

CHANGES IN PHYSICO-CHEMICAL COMPOSITION OF POTATO TUBERS AT ROOM STORAGE CONDITION

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ABSTRACT: The experiment was conducted on “changes in physico-chemical-composition of potato tubers at room storage condition” in Food Technology Section, Agricultural Research Institute, (N), Mingora, Swat on the behalf of the Department of Horticulture, Khyber Pukhunkhwa Agricultural University, Peshawar. Tubers were kept in store for three months at room condition. The temperature and Relative Humidity (RH) data were recorded daily with the help of digital hygrometer. The data recorded in different quality attribution at 15 days interval. Physico- chemical attributes such as Carbohydrates, Specific Gravity Weight loss, Rotting%, Sprouting%, Green tubers, Weight of sprouting and Length of sprouting (cm), during 90 days in storageto evaluate the influence of storage at room temperature on the Physico-chemical composition of potato three cultivars Diamont, Desiree and Kruda. The highest quantity of carbohydrates (24.513) was recorded at 90 days of storage. While maximum mean values of Cultivars of carbohydrates (23.359 g/100g) recorded in Diamant. The highest PWL 2.766 (g/100g) was recorded at 0 to 75 days of storage. The highest SG value i.e., 1.107 was recorded in Kruda cultivar after 75 days in storage while the highest rotten i.e. 33.607 was recorded in Desiree. The maximum green tubers (%), shrinkage (%) and sprouting length were recorded in Kruda whereas maximum rotten (%) and number of sprouted tubers were recorded in Desiree and Diamont cultivars.

Key words: Carbohydrates, Relative Humidity, Physiological weight loss, Physiological disorders, Specific Gravity.

INTRODUCTION

The potato (*S.tuberosum* L.) is one of the most essential nutritional crops and native to South America. During the 19th century in British Government, its cultivation was introduced for the first time in Indo-Pak subcontinent. In 2011-12 the area under potato cultivation in Pakistan was 106.4 ha, and its production was 3550(tons), while In KPK the area under potato cultivation was 9.9000 ha and its production was 119 (tons) [1].

Potato (*S.tuberosum*) is a rich source of carbohydrates, vitamins, minerals and dietary fiber and due to its dietary value and nutritional benefits; it is the most widely used vegetables in both urban and rural areas of the Khyber Pukhunkhwa. These potato tubers are semi perishable and can be stored for a longer period under room condition. Various pre and post- harvest factors such as cultivars, growing seasons, nitrogenous and potash fertilizers application, soil types, curing, storage temperature and relative humidity are known to affect the Physico- chemical composition and nutritional quality of potato [2,3].

Starch is the main component of the potato dry matter (DM), ranging from 60-80 %. Therefore, measurement of dry matter (DM) and specific gravity (SG) are the indices of quality and yield of the processed products (Burton, 1966). Potato tuber contains about 75 to 80% water, 16 to 20% carbohydrates, 2.5 to 3.2% crude protein, 1.2 to 2.2% true protein, 0.8 to 1.2% mineral matter, 0.1 to 0.2% crude fats, 0.6% crude fiber and some vitamins [4].

Conventional storage of potatoes for processing takes place at

8–9 °C, resulting in less accumulation of reducing sugars, but an increase in sprout growth [5]. Potatoes which have good quality are relatively smooth, firm, without defects and sprouts, and are of poor colures. Moreover, such factors may depend on different cultivars, degree of maturity, storage condition and harvesting time.

Potato is very important and leading vegetable crop. A lot of research work has been carried out on field production or yield of potato but very less work has been done, alone on potato storage in Pakistan. Especially biochemical changes that occur in post harvest physiology of tubers in Different storage duration.

MATERIALS AND METHODS

The project “Effect of Storage Duration on the Chemical Composition of Different Cultivars of Potato” was initiated at Food Technology Section, Agricultural Research Institute, (N), Mingora, Swat on behalf of the Department of Horticulture, Khyber Pukhunkhwa Agricultural University, Peshawar.

Three cultivars of Potato tubers were procured from Agricultural Research Institute, Tarnab, Peshawar. The bruised and injured tubers were discarded and the tuber were cleaned and washed under running tape water. The tuber get were held at room temperature to remove the surface moisture and kept in store for three months period at room temperature. Each cultivar was divided in to three lots; each lot consisted of 15 kg. Temperature and Relative Humidity (RH) data was recorded daily with the help of digital hygrometer.

LAY OUT OF EXPERIMENT AND DATA RECORDING:

The experiment was conducted on the tubers of three cultivar of potato i.e., Diamont, Desiree and Kruda. The storage duration was 90 days while CRD and RCBD design were used during the experiment. The data recorded on different physio-chemical components at 15 days interval. The PHYSIO-chemical components such as Carbohydrates, Specific Gravity, Weight loss, Rotting%, Sprouting%, Green tubers, Weight of sprouting and Length of sprouting (cm), were recorded during 90 days at storage Duration.

PHYSICOCHEMICAL ANALYSIS:

TOTAL CARBOHYDRATES:

Estimation of Total Carbohydrates (g/100 g):

Carbohydrates produce furfural derivatives under strong acidic condition (H_2SO_4) when treated with anthrone reagent to form green colored complex which are measured on Digital Colorimeter/Spectrophotometer.

Materials:

1. Anthrone
2. Sulfuric acid
3. Standard Glucose
4. HCl
5. Glucose standard
6. Sodium Carbonate

Preparation of Reagent:

A-Anthrone reagent:

Dissolved 200 mg anthrone in 95 % ice cold H_2SO_4

Note:-Prepare fresh before use.

B- Preparation of 2.5 N HCl

STANDARD GLUCOSE GRAPH:

Glucose solution was prepared (10mg/ml) pipette into a series test tube, different volumes of glucose solution (containing 0-100 μ g) and brought the volume of each to 1 ml with distilled water. Then, added 4 ml of ice cold concentrated anthrone reagent into each tube and mix well. After that sample was kept in boiling water for 10 minutes or till the green color developed. Cooled to room temperature and measured the Optical Density (OD) at 630 nm using a blank without the glucose. Standard graph was drawn by plotting the OD values on the Y-axis and the glucose concentration.

Potato sample:

1. Took 100 mg sample in test tube.
2. Added 5 ml 2.5 N HCl, heated in a water bath for three (3) hours and cooled to room temperature.
3. Neutralized the sample with solid sodium carbonate till the effervescence ceased.
4. Made up the volume to 100 ml and centrifuged for 10 minute at 3000 X g
5. Collected the supernatant and took 0.5 ml sample aliquot for analyses
6. Added 4 ml anthrone reagent.
7. Heated the sample for 8 minute in boiling water bath.
8. Cooled rapidly and read the green to dark color at 630 nm.

WEIGHT LOSS (G/100G):

About 10 tubers of each cultivar were weighed on the zero day of the storage and then after 15 days of interval data on each variety was recorded. Percent weight loss was determined by the difference in the weight of each tuber on each storage interval.

$$\text{Weight Loss (g/100 g)} = \frac{W1 - W2 \times 100}{\text{Initial weight of tubers}}$$

UNDER WATER WEIGHT (UWW):

About 5000 gram of tuber was weighed in air and in under water. Specific Gravity was calculated according to the following formula:

$$\text{Specific Gravity} = \frac{\text{Weight in gram (5000) in air}}{5000 - \text{Weight of tuber under water}}$$

POST HARVEST DISORDERS:

Rottening (%):

At the experiment, number of rotten tubers was counted in each replication and converted to % rotten tubers.

Sprouting (%):

Number of sprouted tubers were counted at the end of the experiment and converted to % sprouted tubers.

Green Tubers (%):

Number of green tubers were counted at the end of the experiment and converted to % green tubers.

Weight of Sprout:

Weight of sprouts per tuber was recorded at the end of the experiment at each replication and calculated as weight of sprout per tuber.

length of sprout:

Length of sprout was recorded in centimeters per tuber at the end of the experiment.

Shrinkage (%):

Total numbers of tuber in replication was counted and % shrinkage was recorded in tubers at the end of experiment.

RESULTS AND DISCUSSION

Total Carbohydrates Content (g/100g)

The data regarding total sugar carbohydrate (Table-1) showed that mean values of storage and interaction (cultivar \times storage) remained statistically significant ($p \leq 0.05$). While the mean values of Cultivars were not found statistically significant. Mean values of cultivars showed the maximum value of carbohydrates (23.359 g/100g) recorded in Diamant, followed by 23.14 and 21.581 by Desiree and Kruda respectively.

The mean of storage showed that minimum value (19.496 g/100g) of total carbohydrates was recorded at 30 days of storage while the highest quantity of carbohydrates (24.513) was recorded at 90 days of storage. However, the mean values at 15, 45, 60, 75, and 90 days storage interval remained statistically at par with each other ($p \leq .05$).

The interaction of cultivars \times storage indicated that

carbohydrates increased from 0 to 15 in storage. After 30 days in storage, total carbohydrates remained at minimum level i.e. 17.91 and 19.57 in Diamont and Desiree cultivars. Similarly, the highest total carbohydrates i.e., 27.56 and 27.73 in Diamont and Kruda cultivars after 75 and 45 days in storage.

Carbohydrates are composed of reducing sugars (glucose +fructose), sucrose and starch. Reducing sugars are used as substrate in respiration and is converted in to water and carbon dioxide. However, losses due to respiration process are about 0.5-0.6 % of the tuber on fresh weight basis. The carbohydrates exist in the equilibrium form in the tubers during storage. Its conversion of starch into sugars takes place while the reconversion of sugars in to starch also takes place in storage which has little effect on the quantity of total carbohydrates in the tubers in storage.

Physiological Weight Loss (PWL) (g/100g)

Physiological weight loss (g/100g) (Table-2) showed that significant differences ($p \leq 0.05$), were found in storage means and their interaction (storage x cultivars) means. While mean values of cultivars were not statistically significant ($p \leq 0.05$)

The storage means shows that the highest PWL 2.766 (g/100g) while the lowest PWL 1.156 was recorded at 0 and 75 days of storage. Mean values at 30, 60 and 90 days of storage were at par statistically one another.

Mean values of Interaction (storage x cultivars) showed the decreasing trend in all cultivars during the first month of storage period. The highest PWL (g/100g) 3.0433 was recorded after 15 days of storage in Diamont while the lowest PWL 0.596 was recorded after 60 days of storage in the same cultivar. Mean values of Diamant, Desiree and Kruda at 30, and 90 days remained statistically at par with one another.

About 5.19 % and 1.39 % weight loss were recorded for control and CIPC treated tubers respectively fewer than 8 °C storage conditions [6]. Physiological weight losses in stored potatoes are mostly triggered by evaporation of water, sprouting and respiration, in the potato tubers, during the storage spreading of diseases, changes in physical properties, chemical composition of the potato tubers and damage by extreme temperatures. These processes are influenced by storage condition [7]

Specific Gravity

Specific Gravity (Table-3) shows that mean values of storage, cultivars and their interaction (storage x cultivars) were not found statistically significant ($p \leq 0.05$). Highest storage means value of SG i.e. 1.102 was recorded after 30 days of storage while the lowest 1.083 SG was recorded after 15 days of storage. The rest of the SG values were statistically at par with one another.

In interaction (cultivars x storage), the highest SG value i.e., 1.107 was recorded in Kruda cultivar after 75 days in storage while the lowest SG 1.063 value was recorded in Desiree cultivar after 15 days in storage. The rest of the SG values remained statistically at par with one another ($P \leq 0.05$). Mean values of SG in cultivars did not show significant differences. DM is an important quality criterion for both fresh and fried products and is influenced by a large number of pre harvest factors such as cultivars, maturity, climate, soil, and nitrogen and potassium fertilizers application the weights of processed

products depend directly on the quantity of DM present but for processors, DM estimation is the time consuming procedure [8, 9]. However, the Specific Gravity estimation is the easiest way to assess the quality of potato tubers in the storage and this parameter has been correlated with the DM and starch content by many research workers [10, 4, 11]. Therefore, the highest SG, indicates the highest DM and the highest Starch content in the tubers and vice versa.

Rottening (%):

Mean values of decay (%) (Table -4) showed that statistically significant differences were found in the of rotten percentage ($P \leq 0.05$). The highest rotten i.e. 33.607 was recorded in Desiree while the lowest 3.617 % was recorded in Kruda cultivar. It has been reported that Losses due to physical wounding such as cuts and bruises can be as high as 40 % [12].

Sprouting Numbers:

Mean values of sprouting numbers (table-4) showed statistically significant differences. The highest number of spouting i.e., 5.667 was recorded in Diamont cultivar while the lowest 3.667 was recorded in Kruda cultivar after the end of three months of storage period. [13] has reported that numbers of sprout per tuber increases with the size of the tuber.

Green tubers (%)

Mean values of Green tubers (%) (Table -4) revealed that statistically significant were found in the cultivars ($P \leq 0.05$). The highest % green tubers 13.75 was recorded in Kruda cultivar while the lowest i.e., 10.187 % was recorded in Diamont cultivar after three months of storage period at room condition. Many physiological changes occur within the tubers due to exposure to light during storage and marketing. Appearance of greening on the tuber is one of the factors that affect the tuber quality in market chain. Though chlorophyll is safe and tasteless, however, it is also considered harmful for consumption [14].

Weight of Sprouting (g / g):

Mean values of sprouting weight (Table-4) remained statistically significant after three months of storage period ($P \leq 0.05$). The lowest sprouting weight 1.72 (g) was recorded in Diamont cultivar while the sprout weight of Kruda and Desiree cultivars remained at par statistically with one another. [15] Reported that storage temperature, tuber growth, time of harvesting of potatoes, and tuber size influence growth rate of the sprout in storage.

Sprouting Length (cm):

Mean values of sprouting length (table-4) revealed statistically significant differences ($P \leq 0.05$). The highest sprouting length, i.e., 10.47 was recorded in Kruda cultivar while 3.443 was recorded in Diamont cultivar after three months of storage at room condition. Sprouts of smaller tubers grow more slowly than those of the larger one [13].

Shrinkage (%):

Data of shrinkage (%) (table-4) revealed that statistically significant differences were found in the mean values ($P \leq 0.05$). The highest % shrinkage i.e., 27.813 was recorded in Kruda cultivar while the lowest value i.e., 12.81 was recorded in Diamont cultivar.

Table-1. Carbohydrates Content (g/100 g) of the three Cultivars of Potato during 3 months Storage at room Condition.

Storage Days	Diamant	Desiree	Kruda	Storage Means
0	20.563	19.830	18.943	19.779 b
15	25.297	25.207	22.763	24.422 a
30	17.913	19.573	21.000	19.496 b
45	20.610	22.607	27.727	23.648 a
60	24.447	21.490	24.583	23.507 a
75	27.557	20.593	22.130	23.427 a
90	27.123	21.767	24.650	24.513 a
Cultivars Mean	23.359	23.114	21.581	

Grand Mean = 22.684, CV % = 11.92, LSD interaction = 4.4630, LSD Storage = 2.5767

Table-2. Physiological Weight loss (g/100 g) of the Three Cultivars of Potato during 3 months Storage at room Condition.

Storage Days	Diamant	Desiree	Kruda	Storage Means
15	3.0433	3.0233	2.2300	2.766 a
30	1.3333	0.9533	1.2267	1.171 d
45	2.1200	2.1033	2.2667	2.163 b
60	0.5960	1.4600	1.5400	1.199 d
75	0.7927	1.5067	1.1700	1.156 d
90	1.3933	1.3233	2.1200	1.612 c
Cultivars Mean	1.5464	1.7283	1.7589	

CV% = 22.50, Grand Mean = 1.6779, LSD interaction = 0.6264, LSD Storage = 0.3616

Table -3. Specific Gravity of the Three Cultivars of Potato during 3 months Storage at room Condition. Grand Mean = 1.0934, CV % = 1.43

Storage Days	Diamant	Desiree	Kurda	Storage Means
0	1.0867	1.0967	1.0933	1.0922
15	1.0900	1.0633	1.0967	1.0833
30	1.0967	1.1067	1.1033	1.1022
45	1.0913	1.1067	1.0967	1.0982
60	1.0967	1.0833	1.0900	1.09
75	1.0867	1.1000	1.1067	1.0978
90	1.0867	1.1000	1.0833	1.0900
Cultivars Mean	1.0907	1.0938	1.0957	

Table -4. Physiological disorders of the three cultivars of potato after completion of the three months storage at room condition.

Parameters	Diamant	Desiree	Kruda	Cultivars Means	CV %	LSD
Rotten %	12.353	33.607	3.617	16.526	17.77	6.6582
Green Tuber %	10.187	13.087	13.750	12.341	13.09	3.6635
Shrinkage %	12.810	13.147	27.813	17.923	14.60	5.9318
Length of Sprouting	3.443	5.977	10.470	6.6300	13.68	2.0568
No. of Sprouting / Tuber	5.6667	4.0000	3.6667	4.4444	17.59	1.7722
Weight of sprouting / Tuber	1.7200	1.8367	1.8367	2.3000	13.62	0.7099

CONCLUSION AND RECOMMENDATION.

- Minimum SG and PWL (%) recorded in Diamont cultivar while maximum PWL and SG were recorded in the tubers of Kruda cultivar during 90 days of storage.
- Minimum Green tubers (%) and sprouting length (cm) recorded in Kruda while these parameters were recorded minimum in Diamant cultivar.
- Maximum carbohydrates (%) recorded in Desiree and Diamont cultivars where as the carbohydrates (%)

components remained in the lowest range in Diamont and Kruda cultivars

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