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### EFFECT OF STORAGE TEMPERATURE ON VITAMIN C CONTENT OF MUSHROOMS (*AGARICUS BISPORUS*)

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MUSHROOMS are generally consumed for their flavour and texture but their nutritive value has been appreciated only recently. They constitute a good source<sup>1-3</sup> of vitamin C. Very few studies are available on vitamin C content of mushrooms and there is a wide variation in the reported values (2.6 to 788 mg/100 g). Besides, mushrooms have short shelf-life at ordinary temperature but can be stored for several days in a refrigerator. Changes in vitamin C levels in mushrooms during post-harvest storage have been studied in the present investigation (vitamin C includes both ascorbic acid and its oxidation product, dehydroascorbic acid (DHA) as both are antiscorbutic).

Button mushrooms ( $3.5 \pm 0.2$  cm cap diameter), packed (200 g lots) in 100 gauge perforated polyethylene packets were stored in B.O.D. incubators at 5°C (85-90% RH), 10°C (70-75% RH) and 15°C (55-60% RH). Four replications were maintained. Samples were drawn every day till the 4th

day. For analysis, one longitudinal quarter from each mushroom was pooled; 20 g of the pooled sample were extracted twice with a mixture of 5% metaphosphoric acid + 10% acetic acid and filtered on a sintered Buchner funnel (porosity G. 2). The filtrate was analysed for the total vitamin C content, ascorbic acid and dehydroascorbic acid by dinitrophenyl hydrazine method using acid washed Norit as oxidant<sup>4</sup>.

Immediately after harvesting, the mushrooms contained about 83  $\mu\text{g}$  vitamin C (80  $\mu\text{g}$  ascorbic acid + 3  $\mu\text{g}$  DHA) per gram fresh weight. Similar values have been reported by other workers<sup>2,5</sup>. Almost all the vitamin C in fresh mushrooms was in the reduced form as in other vegetables and fruits<sup>4,6</sup>. After 4 days of storage the mushrooms lost about 12-25% of vitamin C, the loss being greater at 15°C, but major changes were noticed in the proportion of reduced: oxidized forms of vitamin C. Decrease in ascorbic acid was accompanied with increase in DHA, and higher storage temperature had profound effect. The above changes, not significant up to 24 h, increased significantly with time (figure 1).

Ascorbic acid is oxidized to dehydroascorbic acid by many oxidases especially the ascorbic acid oxidase which catalyses direct oxidation using molecular oxygen. Other oxidases cause indirect oxidation i.e. through their oxidation products. DHA is reduced to ascorbic acid by DHA reductase using glutathione. The oxidation of ascorbic acid to DHA, therefore does not represent the loss of vitamin C as both forms are antiscorbutic. The loss of the vitamin occurs due to further conversion of DHA to diketogulonic acid (DKA), which is irreversible. The reaction is highly pH-dependent, slow

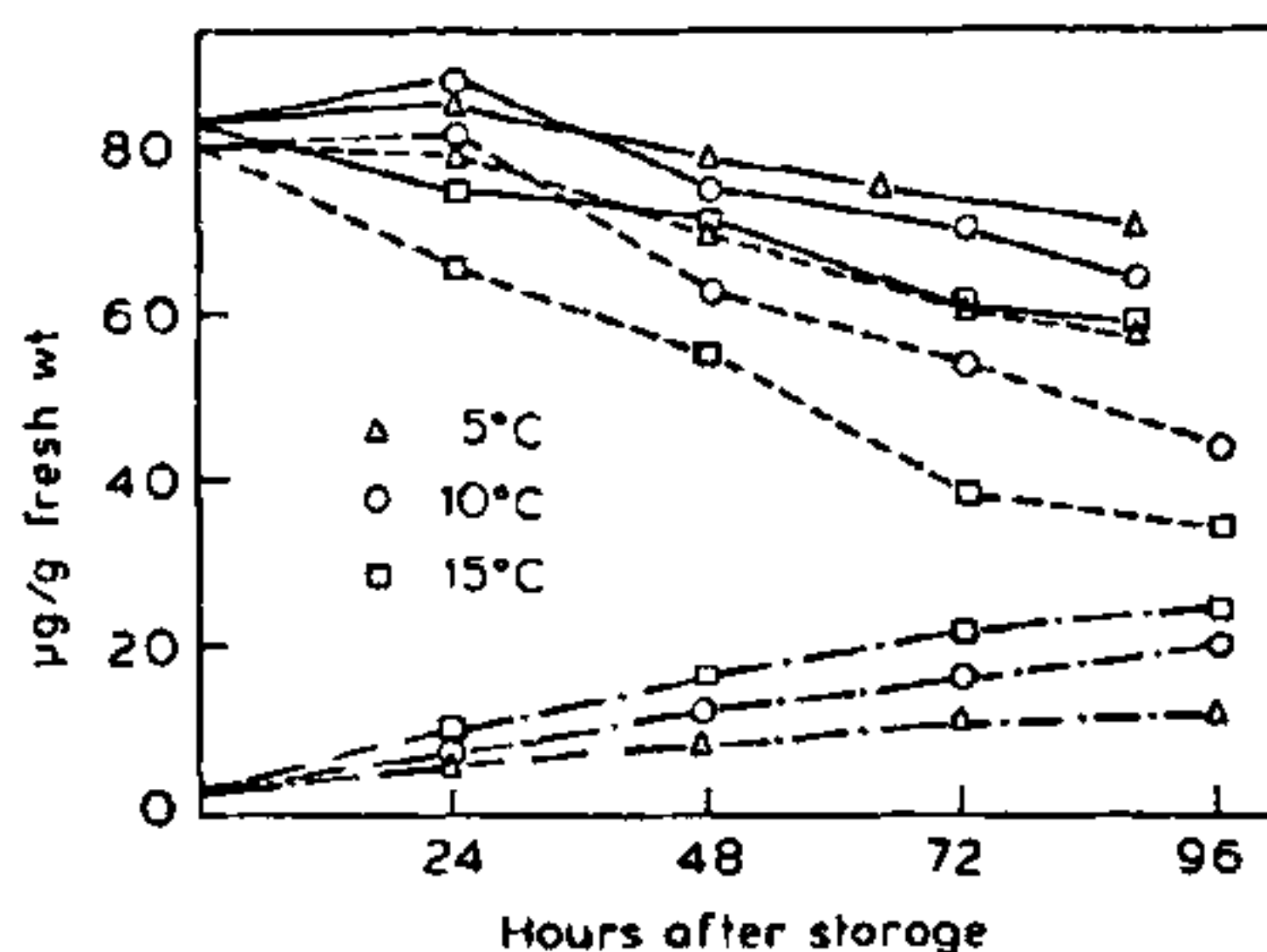


Figure 1. Effect of storage temperature on the contents ( $\mu\text{g}$  per g fresh weight) of total vitamin C (—), ascorbic acid (---) and dehydroascorbic acid (· · ·) in mushrooms (*Agaricus bisporus*).

in acidic pH, rapid at neutral and extremely rapid at alkaline pH. The high loss (12–25% in 4 days) of vitamin C may be due to high pH (6.8) of the mushroom sap. Loss of vitamin C in citrus fruits (pH 3–4) has been found to be less than in potatoes (pH 6)<sup>6</sup>. Increased rate of conversion of ascorbic acid to dehydroascorbic acid at higher temperature may be due to the increased activity of ascorbic acid oxidase and other oxidases. Oxidases, particularly polyphenol oxidase (E.C.1.10.3.1), are very active in white button mushroom and its activity increases with increase in storage temperature<sup>8,9</sup>. It is known that quinones, the products of the enzymatic oxidation of phenols by phenol oxidase, cause non-enzymatic oxidation of ascorbic acid and this reaction has even been used in the spectrophotometric assay of phenol oxidase<sup>7</sup>. Increased loss of vitamin C at higher temperatures may be due to the high level of DHA available for the conversion to DKA. Slow loss of vitamin C in oranges and grapes has been observed at 5.5°C but the loss increased at higher storage temperature<sup>9</sup>. The vitamin C in mushrooms was best preserved at 5°C.

25 June 1987; Revised 12 October 1987

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## A NOTE ON SPONTANEOUS MIXOPLDID IN *CAPSICUM*

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MIXOPLDIDY is a condition in which the tissue is composed of cells with different ploidy levels. The origin of mixoploids may either be spontaneous or induced. However, their spontaneous occurrence is a rather uncommon phenomenon. A perusal of the existing literature revealed that in majority of the cases mixoploidy was confined mostly to somatic tissues<sup>1,2</sup> although there are a few reports of its occurrence in germinal cells<sup>3</sup>. Hitherto mixoploids were not on record in the genus *Capsicum*. The present paper reports for the first time the occurrence of a spontaneous mixoploid *Capsicum* and documents its cytomorphological details.

A semisterile variant was located in LCA 250, a cultivar of *C. annum*. Meiotic studies were made following acetocarmine squash technique. Morphologically the variant plant showed normal growth with good height (82.5 cm) and spread (112 cm). Leaves were small when compared to the diploid progenitor. Further it was characterized by its semisterile nature with very low fruit set. Pollen sterility was moderate (58%) with marked pollen polymorphism.

Meiotic studies revealed that the PMCs with diploid (figure 1) and tetraploid (figure 2) chromosome numbers were intermixed, the frequency of which was 64.7% and 35.2% respectively. In diploid cells the rod bivalents occurred in a greater frequency over the rings. Chromosome associations such as quadrivalents and trivalents ranging from 5 to 8 and 0 to 2 per cell respectively were noticed in the tetraploid cells (figure 2). The chiasma frequency per cell was quite low in diploid cells (13.58) in contrast to the good number of chiasmata per nucleus (38.5) in tetraploid cells. The post metaphase I meiotic stages were somewhat irregular with unequal anaphase segregations (8.25%), laggards (2.5%) and variable number of nuclear groups (6.4%) at telophase II.

Earlier investigators opined differently regarding the origin of mixoploidy and attributed it to the fusion of neighbouring cells prior to preleptotene<sup>4</sup>, assembling of chromosomes from different cells<sup>5</sup> and defective cell wall formation<sup>2</sup>. The presence of diploid and tetraploid PMCs in the same anther in the present study may be due to defective cell wall