

# Changes in Composition of Potatoes *Solanum Tuberosum* cv. Huinkul Stored in Clamps

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## ABSTRACT

Changes in tuber composition related to potato (*Solanum tuberosum* cv. Huinkul) storage in clamps for 120 days, were studied. Dry matter ( $22.5\text{g} \pm 2.9$ ) was unaffected by storage. Protein, vitamin C, total lipids and phospholipids were calculated on a 100g dry weight basis. Initial protein content ( $4.71\text{g} \pm 0.5$ ) fluctuated during storage, having a similar percentage value at the end of the storage period. Vitamin C at harvest was  $100\text{mg} \pm 8.1$  and decreased to  $55.8\text{mg} \pm 8.4$  (120th day). Total lipids were  $0.6\text{g} \pm 0.15$  and  $0.25\text{g} \pm 0.06$  at the beginning and at the end of storage, respectively. Initial and final phospholipid content were  $0.14\text{g} \pm 0.02$  and  $0.16\text{g} \pm 0.02$ , respectively.

## INTRODUCTION

POTATO STORAGE in field clamps is a widely used method in Central and North Europe as well as in Spain and South America (Fabiani, 1967). In spite of possible variations in some physical parameters such as temperature inside the clamps (Crook and Watson, 1950), this storage system is reasonably efficient for the post-harvest conservation of potatoes (Burton, 1972) and it prevents tuber spoilage at low cost (Burton, 1966; Booth and Shaw, 1981).

Potato is a good source of vitamin C, particularly for individuals who do not regularly consume other fresh or frozen fruit and vegetables (Amer. Med. Assoc., 1974). Although the tuber lipid content is low (Galliard, 1973; Mueller and Mondy, 1977; Lee and Shin, 1979) it has been associated with discoloration in fresh potatoes (Mondy et al., 1965), unpleasant taste in dehydrated potatoes (Highlands et al., 1954) and to other problems related to potato processing (Kim and Kim, 1972).

Cheng and Muneta (1978) reported a detailed lipid analysis in Russet Burbank potatoes during storage. Also, lipid changes in several other potato varieties have been detailed (Galliard, 1973; Berkeley and Galliard, 1974). However, data on lipid and phospholipid changes in Huinkul potatoes during storage are lacking.

The main purpose of the present work was to investigate changes in dry matter, protein content, vitamin C, total lipids and phospholipids of potatoes during their storage in field clamps.

## MATERIALS & METHODS

*SOLANUM TUBEROSUM* potatoes, cv. Huinkul, were cultivated at the Balcarce Agricultural Research Station (I.N.T.A.). This variety represents approximately 45% of the total potato used as food in Argentina. Mature tubers were harvested by the end of March (early fall season) and immediately conditioned in three clamps. Clamps were built by tipping the tubers in heaps of conical shape (approximately 1.2 m diameter and 0.8 m height). Clamps were covered with layers 0.15–0.20 m thick of corn straw. Other characteristics of clamps and changes in physical conditions (e.g. temperature and humidity) during storage, have already been described (Burton, 1966; Crook and Watson, 1950).

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The potatoes were stored up to 120 days. Average fall temperature and relative humidity were  $10.3^{\circ}\text{C}$  and 84%, respectively. Under the above storage conditions and after 30–45 days of storage, about 20% of the tubers developed eye buds. After 90 days of storage, 2–3 mm sprouts were present in 50% of the tubers. At the end of the storage period (120 days), all the tubers were sprouted, with approximately 10 mm length sprouts protruding from potatoes.

At harvest and at different storage times, four tubers were taken at random from the center of each clamp to make up each sample. Each individual tuber was considered to be a subsample, and conveniently sliced in 2 mm thick pieces. Each slice was chopped into smaller pieces. Ten grams of material from every subsample were taken randomly.

Dry weight was determined by drying 10g of chopped potatoes at  $50^{\circ}\text{C}$  up to constant weight. Protein content was determined by Lowry's method (Lowry et al., 1951).

Vitamin C was extracted from tuber slices with 2.5% (w/v) oxalic acid, and ascorbic acid was oxidized to dehydroascorbic acid by the addition of bromine. 2,4-Dinitrophenylhydrazine was added to the oxidation products and the red color of resultant osazone was photometrically measured according to the method of Roe and Oesterling (1944).

Total lipids were extracted from fresh tuber slices (10g) with 10mL cold chloroform-methanol 2:1 (v/v) mixture, in a Virtis homogenizer. The homogenate was filtered through Whatman paper and the filtrate collected. The extraction and filtration steps were repeated twice and the filtrates were mixed to obtain the crude Folch's extract (Folch et al., 1957). The bulk of the neutral lipids, phospholipids and free fatty acids are present in this extract (Cheng and Muneta, 1978). To extract the remaining high polarity lipids, the residue was extracted three times with  $\text{Cl}_3\text{CH}/\text{CH}_3\text{OH}/\text{HCl}$  (2:1:0.25% v/v/v) to obtain the crude Dawson-Eichberg's extract (Dawson and Eichberg, 1965). Both crude Folch's and Dawson-Eichberg's extracts were purified as described previously (Folch et al., 1957; Dawson and Eichberg, 1965).

After separation of aliquots for determination of phospholipid phosphorus, Folch's and Dawson-Eichberg's extracts were dried under nitrogen and weighed. Total Folch's plus Dawson-Eichberg's dry weight was associated to total lipid content.

Aliquots of Folch's and Dawson-Eichberg's extracts were digested with perchloric acid, and inorganic phosphorus was determined by the method of Chen et al. (1956). The phosphorus content of both fractions were added. Total phospholipid value was calculated using 1-linoleyl-2-linolenyl phosphatidyl ethanolamine and 1-linoleyl-2-linolenyl phosphatidyl choline mixture (1:1) as the model phospholipid. These are the predominant phospholipids and fatty acids in Huinkul potatoes (Plaza et al., 1983).

Confidence limits were calculated for each mean ( $p < 0.05$ ). Differences among means were tested by the Tuckey test (Steel and Torries, 1960).

## RESULTS & DISCUSSION

DRY MATTER of tubers was  $22.5 \pm 2.9\%$  at the beginning of storage. This value remained significantly constant ( $p < 0.05$ ) through all the storage time, and up to 120 days after harvesting. A similar initial value was reported by Ordóñez (1977) for the same cultivar. In other potato cultivars Treadway et al. (1949) reported no changes in per cent of dry matter during storage. Burton (1966) showed that the cover of clamps reduced bud, but did not completely prevent the loss of water from the tubers, therefore the constancy of the dry matter percentage has been attributed to decreases in starch and sugar content (Treadway et al., 1949).

Changes in protein content during potato storage are shown

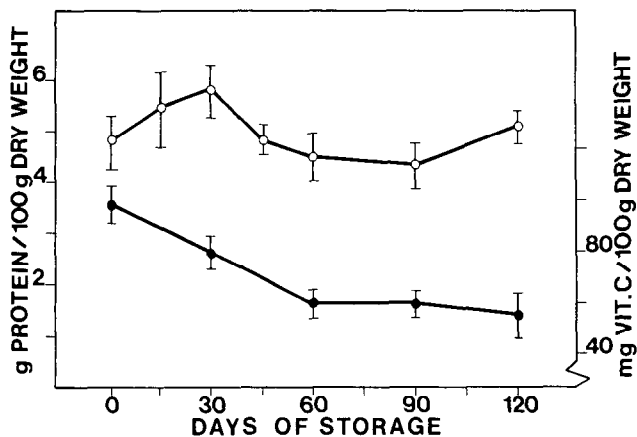


Fig. 1—Effect of storage in clamps on protein (○—○) and vitamin C (●—●) contents of *Solanum tuberosum*, cv. Huinkul. Vertical bars represent confidence limits ( $p < 0.05$ ).

in Fig. 1. At harvest time potato contained an average of 4.5% protein. A 21% increase ( $p < 0.05$ ) in protein content was observed during the first 30 days of storage. After 60 days of storage, protein content decreased ( $p < 0.01$ ) to previous levels. This fluctuation in protein content could be attributed to demands of enzymatic system affiliated with sprouting (Szalai and Devay, 1957) or to relative respiratory losses of carbohydrates (Ashford and Levitt, 1965).

Vitamin C content in potatoes is dependent on several factors including production, potato cultivar, harvest and storage conditions as well as on the length of storage (Agustin et al., 1978; Vitek and Mihelic, 1978; Shekhar et al., 1978).

After harvest, mature Huinkul tubers contained 100 mg vitamin C/100g dry weight (Fig. 1). Previous work showed considerable varietal differences in ascorbic acid contents of potatoes (Biletska, 1961). Vitamin C levels in Huinkul cultivar were similar to those reported for Pungo and Rossemont Cobbler cultivars (Sweeny et al., 1969) and higher than those found in either Kennebec or Russet Burbank cultivars, although the latter were analyzed for ascorbic acid only (Shekhar et al., 1978).

The influence of storage on the vitamin C content of tubers is shown in Fig. 1. Potatoes lost 40% of the vitamin C content during the first 60 days of storage and no major changes were observed thereafter. A similar vitamin C decrease during the storage was reported by other workers (Sweeny et al., 1969; Shekhar et al., 1978). Since storage at low temperature alters carbohydrate metabolism in tubers (Treadway et al., 1949) and carbohydrate metabolism is related to ascorbic acid biosynthesis (Trautner and Somogyi, 1964), it is not surprising to observe a decrease in ascorbic acid during potato storage.

At the beginning of storage the total lipid content in Huinkul potato was 0.6% (Fig. 2). Similar low lipid contents were also found in other cultivars (Lee and Shin, 1979; Mondy and Mattick, 1969). Total lipid content in Huinkul tubers experienced a 29% decrease during the first 60 days of storage, it remained fairly constant during the next 30 days, and decreased again up to the 120 days total storage time (Fig. 2). The total fall in lipid content was 59% during the 120-day period of storage after harvesting. Lipid content in Majestic, Maris peer and Golden Wonder potato varieties stored at 5°C decreased 12, 21, and 25%, respectively, during the 30 days following harvest (Berkeley and Galliard, 1974). Mondy and Mattick (1969) reported only a slight decrease in lipid content of cortex and pith sections of Pontiac potatoes stored at 5°C, following sprouting.

In unstored potatoes phospholipids accounted for 23% of total lipids (Fig. 2). Phospholipid content decreased during the first 30 days of storage in a way similar to that of total lipids in the same period. An important increase was observed be-

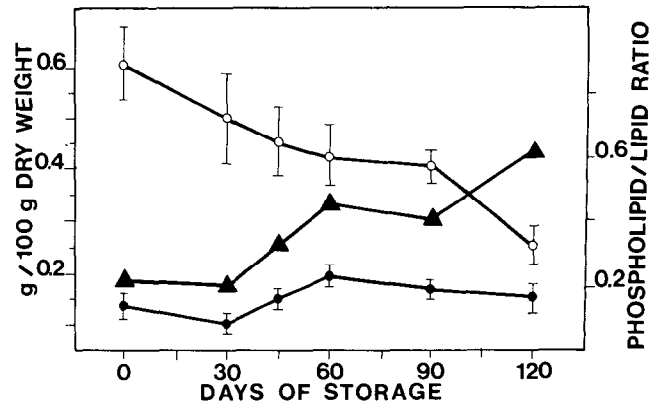


Fig. 2—Effect of storage in clamps on total lipids (○—○) and phospholipids (●—●) of *Solanum tuberosum* cv. Huinkul. (▲—▲) Phospholipids to total lipids ratio. Vertical bars represent confidence limits ( $p < 0.05$ ).

tween 30 and 60 days of storage and a gradual decrease thereafter, until the end of storage. Sixty percent of total lipids were phospholipids (Fig. 2) at 120 days of storage.

Similar phospholipid profiles were found in other cultivars stored in identical conditions and in several consecutive years (Plaza et al., 1983). Cheng and Muneta (1978) reported a decrease in phospholipids content and changes in phospholipid composition in Russet Burbank potatoes stored 225 days at 5.6°C.

The phospholipid to total lipid ratio shows a general tendency to increase (Fig. 2). This is mainly reflecting the total lipid fall and the overall tendency of phospholipids to remain constant at the end of storage.

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