

## BIOCHEMICAL BEHAVIOUR OF DIFFERENT CULTIVARS OF POTATO TUBER AT DIFFERENT STORAGE CONDITIONS

A.D. Kaul, Pradeep Kumar, Vandana Hooda, Anil Sonkusare  
CSIO Chandigarh.  
vandanahooda@gmail.com

**Abstract:** Storage behaviour of two processing cultivars were studied up to 210 days in controlled physical atmosphere of 800ppm CO<sub>2</sub> concentration and 90-95% RH at temperature 8 and 12° C. The processing varieties studied were K. Chipsona-1 and K. Chipsona-2 both grown at CPRI Patna. CIPC (isopropyl N-(3-chlorophenyl carbamate) in the form of spray were applied in storage to inhibit sprouting. Concentration variation of different biochemical parameter, reducing sugar, dextrose, sucrose, dry matter, specific gravity, chip color was observed after every 30 days during whole storage period. Reducing sugar increases during storage [1]. This was due to LTS and senescent sweetening (Breakdown of starch into dextrose and fructose).

### 1. INTRODUCTION

India is the third largest producer (approx. 25 million tones annually) of potato tuber in the world. Hardly 1% of the annual production is processed into value added products. One of the major reasons is the inadequate supply of quality raw material for processing industry. As potato is a seasonal crop, long term storage is necessary to provide raw material for processing industry throughout the year. Maintenance of high quality of potatoes for processing during long period storage is very difficult. There's always a sacrifice between processing quality and weight loss during storage. At low temperature storage potatoes shows accumulation of reducing sugar (fructose & dextrose) and sucrose in high amount, while at high temperature great weight loss in the tubers is found. Biochemical conversions in potato tuber during tuberization and storage are (Starch to Sugar & simultaneously Sugar to Starch) responsible for these losses. During storage Starch to Sugar conversion is 1/3 lower whereas the rate of opposite reaction i.e. Sugar to Starch is twenty times low as compared to reaction rate during tuberization. Whereas the sugar oxidation rate during respiration decreased by three times. [2] As a result of above conversions there are accumulation of sugars in potato tuber during storage. The phenomenon of accumulation of reducing sugar at low temperature is called low temperature sweetening (LTS). LTS happens due to increased membrane permeability and starch breakdown as starch is converted into glucose-1-phosphate in the presence of starch synthase and Glucose-1- Phosphate produces UDP-glucose, which combines with fructose-6-phosphate and synthesizes sucrose. Simultaneously Invertase converts sucrose into Hexose which is the respiration substrate in glycolysis. High sugar level is not acceptable for processing potatoes as it causes browning of the chip color due to

Maillard reaction in which the reducing sugar accumulated during storage reacts with proteins present in potato during frying at high temperature causes the dark color and bitter flavor in chips. The general Maillard reaction is:

(Carbonyl group of sugar +  $\alpha$ -amino acid group of nitrogenous compounds

→ melanoidin pigments + Flavor compounds). [3]

The color & flavor of chips is the major factor determining their acceptability by the consumer. Murata Yosuke observed low sugar in potato tuber stored at 10°C later Ezekiel study the less sugar accumulation and better chip color at high temperature in Indian potato varieties. To obtain chips of acceptable color warm storage can be tried. Chemical inhibitor is sprayed on the tubers to prevent sprouting to reduce the weight loss at high temperature. [1,3]RH and CO<sub>2</sub> are maintained to reduce starch and specific gravity changes. CO<sub>2</sub> accumulates due to Potato respiration which increases the level of sucrose and reducing sugar. G Mazza & A.J Siemens studied the detrimental effect of high levels of carbon dioxide on chip color.

The primary objective of our study is to see the effect of the storage environment conditions during long period of storage to determine the optimum storage environment conditions for different Potato varieties by studying their biochemical parameter. The effect of CO<sub>2</sub> concentration on fry color of potato tuber was studied at 800ppm CO<sub>2</sub> concentration in the storage.

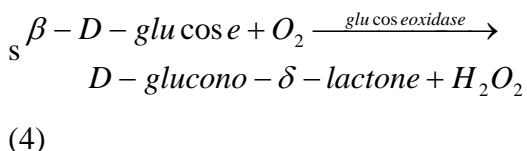
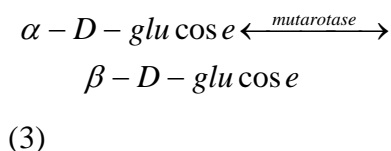
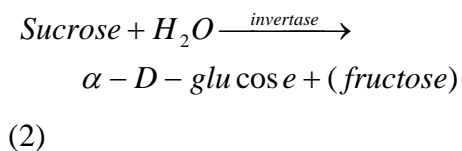
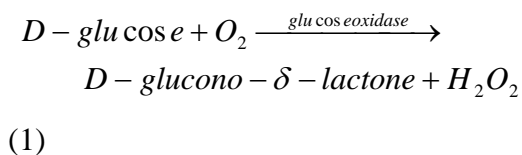
### 2. MATERIALS AND METHOD

**Materials** Two different cultivars K Chipsona 1 and K Chipsona2 of mature *Solanum tuberosum* were obtained from CPRI Shimla in April 2009; both were grown at Patna. Prior to storage, all tubers were cured for 2 weeks at 15°C and 90-95% RH at CPRI Shimla.

**Storage facilities and conditions** Potatoes were stored at CSIO Chandigarh storage facility. Two walk in chambers, one of them at 8°C with 800 ppm CO<sub>2</sub> and other at 12°C with 800ppm CO<sub>2</sub> were maintained during the storage period. Relative humidity in both chambers was 90-95% .Tubers was treated with CIPC to inhibit sprouting.

**Methods**

**Sugar analysis** Dextrose and sucrose were measured using Biochemistry analyzer (YSI 2700 ).100-200gm of washed peeled potatoes were used for each replication (n=3).The potatoe juice was drawn through a juicer and collected in a beaker. The juice was diluted up to 250 ml with buffer (40g/l NaH<sub>2</sub>PO<sub>4</sub>, 10g/l Na<sub>2</sub>HPO<sub>4</sub> in reagent water).solution was refrigerate for one hour prior to analysis (particles of high molecular weight like starch, proteins were settle down in the bottom. Measurement was carried out in triplicate. Immobilized enzyme biosensor for glucose and sucrose were installed in the Biochemistry analyzer.



An enzyme specific for the substrate (glucose, sucrose) is immobilized between two membrane layers: polycarbonate and cellulose acetate. Substrate is oxidized as it enters the enzyme layer, producing hydrogen peroxide, which pass through cellulose acetate to a platinum electrode, where the hydrogen peroxide is oxidized. The resulting current is proportional to the concentration of the substrate.

**Reducing sugar** Reducing sugar was determined by Nelson’s method (Nelson 1944).[5]

**Chip color** For chip color determination nine potatoes were taken, three for each replication .cut them

longitudinally into two equal half, one half for chips and other half for dextrose measurement. Starch from the slices were removed by washing them with flowing water and then dried with paper towels. Dried slices were fried in oil at 180-185°C. Chip color was compared to color cards (issued by CPRI Shimla) [1,4]scored from 1to10 (1for lightest color and 10 for the darkest) the chip color grade up to 4 is acceptable.

**Specific gravity** Specific gravity wad determined by PM 2050 Weigher (Weltech international ltd).Potatoes were weighed in air and water. Temperature of atmosphere and temperature of water was also taken into consideration.

**Dry matter** For dry matter content 50g of diced tubers for each replication (n=3) were dried at 80°C for 6 hours and then at 65°C until constant weight was achieved.

**3. RESULTS AND DISCUSSION**

**Sucrose** - both the varieties showed decrease in sucrose concentration up to 150 days of storage.KChipsona1 showed the highest concentration 410mg/100gm at 12°C and 800ppm CO<sub>2</sub>.K Chipsona2 also showed maxi concentration 339mg/100g at the same storage condition .In both verities considerable increase was observed from 150 to 210 days at 12°C.

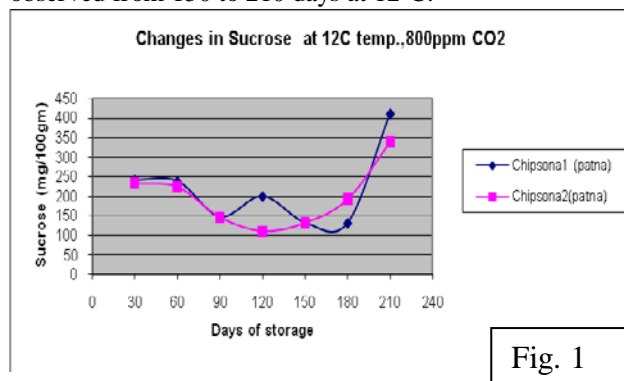


Fig. 1

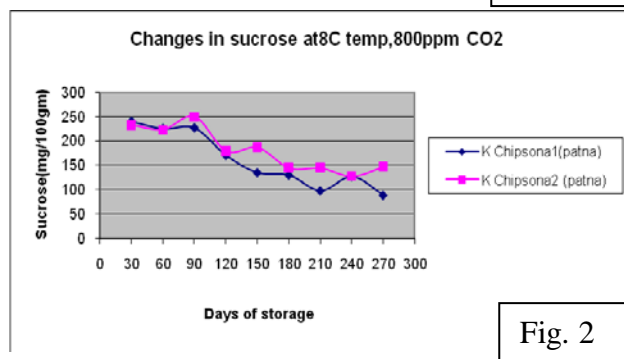


Fig. 2

**Reducing Sugar** Reducing sugar is main compositional factor responsible for potato chip color development. According to AP Rees Glucose and

fructose is the major constituent of reducing sugar in potato tuber. Invertase hydrolyzed sucrose into equimolar glucose and fructose ratio. But different turnover rates of glucose and fructose may cause the ratio to deviate from exact equimolarity. During storage concentration of glucose generally higher than that of fructose.

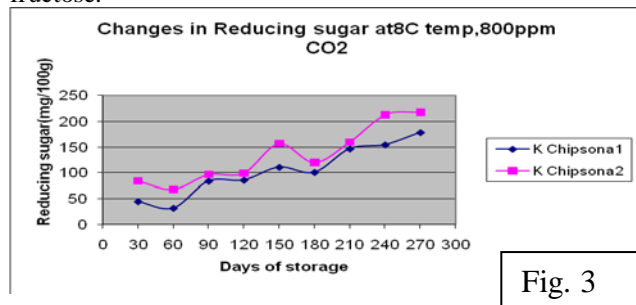


Fig. 3

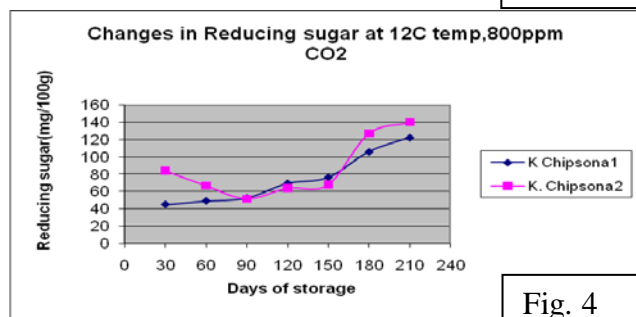


Fig. 4

variety	K Chipsona-1				K Chipsona-2			
	8C		12C		8C		12C	
Temp.	Dextrose	Chip color	Dextrose	Chip color	Dextrose	Chip Color	Dextrose	Chip color
Days								
30	9.5		9.5		64.33		64.33	
60	14.5	1	34.03	1	52	2	52	1
90	55	1	30	1	78	2	37	1
120	41.66	2	14.37	4	55.17	3	65	2
150	69.16	3	18.67	2	81.67	2	54	2
180	43.9	4	13	2	52.42	2	22.16	2
210	60	4	27.93	2	28	2	35.33	2

**Changes in chip color** Table1 shows changes in chips color during storage. We were using color cards, issued by CPRI Shimla [1,7]for comparison of the color of fried potato Chips. Score up to 4 were considered commercially acceptable. These score were correlated with total reducing sugar and dextrose. Considerable increase in browning were observed in sample stored at 8°C as compared to sample stored at 12°C in both cultivars during storage. This was due to higher reducing sugar accumulation at lower

**Total reducing sugar** Fig 3,4 showed changes in reducing sugar content during storage.[1,2,6]

Considerably higher content of reducing sugar were accumulated at 8°C in both varieties as compared 12°C. K. Chipsona 1 and K Chipsona 2 were showing acceptable concentration of reducing sugar up to 210 days of storage (below 250mg/100g). Reducing sugar increases throughout the storage period in both varieties.

**Dextrose** In case of K Chipsona-1 dextrose content were higher at 8°C except after 60 days of storage. Similar behavior was showed by K Chipsona-2 except at 120 and 210 days of storage. K Chipsona-2 showed higher dextrose as compared to K Chipsona-1 (Table1). [4]

temperature and milliard reaction between amino acids and the accumulated reducing sugar. Chip color deteriorated during storage.

K Chipsona 1 and K Chpsona 2 were given chips of acceptable quality up to the 210 day of storage period at both 8 and 12°C temperature. There's large positive correlation between reducing sugar and chip color. At 8°C, in case of K Chipsona-1 it was 0.84 and in case of K Chipsona-2 it was 0.62.

**Specific Gravity** specific gravity of potato tuber is the quality parameter that represents its solid content. Higher the specific gravity, higher will be the product yield made from per unit fresh tuber.[7,8] Under warm storage conditions increase in specific gravity was observed. Specially developed processing varieties K Chipsona-1 and K Chipsona-2 have very high content of specific gravity. There's no considerable effect of temperature on specific gravity during storage as shown in fig.5,6. Their mean specific gravity content was 1.084 and 1.094 respectively which increases up to 1.09and1.109respectively.

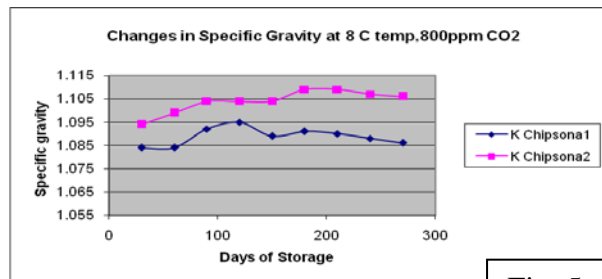


Fig. 5

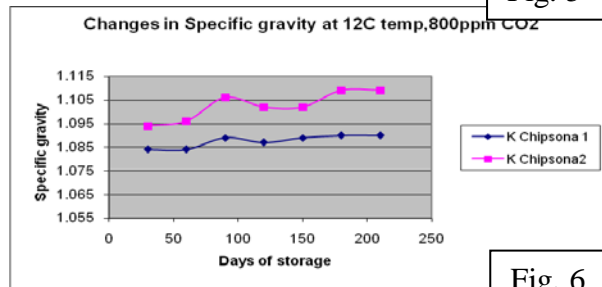


Fig. 6

**Dry matter** As shown in fig 7,8 dry matter increases during storage due to evaporation and respiration. Dry matter increase was higher at 12°C in both the varieties as compared to at 8°C temperature. This was due to high evaporation rate at higher temperature.

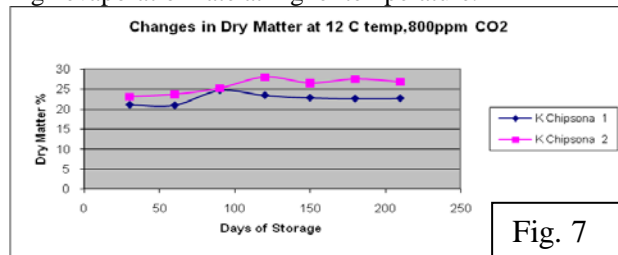


Fig. 7

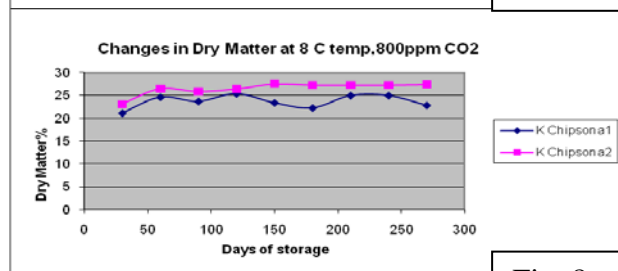


Fig. 8

#### 4. CONCLUSION

K Chipsona-1 and K Chipsona-2 both varieties gave acceptable chip color throughout the storage period. Complete inhibition of sprouting by CIPC spray was observed. Large positive correlation between reducing sugar and chip color was observed. At 8°C it was 0.84 and 0.69 for K Chipsona-1 and K Chipsona-2 respectively while at 12°C it was 0.56 and 0.29. Overall increase in reducing sugar was higher at 8°C as compared to 12°C [1, 8]. Chip color deteriorated as sugar increases during storage [1,9,10]. Dry matter has approximately. Same variation at both temperature 8 and 12° C. Dry matter increases slightly during storage due to moisture loss by evaporation and respiration. Sucrose decrease up to 150 days at both temperatures in both the varieties.

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