical scavenging activities of frozen potato snacks prepared from different cultivars.

matter content (15.31%) displayed maximum uptake of oil in the developed product while 'Kufri Chipsona-1' with highest dry matter content (24.31%) produced snacks with minimum oil uptake. A positive correlation of tuber dry matter with oil uptake is also reported earlier (Marwaha and Sandhu, 19; Kaur *et al.,* 15; Kaur *et al.,* 16).

Storage studies

Bioactive (phytochemical) composition : Phenolic compounds are secondary plant metabolites present in fruits and vegetables. Phenolic acids and flavonoids are the two major classes of phenolic compounds which are known to possess antioxidant activity. In the present study, total phenolic content in the fresh frozen potato snack ranged 65.20-82.83% (Fig. 3A). Between the cultivars studied, 'Kufri Pukhraj' snack had the highest phenolic content (82.83 mg GAE/100g), followed by 'Kufri Chandramukhi' (76.84 mg GAE/100g) and 'Kufri Chipsona-1' (65.20 mg GAE/100g). This might be due to higher level of total phenolics in the raw tubers of cultivar 'Kufri Pukhraj' which might have contributed to the overall total phenolic content in the prepared product.

As explained by Bof *et al,* (6), bioactive compounds including phenolics are susceptible to oxidation reactions during the processing and storage of food because some of these compounds are unstable under thermal processing and cold storage (Ibrahim *et al*., 12). In the present study, storage temperature of -20°C did not affect the total phenolic content of the snacks significantly, indicating that the temperature of -20°C had a protective effect on total phenolic content.

Total antioxidant activities of fresh and stored frozen snack as determined by DPPH radical scavenging method is presented in Fig. 3B. DPPH radical has an intense violet color but turns colorless as unpaired electrons are sequestered by antioxidants (Suna *et al.,* 31). Radical scavenging activities of methanolic extracts of fresh frozen snack samples was in the range of 58.14-67.89% (Fig. 3B) with maximum antioxidant activity in snack prepared from 'Kufri Pukhraj' (67.89%), followed by 'Kufri Chandramukhi' (61.18%) and minimum in 'Kufri Chipsona-1' snack (58.14%). It can be observed from Fig. 3C that radical scavenging activity in fresh frozen kebab samples decreased continuously with increase in retention time

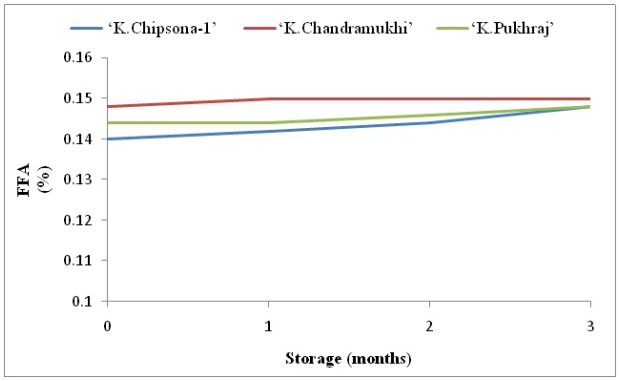

Fig. 4A : Effect of storage on FFA of frozen potato snack prepared from different cultivars. Values are mean ± SD, n = 3.

and maximum activity was shown at 30 minutes and became stable thereafter. The higher antioxidant activity in snack prepared from 'Kufri Pukhraj' might be due to higher total phenolic content in the raw tubers of 'Kufri Pukhraj' which might have contributed towards it high antioxidant activity. These results are in agreement with previous reports (Reyes *et al.,* 22) which suggested that phenolic compounds were the major contributor to total antioxidant capacity in potato.

Many research groups have documented the influence of different processing methods and storage conditions on retention of these phytochemicals in fresh fruits and vegetables (Srzednicki and Craske, 30; Patthamakanokporn *et al.,* 21). But very limited studies

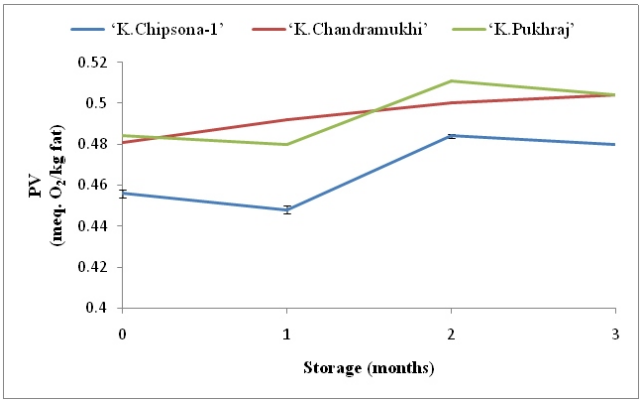

Fig. 4B : Effect of storage on PV of frozen potato snack prepared from different cultivars. Values are mean ± SD,

are available on the effect of storage on these bioactive components in frozen snack foods. In the present study, slight but non significant ($p < 0.05$) change in antioxidant activity was observed in the frozen potato snack during storage at -20°C for 3 months.

Changes in free fatty acids (FFA) and peroxide value (PV)

FFA are the products of enzymatic or microbial degradation of lipids (Kashyap *et al.,* 13). Determination of FFA gives information about stability of fat during storage. Fig. 4A and 4B represents the change in FFA and PV of the prepared snacks during the frozen storage. There was no significant ($p < 0.05$) varietal difference in the levels of FFA in fresh frozen snacks. The mean FFA content and PV of snack samples increased at the end of 3 months of frozen storage but the increase was found to be non-significant ($p < 0.05$) (Fig. 4A; 4B). The change in FFA content and PV during the entire frozen period from the initial values was very less i.e. 2.7 and 4.8%, respectively, which might be due to low temperature (-20°C) of the storage at which rate of chemical reactions ceases down.

Maity *et al.* (18) observed a restricted rise in FFA content and PV of frozen vegetable snack with the progression of storage period. On contrary, Berry (4) and Kashyap *et al.* (13) reported a significant increase in FFA content in ground beef and chicken patties, respectively after a frozen storage of 18 months.

Organoleptic evaluation : Table 4 represents the effect of storage on organoleptic attributes of frozen potato vegetable snack. The scores for appearance, flavor, texture and overall acceptability were found to be almost the same, indicating a non-significant ($p < 0.05$) effect of storage on sensory quality of prepared snack, regardless of the cultivars. Smith *et al.* (29). reported appearance and sensory scores unaffected on storage at -18°C up to 12 months in case of beef patties. Devalakshmi *et al.* (8) studied the sensory quality of chicken meat chips stored under refrigerated (7±1°C) temperature and the authors found the sensory scores within the acceptable limits upto 2 months of storage.

In the present study, the developed products retained the desirable brown color, flavor and crispy texture during storage for up to 3 months at -20°C.

CONCLUSION

A simple process for preparation of frozen potato snack was standardized. Total phenolic content and antioxidant properties in the prepared snack did not change significantly for a period of 3 months of frozen storage. The developed snack maintained the sensory attributes throughout the storage period. These products could be successfully prepared from underutilized low dry matter and high sugar verities which are considered unfit for processing. Moreover,

the developed ready-to-fry frozen vegetable snack can provide convenience to the consumers by restricting the kitchen drudgery and time involved in the preparation of the snack.

REFERENCES

1. Abbas, G., Farooq, I.A., Hafiz, A., Hussain, A., Abbasi, N.A. and Shabbir, G. (2011). Assessment of processing and nutritional quality of potato genotypes in Pakistan. *Pak. J. Agric. Sci.,* **48**(3): 169-175.
2. AOAC (2005). *Official Methods of Analysis* (18th ed) Association of Official Analytical Chemists, Gaithersburg, Md.
3. Ah-Hen, K., Fuenzalida, C., Hess, S., Contreras, A., Vega-Galvez, A. and Lemus-Mondaca, R. (2012). Antioxidant capacity and total phenolic compounds of twelve selected potato landrace clones grown in Southern Chile. *Chilean J. Agric. Res.,* **72** (1)**:** 3-9.
4. Berry, B.W. (1990). Changes in quality of all-beef and soy-extended patties as influenced by freezing rate, frozen storage temperature and storage time. *J. Food Sci.,* **55**(4): 893-897.
5. Bhat, Z.F. and Pathak, V. (2011). Effect of black bean (*Vigna mungo*) on the quality characteristics of oven-roasted chicken seekh kebabs. *J. Stored Prod. Postharvest Res.,* **2**(1): 15-23.
6. Bof, C.M.J., Fontana, R.C., Piemolini Barreto, L.T. and Sandri, I.G. (2012). Effect of freezing and processing technologies on the antioxidant capacity of fruit pulp and jelly. *Braz. Arch. Biol. Technol.,* **55**(1): 107-114.
7. Creed, P.G. (2006). Quality and safety to frozen ready meals. In: Sun D.W. (ed) *Hand Book of Food Processing and Packaging*. pp 23-25, Taylor and Francis New York.
8. Devalakshmi, N., Reddy, K.P. and Mallika, E.N. (2010). Physico-chemical, sensory and microbial quality of chicken meat chips. *Vet. World,* **3**(4): 182-184.
9. Ezekiel, R., Singh, N., Sharma, S. and Kaur, A. (2013). Beneficial phytochemicals in potato – a review. *Food Res. Int.,* **50**: 487-496.
10. Gumul, D., Ziobro, R., Noga, M. and Sabat, R. (2011). Characterization of five potato cultivars according to their nutritional and pro-health components. *Acta. Sci. Technol. Aliment.,* **10**(1): 73-81.
11. Hesam, F., Balali, G.R. and Tehrani, R.T. (2011). Evaluation of antioxidant activity of three common potato (*Solanum tuberosum*) cultivars in Iran. *Adv. J. Phytomedicine*, **2**(2): 79-85.
12. Ibrahim, G.E., Hassan, I.M., Abd-Elrashid, A.M., El-Massry, K.F., Eh-Ghorab, A.H., Ramadan Manal, M. and Osman, F. (2001). Effect of clouding agents on the quality of apple juice during storage. *Food Hydroc,.***25**(1): 91-107.
13. Kashyap, A., Thind, S.S. and Kaur, A. (2012). Development of chicken meat patties incorporating natural antioxidants. *Int. J. Food Sci. Technol.,* **2**(2): 27-40.
14. Kaur, C. and Kapoor, H.C. (2002). Antioxidant activity and total phenolic content of some Asian vegetables. *Int. J. Food Sci. Technol.,* **37**: 153-161.
15. Kaur, A., Singh, N. and Ezekiel, R. (2009). Quality parameters of potato chips from different potato cultivars: Effect of prior storage and frying temperature. *Int. J. Food Prop.,* **11**: 791-803.
16. Kaur, S., Sandhu, K.S. and Aggarwal, P. (2012). Chlorpropham affects processing quality of potato during storage. *Int. J. Veg. Sci.,* **18**: 328-345.
17. Larmond, E. (1977). *Laboratory methods for sensory evaluation of foods.* Canada Department of Agric Publications, Ottawa.
18. Maity, T., Shah, A., Raju, P.S. and Bawa, A.S. (2012). Development of ready to fry frozen vegetable snack and its quality evaluation. *J. Food Sci. Technol.,* **49**(1): 42-49.
19. Marwaha, R.S. and Sandhu, K.S. (2003). Yield, sensory and nutritional qualities of potato flours prepared from low and high dry matter cultivars stored at different temperatures. *J. Food Sci. Technol.,* **40**(6): 638-641.
20. Pandey, M.C., Harilal, P.T. and Radhakrishna, K. (2014). Effect of processing conditions on physico-chemical and textural properties of shammi kebab. *Int. Food Res. J.,* **21**(1) : 223-228.
21. Patthamakanokporm, O., Puwastien, P., Nitithamyong, A. and Sirichakwal, P.P. (2008). Changes in antioxidant activity and total phenolic compounds during storage of selected fruits. J. Food Comp. Analy., 21: 241-248.
22. Reyes, L.F., Miller, J.C. and Cisneros, Zevallos L. (2005). Antioxidant capacity, anthocyanins and total phenolics in purple and red-fleshed potato

(*Solanum tuberosum* L.) genotypes. *Am. J. Potato Res.,* **82**: 271-277.

23. Shah, B., Cai, Y.Z., Sun, M. and Corke, M. (2005). Antioxidant capacity of 26 spice extracts and characterization of their phenolic content. *J. Agric. Food Chem.* **53**(20): 7749-7759.
24. Sandhu, K.S. and Parhawk, B. (2002). Studies on the preparation of dehydrated potato cubes. *J. Food Sci. Technol.* **39**(6): 594-602.
25. Shimada, S., Fujikawa, K., Yahara, K. and Nakamura, T. (1992). Antioxidant properties of Xanthan on the antioxidation of soybean oil in cyclodextrin emulsion. *J. Agric. Food Chem.,* **40**: 945-948.
26. Singleton, V.L. and Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic phosphotungtic acid reagents. *Am. J. Eco. Viticul.,* **163** : 144-158.
27. Singh, N., Kaur, S.P., Kaur, L. and Sodhi, N.S. (2005) Physiochemical, rheological and chapati making proerpites of flours from some Indian potato cultivars. J. Food Sci. Technol., 42(4): 344-348.
28. Singh, S.V., Marwaha, R.S., Kuamr, D., Kumar, P. and Pandey, S.K. (2009). Suitability of potato varieties grown in north eastern Indian plains for processing. *Potato J.,* **36**: 25-34.
29. Smith, J.J., Seidman, S.C., Rosankrans, R.L. and Secrist, J.L. (1985) Vacuum packaged trimmings as a source for ground beef patties: changes during one year frozen storage. *J. Food Prot.,* **48**: 200-203.
30. Srzednicki, G. and Craske, J. (2004). The change of total anthocyanins in blueberries and their antioxidant effect after drying and freezing. *J. Biomed. Biotechnol.,* **5**: 248-252.
31. Suna, S., Tamer, C.E., Incedagi, B., Sinir, G.O. and Copur, O.U. (2014). Impact of drying methods on physicochemical and sensory properties of apricot pestil. *Indian J. Traditional Knowledge,* **13**(1): 47-55.
32. Torres, M.D.A. and Canet, W. (2001). Rheological properties of frozen vegetable purees. Effect of freeze-thaw cycles and thawing conditions. *Eur. Food Res. Technol.,* **213**: 30-07.
33. Zeb, A. and Ali, M. (2008). Thermal stability of animal tallow used in kebab preparation. *J. Chem. Soc. Pak.,* **30**(5): 750-755.

❑

Citation : Kaur S. and Aggarwal P. (2014). Development of ready-to-fly frozen-potato snack and its quality evaluation during storage. *HortFlora Res. Spectrum,* **3**(4) : 315-322