



Storage influence on physicochemical and quality characteristics of selected potato cultivars (*Solanum tuberosum* L.)

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Abstract

Potato (*Solanum tuberosum*) popularly known as “The king of vegetables”, has emerged as fourth most important food crop after rice, wheat and maize. Potato contains carbohydrates, minerals, vitamins and antioxidants. The antioxidants of potatoes especially vitamin C helps in reducing cancer, cardiovascular diseases and high blood pressure by binding free radicals. Physicochemical and quality characteristics of different potato cultivars at fresh and during storage were investigated in the present work. Two potato cultivars having different skin colors namely, Sante (white) and Lal moti (red) were collected from the field and stored at two different temperatures i.e. 6°C and 12°C at 85% relative humidity (RH) for the period of 3 months. Physicochemical attributes including weight loss, sprouting, specific gravity, pH, total sugars (reducing and non-reducing), vitamin C were analyzed during the whole storage period. The time, temperature and storage conditions influence the potato processing quality and consequently their acceptability to consumer. Among both the varieties, Sante performed well at 6°C as compared to the Lal moti at 12 °C. It observed that at 6°C, 3.5 and 8% weight loss, 4 and 9 % sprouting, 1.082 and 1.085 specific gravity, 21.22 and 19.25% dry matter, pH 5.4 and 5.6, 5.5 and 8.9 % total sugars with 2.5 and 4.2% reducing sugars, 10.40 and 13.55 mg/100g ascorbic acid were observed for both Sante and Lal moti respectively. There were low accumulation of sugars found at 12°C but increased rate of sprouting, weight loss, ascorbic acid and dry matter was observed. Overall results indicated that 6°C temperature is however acceptable to enhance the storage life of the tubers, as higher exposure of temperature results in weight loss and ultimately lower the chip processing quality of tubers.

Keywords: storage influence, physicochemical, *Solanum tuberosum* L

Introduction

Potato (*Solanum tuberosum*) belongs to *solanaceae* family and is a perennial plant, herbaceous in nature. Potato is native to several countries of Latin American continent like Peru, Chile, Bolivia, Argentina, Colombia etc. It is believed that the cultivated potato was derived from the feral species found in South America, particularly in the Andes of Peru and Bolivia. The crop is introduced in the European continent through Spain and then into England. The wide spread of this crop throughout the world is witnessed during the start of 17th century into different British colonies like Ireland, Scotland, United states and Indo-Pak subcontinent (PIC, 2008) [17]. The plant however is grown in Pakistan annually and its propagation is carried out through tubers, which are thick puffy part of the rhizome found underground and covered by modified eyes and buds (Abbasi *et al.*, 2011) [1].

The overall estimated yield of potato in the world is about 320.67 million tons and China being the major contributor produces 72 million tons followed by Russian Federation and India with yield of 35.7 and 26.2 million tons respectively. The demand for potato in the international market is on the rise and all the major exporting countries are trying to increase the yield (FAO, 2007). Potato is the most imperative and widely cultivated vegetable crop in Pakistan with an estimated 2.5 million tons production from an area of 150 thousand hectare (PHDEB, 2008) [16].

Potato carries broad biodiversity, with more than 4000

known varieties most of which belong to the species (*Solanum tuberosum*) consumed in 150 countries of the world (Burlingame *et al.*, 2009) [2]. Few of the most recognized varieties of potato in Pakistan are red skinned (Desiree, Courage, Lal moti, Kuroda, Lady Rosetta, Lal moti, etc.) and white skinned (Agria, Hermes, Chipsona, Satellite, Sante and Diamont, etc.), which are produced on large scale across the country and consumed for processing and table use (GOP, 2009) [7].

Potatoes are best studied for their carbohydrate content. Starch is the prime form of carbohydrate found in potatoes. Out of the six vitamins included in the recommended 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 liable to heat and light, and is also the index of quality change in the potato tubers during storage. In addition is also important against treatment of various chronic diseases such as sickle cell anemia, asthma, and cancer (Burlingame *et al.*, 2009) [2].

Potato is low cholesterol, high potassium vegetables with significant antioxidants potential thus capable of protecting human beings against cardiovascular diseases and cancer (Lachman *et al.*, 2000) [13]. Polyphenol in addition are the most common dietary antioxidant being efficient as reducing agents, metal chelators and reactive oxygen species quenchers in biological system (Lachmann *et al.*, 2008) [14]. Potato tuber undergoes physiological dormancy

period during the postharvest storage. The length of the dormancy period is dependent on the varietal genetic profile, environmental factors and storage conditions (Suttle, 2007)^[18].

Potato is semi perishable crop however placed under low temperature storage to prevent them from sprouting and to ensure their regular supply whenever required. Low temperature potato storage is however associated with low temperature sweetening and is specifically undesirable in processing potato varieties (Kyriacou *et al.*, 2009)^[12]. Potato value addition includes different commercial preparations like potato chips, mashed potatoes, steamed potato, potato patties, whole baked potatoes, potato flakes and dehydrated potato granules. However the most important one being the potato chips which gained terrific economic value in processed food industry (Clark, 2003)^[5]. To enhance potato accessibility and avoid deterioration of quality, proper storage is required. Suitable conditions should preserve tubers in their eatable and saleable situations by inhibiting moisture losses, pathogens spoilage, and sprout growth. By providing cold storage environment, we may reduce weight loss sprouting and spoilage. On the other hand, warmer storage temperatures will result in superior quality loss, increased respiratory activity and also reduced storage life of potatoes (Chourasia and Goswami, 2001)^[3].

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, quality and sensory parameters of profit-making potato varieties to reveal their varieties characteristics.

Materials and Methods

The research was carried out at Fruits and Vegetable Processing Laboratory, Institute of Food Science and Nutrition, Bahauddin Zakariya University, Multan.

Sample procurement

Two varieties of potatoes were procured from the field by keeping in mind their harvesting time and maturity stage. Sante (V_1) having white color and Lal moti (V_2) with red color. The varieties were immediately transferred to laboratory.

Sample preparations

The following steps were adopted during the sample preparation and analysis.

Washing

Samples were washed under tap water to remove dust and dirt particles, especially to remove mud that is present on potato varieties during harvesting.

Drying

Washed, sorted and graded potatoes were subjected to air

drying technique to get clean, good quality and properly dried samples.

Storage

After drying both varieties were packed in net bags and stored at 6°C and 12°C in electric chamber with 85% relative humidity.

Physicochemical analysis

Specific gravity

Specific gravity was determined by taking the weight of the tuber in air and water according to AOAC (2007) method no. 936.13:

PH value

The pH values were recorded by using a pH-meter (Inolab. WTW Series, Germany) as illustrated in AOAC (1990) method no. 981.12.

Weight loss

The weight loss (%) in different experiments at specified storage interval was determined by weighing the samples with digital balance (OHAUS, Model TS4KD Florham Park, NJ, USA) and reported as percent loss in sample weight based on its initial weight (Bassetto *et al.*, 2005).

Sprouting

Sprouting of the tubers will be measured in terms of percentage of sprouted eyes per tuber. Then tubers will be weighed before removing all sprouts from sprouted tubers. Sprouting (SPRT) percentages in potato tubers (sprout length > 3mm) were calculated by the equation described by (Zhang *et al.*, 2012).

Total sugars (Reducing and non-reducing)

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 (2007) method no. 925.35.

Ascorbic acid (AA)

Ascorbic acid (AA) was determined by titrametric method using 2, 6 dichlorophenol indophenol dye as described by AOAC (2007) method no. 967.21.

Results and Discussion

Specific gravity is one of the most important tools for the quality evaluation and is largely associated with the dry matter or total solid contents of potato. It was observed during storage at both the temperature that, differences in specific gravity were not large enough to be statistically significant.

However the specific gravity had increased slightly at the end of the storage period as illustrated in Figure 1. Maximum increment was recorded at 12°C in both of the cultivars.

Claassens and Vreugdenhil (2000)^[4] also reported that specific gravity of potato tuber increases during storage due to the rapid depletion of starch reservoirs eventually lead to the overall increase in specific gravity value.

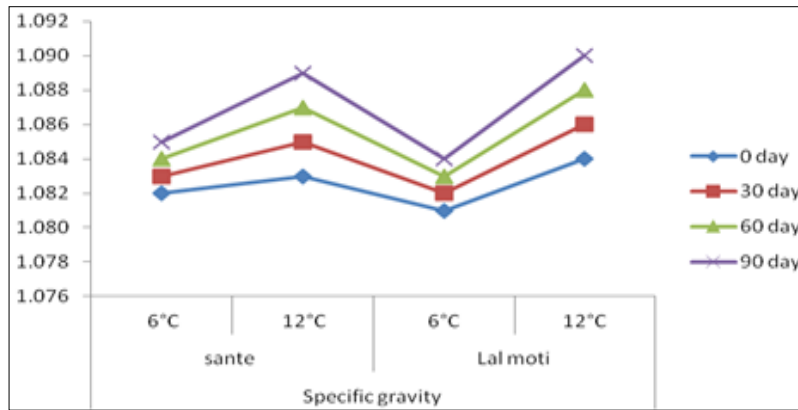


Fig 1: Specific gravity in stored potatoes at 6 and 12°C

pH of the vegetables and fruits is closely related to the acidity to check for the maintenance of quality on the food industry. This factor also indicates storage ability of fruits, vegetables and other juices. The results regarding (Figure 2) pH values in variety Sante (V_1) were increased during storage at 6°C and 12°C, but maximum increase was found at 12°C. Same trend was observed in variety Sante (V_2), but in both varieties maximum pH was recorded in Variety Sante at 12°C. The results of our study are in the collaboration with the findings of Mahajan *et al.*, (2011) who also observed that pH of the potato varieties increases during storage at the cost of decline in acidity.

Sprouting

It was observed that sprouting of tubers started after 4 weeks of storage (Figure 2.). Sprouting is directly correlated with the tuber weight loss results in low tuber quality. It was obvious from (Figure 2) that Sante has minimum sprouts (2%,5.7%) at 6 and 12°C as compare to Lal moti (2.6% and 7.8%) at 6 and 12°C respectively. The data indicated that low temperature is quiet better in controlling the sprout growth as compare to high temperature. Hence, low temperature could be an effective treatment in prolonging the dormancy period of tubers. However, sprout growth is also a varietal dependent factor but the temperature has its own role (Gamboa *et al.*, 2003) [20], as suggested by (Khanal and Uprety, 2014) [21] that Low temperature maintains the storage quality of tubers for longer period as compare to higher temperatures. On the other hand, high amount of dry matter and less sprouting favors in longevity of tubers in low temperature storage.

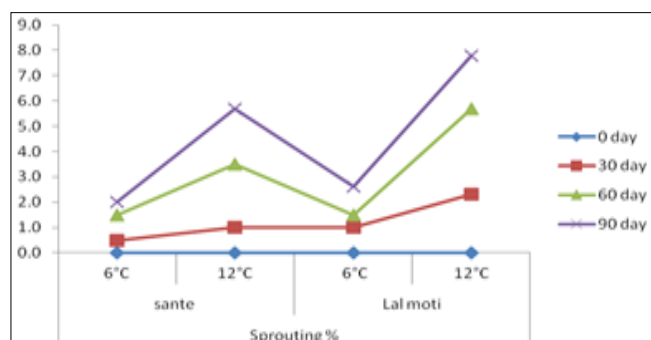


Fig 2: Sprouting in stored potatoes at 6 and 12°C

Weight loss

Weight loss is generally detrimental in fruits and vegetables during storage because it lowers the acceptability of

produce. The effects of dehydration results in the noticeable skin changes and shrinkage. The results regarding weight loss of potatoes were showed in Figure 3. The data indicated that there was low weight loss (1.5%, 2%) at lower temperature (6°C) as compare to higher temperature (4.5%, 5.7%) of 12°C for Sante and Lal moti respectively. As higher temperature causes gradual moisture loss during the storage. The increased in weight loss above 10°C storage has also been reported by Kyriacou *et al.*, (2009) [12] due to moisture loss and respiration process.

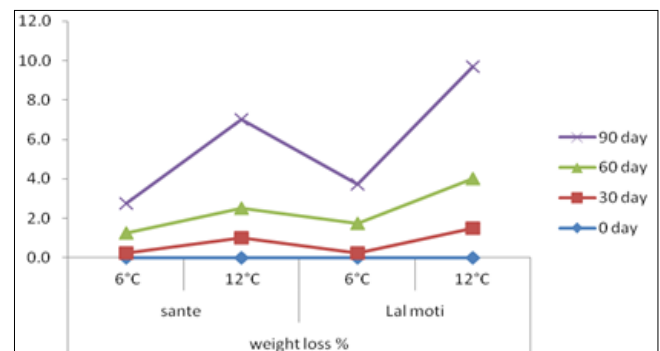


Fig 3: Weight loss in stored potatoes at 6 and 12°C

Sugars

Generally, total sugars increases in potato during storage due to starch degradation. The results regarding total sugar, reducing and non-reducing sugars were showed in Figures 4, 5 and 7 respectively. Sugars were increased during the three month storage interval in both varieties stored at 6°C and 12°C. However, Sante showed low sugar accumulation as compare to Lal moti. But the overall results indicated that sugar accumulation was more at 6°C in both of the varieties as compare to 12°C. It was observed that low temperature (<10 °C) initiates starch degradation. Sugar accumulation in some potato varieties under different storage temperatures (8°C, 10°C and 18°C) were reported by (Kyriacou *et al.*, 2009) [12]. The maximum sugar contents were observed below 10°C. Similar observations were recorded by Kazmi *et al.*, (2000) who estimated inverse relationship between total sugar and storage temperature during storage. Uri *et al.*, 2014 [22] had determined the sugar, amino acids, organic acid and alcohols of six different potato cultivars grown locally. The storage was conducted at 20-22°C in dark. It was observed that storage at this temperature had decreased the fructose and sucrose contents of tubers. This study evaluated that the higher temperature results in low sugar accumulation but on the other hand, sprouting and

weight loss of the tuber were increased gradually. There was inverse relation between sprouting and weight loss compare with the sugar accumulation.

Cold storage (<10°C) requires more energy consumption that also makes it expensive. Whereas, storage at above 10-12°C is low energy consuming, prevents undesirable accumulation of reducing sugars (Mahto and Das, 2015) [24].

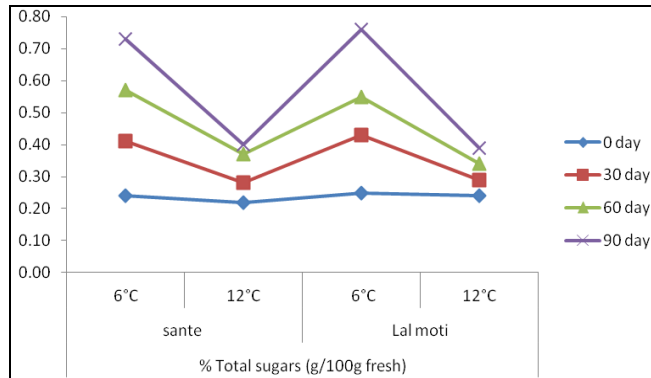


Fig 4: Total sugars in stored potatoes at 6 and 12°C

Reducing sugar

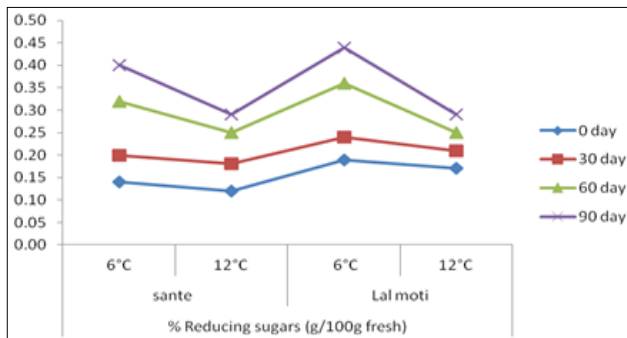


Fig 5: Reducing sugars in stored potatoes at 6 and 12°C

Non reducing

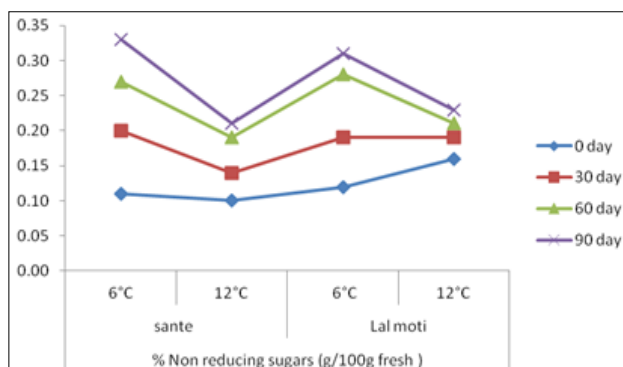


Fig 6: Non reducing sugars in potatoes stored at 6 and 12°C

Ascorbic acid

Ascorbic acid is naturally present in potatoes. It acts as antioxidant and has nutritional values. General trend was decrease in ascorbic acid contents in all treatments however the retention of ascorbic acid was inversely proportional to the storage temperature. The results regarding ascorbic acid were shown in Figure 7. Ascorbic acid was decreased in both varieties Sante and Lal moti stored at 6°C and 12°C during the three month storage interval. It was also reported by (Al-Saikhan, 2015) [23] that tuber ascorbate content start

to decline during storage phase and continued to decrease gradually throughout the whole storage period, depending upon the cultivar susceptibility and type.

Nourian *et al.*, (2003) [15] studied the changes in ascorbic acid contents under different temperatures and stated that ascorbic acid decreased with the increase in storage temperature and duration. Similar results were reported by Singh and Pal (2008) regarding decline in ascorbic acid with progression in storage time.

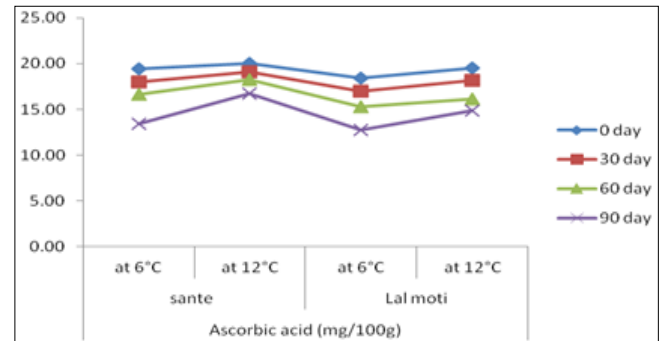


Fig 7: Ascorbic acid in potatoes stored at 6 and 12°C

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Conclusion

This study revealed the physicochemical analysis on, the two varieties of potatoes Sante (V₁) and Lal moti (V₂) during storage at 6°C and 12°C temperatures for 90 day storage interval. During storage changes occurs in both varieties of their physical and chemical parameters. Sprouting, pH, total sugar, Reducing sugar, non-reducing sugars and TPC were increases during storage, but ascorbic acid (Vit.C) was decreases. Among both varieties sante was better at 6°C than Lal moti during storage interval due to less physicochemical and quality changes.

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