Archana et al., Vegetos 2016, 29:4
10.5958/2229-4473.2016.00114.2

Vegetos- An International Journal of Plant Research

Research Article

A SCITECHNOL JOURNAL

Effect of Varieties and Tuber Sizes on Losses of Ascorbic Acid and Phenol Content of Potato Tubers Stored Under Ambient Conditions

Archana B[1*], Rana MK[1] and Vineeta P[2]

Abstract

The Investigation was conducted by keeping healthy potato tubers of three different sizes for each genotype in hessian cloth bag at room temperature in four replications. The experiment was carried out to evaluate the effect of varieties and tuber sizes on the ascorbic acid and phenols during the storage period of three months. From the findings, it was concluded that the ascorbic acid content and phenolic content decreased with increasing storage period. The maximum ascorbic acid and phenols were noticed in Kufri Bahar and minimum in Kufri Pushkar. Among the sizes, ascorbic acid had positive, while the phenol content had negative correlation with tuber size.

Keywords

Potato; Different sizes; Varieties; Room temperature storage; Ascorbic acid and Phenol content

Introduction

Potato (*Solanum tuberosum L.*) is one of the most important tuber crops being widely consumed in the world. Apart from the supply of energy and high quality protein, potato has also been documented as an important source of vitamins and minerals and also as a valuable source of scurvy preventive Vitamin C, more commonly known as ascorbic acid. Ascorbic acid being anti-oxidant also enhances the absorption and internal transport of dietary iron and zinc from other plant sources as it is a strong reducing agent in the plant metabolism [1]. Potato tubers have been reported to contain up to 46 mg of ascorbic acid per 100 g tubers on fresh weight basis) and its availability depend on the variety, maturity status and the environmental conditions under which crop is grown [2]. In the year 2000, the recommended daily allowance (RDA) of Vitamin C has been replaced by dietary reference intake (DRI). Dietary reference intakes for Vitamin C have been established as 90 mg for men and 75 mg for women. Many authors [3,4] have reported that the ascorbic acid content is affected by the storage conditions as well as length of storage period. Presently besides being part of a regular diet, potatoes are also processed in chips, French fries and flakes etc. and it is pertinent to know the status of ascorbic acid in potato cultivars being used in processing.

***Corresponding author:** Archana B, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar-125 004, Haryana, India, E-mail: brararchanaarch@gmail.com

Received: October 07, 2016 **Accepted:** December 01, 2016 **Published:** December 09, 2016

Phenolic compounds are considered to be health promoting phytochemicals. They exhibit beneficial antibacterial, antiglycemic, antiviral, anticarcinogenic, anti-inflammatory and vasodilator properties [5-7]. Phenolic compounds represent a large group of minor chemical constituents in potatoes, which play an important role in determining their organoleptic properties [8], the phenolic content of potatoes was reported to be high, and ranged from 530 to 1770 µg g^{-1} [9]. Potatoes were considered the third most important source of phenols after apples and oranges [10]. Talburt et al. reported presence of lignin, coumarins, anthocyanins and flavones, tannins, monohydric phenols and polyhydric phenols in potatoes [11].

Therefore, present study was conducted to evaluate the changes in ascorbic acid and phenolic content and their correlation with different sized potato tubers of indigenous and exotic popular processing varieties during storage.

Material and Methods

Experimental details

The present investigation was carried out in laboratory of the Department of Vegetable Sciences, CCS Haryana Agricultural University, Hisar. All the four varieties V1: Kufri Badshah, V2: Kufri Bahar, V3: Kufri Pukhraj, V4: Kufri Pushkar was harvested from Vegetable Farm, CCSHAU, Hisar. These varieties has been selected due to its wide spread adaptability to the local conditions and superior processing quality attributes like, high dry matter and low sugar contents. Potatoes were sorted and graded into three different sized tubers *i.e.*, S1: >25-50 g, S2 : > 50-75 g and S3 : > 75 g and subsequently cured for one week (20-22°C) before being subjected to different analytical trials during storage. Potatoes were placed under ambient room conditions.

Four kg healthy clean tubers of each genotype were placed in hessian cloth bag at room temperature in four replications. The experiment was design out in Complete Random Design (factorial) with twelve treatment combinations and four replications. The set of treatments were as follows: V_1S_1, V_1S_2, V_1S_3; V_2S_1, V_2S_2, V_2S_3; V_3S_1, V_3S_2, V_3S_3; V_4S_1, V_4S_2, V_4S_3.

Ascorbic acid (mg/100 g)

Ascorbic acid content was estimated by the method given by AOAC (1980), using fresh peeled sample stored under room temperature [12]. This method was based on the reduction of 2, 6 dichlorophenol indophenols (2, 6-DCPIP) by ascorbate. A tissue sample of 1.0 g was macerated with 4 mg of 3% metaphosphoric acid in a chilled mortar and pestle. The homogenate was centrifuged for 20 minutes at 1000 rpm, and then, the supernatant was carefully decanted into flask and final volume was made to 25 ml with 3% meta-phosphoric acid. For extraction aliquot sample of the extract 1.0 ml was titrated with 2, 6-DCPIP reagent until a pink end point, which persisted for 15 seconds, was reached. A standard curve was prepared by titrating a known amount of ascorbate with 2, 6 DCPIP reagent. The amount of total ascorbate present in the sample was calculated from standard curve. The results were expressed in mg ascorbic acid per 100 g fresh weight.

Phenols (mg/100 g)

For the phenol estimation, peeled shade dried powder sample was used for the method of Swain and Hillis (1959) [13]. Fifty milliliter of 80% methanol was added to 0.5 g dry powdered sample, heated in boiling water bath for 30 minutes, cooled and centrifuged at 5,000 rpm for 10 minutes. The supernatant was collected. The volume was made 50 ml with 80% methanol and different phenolic constituents were determined. Estmation was carried out by folin reagent 1 ml added to 1 ml extract and shaken thoroughly. After 3 minutes, the saturated Na_2CO_3 solution 2 ml was added and the volume was made to 25 ml with distilled water. The tubes were placed in dark for 1 hour and absorbance reading was recorded at a wavelength of 725 nm. The total phenol content was calculated from a standard curve of tannic acid (10-50 mg/g dry weight).

Results and Discussion

Ascorbic acid (mg/100 g)

The perusal of data reveals that the ascorbic acid content of tubers decreased with the increase in storage length. The rate of loss for ascorbic acid was slower in the starting of the experiment, but thereafter, it increased rapidly. The data in the (Table 1) indicate that the varieties differed significantly with respect to loss of ascorbic acid in tubers during storage period. Among the four varieties, Kufri Bahar showed the significantly highest ascorbic acid content (27.18, 22.17 and 15.32 mg), followed by Kufri Badshah (23.33, 19.12 and 12.55 mg) and Kufri Pukhraj (21.85, 16.92 and 12.25 mg) while the lowest ascorbic acid content showed by Kufri Pushkar (20.36, 15.96 and 11.38 mg) from starting to the end of the storage, respectively. A significant decrease in ascorbic acid at latter ripening stage was noticed, which could be due to enzymatic loss of L-ascorbic acid where it is converted to 2-3-dioxy-L-gluconic acid.

The variation among the tuber sizes was statistically significant with regard to ascorbic acid during storage. Ascorbic acid content had the significantly positive correlation with tuber size. The larger tubers had the significantly highest ascorbic acid content (24.43, 19.85 and 13.96 mg) followed by medium sized tubers (23.26, 18.48 and 13.04 mg), while small sized tubers had the significantly lowest ascorbic acid content (21.85, 17.29 and 11.63 mg) at starting, mid and end of the experimental study, respectively. The large sized tubers contained higher ascorbic acid as compared to smaller tubers harvested on the same day [14,15] in potato.

The interaction effects between varieties and sizes differed significantly for all the treatment combinations. At first observation, the highest ascorbic acid content was recorded with large sized tubers of Kufri Bahar (28.35 mg) closely followed by medium sized tubers of same variety (27.20 mg), whereas, the lowest ascorbic acid content was recorded with small sized tubers of Kufri Pushkar (19.25 mg). At second and third observation, the maximum ascorbic acid content was recorded with large sized tubers of Kufri Bahar (23.35 and 16.50 mg) followed by medium sized tubers of same variety (22.15 and 15.30 mg), whereas, the minimum ascorbic acid content was recorded with small sized tubers of variety Kufri Pushkar (14.80 and 10.20 mg), respectively.

Phenols (mg/100 g)

The phenols are associated with enzymatic browning of cut potatoes exposed to air. This parameter is very important when potato is processes in cottage industries and in making dehydrated products. Some of the constituents like tyrosine and ortho-dihydric phenols present in tubers react with oxygen in the presence of polyphenol oxidase enzyme and tuber flesh turn brown [16]. This type of discoloration can be prevented if potatoes are not exposed to air and are immersed in water. However, this is not a major problem in our country as almost all the cultivated varieties are free from this defect

Table 1: Effect of varieties and tuber size on ascorbic acid (mg/100 g) during storage under ambient conditions.

Treatments		Storage period (days)		
		0	45	90
Kufri Badshah (V_1)	Small (S_1)	21.45	17.50	11.40
	Medium (S_2)	23.65	19.00	12.55
	Large (S_3)	24.90	20.85	13.70
Mean V_1		23.33	19.12	12.55
Kufri Bahar (V_2)	Small (S_1)	26.00	21.00	14.15
	Medium (S_2)	27.20	22.15	15.30
	Large (S_3)	28.35	23.35	16.50
Mean V_2		27.18	22.17	15.32
Kufri Pukhraj (V_3)	Small (S_1)	20.70	15.85	10.75
	Medium (S_2)	21.85	16.80	12.41
	Large (S_3)	23.00	18.10	13.60
Mean V_3		21.85	16.92	12.25
Kufri Pushkar (V_4)	Small (S_1)	19.25	14.80	10.20
	Medium (S_2)	20.35	15.98	11.90
	Large (S_3)	21.48	17.10	12.05
Mean V_4		20.36	15.96	11.38
Mean of Size	Small (S_1)	21.85	17.29	11.63
	Medium (S_2)	23.26	18.48	13.04
	Large (S_3)	24.43	19.85	13.96
C.D. at 1% level of significance				
Variety		0.21	0.21	0.16
Size		0.18	0.18	0.14
Variety x Size		0.36	0.36	0.27

Table 2: Effect of varieties and tuber size on phenols (mg/100 g) during storage under ambient conditions.

Treatments		Storage period (days)		
		0	**45**	**90**
Kufri Badshah (V_1)	Small (S_1)	36.80	34.70	30.50
	Medium (S_2)	36.55	34.00	30.00
	Large (S_3)	35.80	33.25	29.53
Mean V_1		**36.38**	**33.98**	**30.01**
Kufri Bahar (V_2)	Small (S_1)	42.51	40.34	36.50
	Medium (S_2)	41.98	39.72	36.80
	Large (S_3)	41.50	39.15	35.60
Mean V_2		**42.00**	**39.74**	**36.30**
Kufri Pukhraj (V_3)	Small (S_1)	41.55	39.50	35.65
	Medium (S_2)	41.10	38.85	35.10
	Large (S_3)	40.75	38.24	34.80
Mean V_3		**41.13**	**38.86**	**35.18**
Kufri Pushkar (V_4)	Small (S_1)	36.10	34.00	30.20
	Medium (S_2)	35.55	33.15	29.85
	Large (S_3)	35.10	32.00	29.30
Mean V_4		**35.58**	**33.05**	**29.78**
Mean of Size	Small (S_1)	39.24	37.13	33.21
	Medium (S_2)	38.79	36.43	32.94
	Large (S_3)	38.30	35.66	32.31
C.D. at 1% level of significance				
Variety		0.11	0.17	0.22
Size		0.09	0.14	0.19
Variety x Size		0.18	0.29	0.39

[17]. Total phenols increased uniformly with maturity and curing. Verities with low total phenols are generally preferred for processing [18]. Phenol content in potato tubers decreased with the increase in storage period [19]. The perusal of data reveals that variety, size and their interactions influenced the phenol content in potato tubers. The phenol content ranged from 42.51 to 29.30 mg/100 g during the entire experimental study.

The decreased in phenol content was significantly influenced due to the effect of varieties and duration of storage. The rate of loss was slower in the starting of experiment, but thereafter, it increased rapidly. During storage, the phenol content was significantly highest in Kufri Bahar (42.00, 39.74 and 36.30%) followed by Kufri Pukhraj (41.13, 38.86 and 35.18%) and it was lowest in Kufri Pushkar (35.58, 33.05 and 29.78%) followed Kufri Badshah (36.38, 33.98 and 30.01%) at staring, mid and end of the experiment, respectively. The decrease in phenol content was significantly influenced due to the effect of tuber size during the period of 90 days of experiment. There was a negative correlation between the potato tuber size and phenol content. Among the tuber sizes, the small sized tubers had the maximum phenol content (39.24, 37.13 and 33.21%), followed by medium sized tubers (38.80, 36.43 and 32.94%), while large sized tubers had the minimum phenol content (38.29, 35.66 and 32.31%) at starting, mid and end of the experiment, respectively. The phenols are oxidized to o-semiquinone radicals of o-quinone molecules, which are highly reactive to give brown products of higher molecular weight. The decrease in phenols during storage might be due to their condensation into brown pigments [20].

The values for interaction between potato varieties and tuber sizes for all the treatment combinations differed significantly from each other. The maximum phenol content was recorded in small sized tubers of Kufri Bahar (42.51, 40.34 and 36.50 mg) closely followed by medium sized tubers of same variety (41.98, 39.72, and 36.80 mg), whereas, the minimum phenol content was recorded with large sized tubers of Kufri Pushkar (35.10, 32.00 and 29.30 mg) at starting, mid and end of the experiment, respectively (Table 2). The maximum value for phenol content was recorded with small sized tubers of Kufri Bahar (42.51 mg) on zero day of storage, whereas, the minimum phenol content was recorded with large sized tubers of Kufri Pushkar (29.30 mg) at the end of experiment.

Conclusion

Among different potato cultivars, Kufri Bahar with highest ascorbic acid and phenolic content showed much better in nutrient composition under ambient condition of storage. Large sized tubers because of the low phenolic content are much preferred for processing.

References

1. Al-Saikhan MS, Howard LR, Miller JC (1995) Antioxidant activity and total phenolics in different genotypes of potato (*Solanum tuberosum* L). Journal of Food Science 60: 341-343.
2. AOAC (1980) Official Methods of Analysis, 11th edition. Association of Official Analytical Chemists. Washington, USA.
3. Augustin J, Johnson SR, Teitzel C, Toma RB, Shaw RL, et al. (1978) Vitamin composition of freshly harvest and stored potatoes. J food Sci 43: 1566-1570.
4. Bravo L (1998) Polyphenols: Chemistry, dietary sources, metabolism and nutritional significance. Nutrition Reviews 56: 317-333.
5. Chun OK, Kim DO, Smith N, Schroeder D, Han JT, et al. (2005) Daily consumption of phenolics and total antioxidant capacity from fruit and vegetables in the American diet, J Sci Food Agric 85: 1715-1724.
6. Cook JD, Reddy MB (2001) Effect of ascorbic acid on non-home iron absorption from complete diet. Am J Clin Nutr 73: 93-98.
7. Dangour D, Dodhia SK, Hayter A, Allen E, Lock K, et al. (2009) Nutritional quality of organic foods: A systematic review. Am J Clin Nutr 90: 680-685.
8. Duthie G, Duthie S, Kyle J (2000) Plant polyphenols in cancer and heart disease: implications as nutritional antioxidants. Nutr Res Rev 13: 79-106.
9. Fenemma OR (1976) Principles of Food Science. Part-I. Food chemistry. Marcel Dekker Inc., New York, USA.
10. Han JS, Kosukue N, Young KS, Lee KR, Friedman M, et al. (2004) Distribution of ascorbic acid in potato tubers and in home-processed and commercial potato foods. J Agric Food Chem 52: 6516-6521.
11. Kumar D, Ezekiel R (2009) Changes in glycoalkaloids and phenol contents in potato tubers stored under different conditions. J Food Sci Technol 46: 480-483.
12. Marwaha RS (1999) Chipping quality and related processing characteristics of Indian potato varieties grown under short day conditions. J Food Sci Technol 36: 157-159.
13. Mattila P, Hellstrom J (2006) Phenolic acids in potatoes, vegetables, and some of their products. J Food Comp Anal 20:152-160.
14. National academy of Sciences (2000) Dietery reference intakes for vitamin C, vitamin E, selenium and carotenoids 1-7p.
15. Pandey SK, Shekhawat GS, Sarkar D (2000) Quality attributes of Indian potatoes for export: priorities and possibilities. J Indian Potato Assoc 27: 103-111.
16. Schaller K, Amberger A (1974) Relationship between enzymatic browning of potatoes and several constituents of the tubers. Qual Plantrum Plant Foods Human Nutr 24: 183-190.
17. Shekhar VC, Iritani WM, Arteca R (1978) Changes in ascorbic acid content during growth and short-term storage of potato tubers (*Solanum tuberosum* L). American Potato Journal 55: 663-670.
18. Swain T, Hillis WE (1959) The phenolic constituents of *Prunus domestica*: The quantitative analysis of phenolic constituents J Sci Food Agr 10: 63-68.

19. Swiniarski E, Burzynska D, Przybek D (1975) Ascorbic acid content in the potato plant *Biuletyn Instytutu Ziemniaka* 15: 129-140.

20. Talburt WF, Schwimmer S, Burr HK (1987) Structure and chemical composition of the potato tuber, New York: Van Nostrand Reinhold, pp. 11-46.

Author Affiliations

Top

[1]*Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, Haryana, India*

[2]*Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar, Haryana, India*