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EFFECT OF γ IRRADIATION AND STORAGE TIME ON THE ASCORBIC ACID CONCENTRATION IN ONION BULBS (*ALLIUM CEPA* L.)

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A b s t r a c t. The stability of ascorbic acid (AA) of irradiated onion bulbs stored at 4 and 20 °C was studied. Gamma ionisation at 0.10; 0.15 and 0.30 kGy causes losses of 10, 13 and 20% of AA content, respectively, and the *D* value (Decimal Reduction Dose) of AA ionising treatment was estimated at 3.19. During the first 12 weeks of storage AA content decreased in nonirradiated and irradiated bulbs at 0.10, 0.15 and 0.30 kGy, respectively, to 4.52, 4.56, 4.81 and 5.18 mg 100 g^{-1} FW at 20 °C. At 4 °C, AA decreases to 5.92, 6.53, 6.08 and 5.92 mg 100 g^{-1} FW. From 12 weeks to the end of the storage period (24 weeks), AA increased but the final concentrations observed were lower than the initial levels and ranged from 15 to 30% less at 20 °C, and from 5 to 20% at 4 °C.

K e y w o r d s: onions, ionisation, ascorbic acid, storage

INTRODUCTION

Onion bulbs *Allium cepa* L. are one of the world's oldest cultivated vegetables and are widely used for culinary purposes. Apart from their remarkable medicinal, antifungal and antibacterial properties [15], onions are generally consumed for their flavour; their nutritive value has been appreciated only recently [11].

Several investigations have been carried out throughout the world on the use of ionising radiation for sprout control of onions [8,14]. The irradiation at doses from 0.05 to 0.15 kGy inhibits bulbs sprouting, and is most effective when applied during the rest (dormancy) period [13]. Treated bulbs can be stored for several months without heavy spoilage [13,15], though, the storage conditions are also important for determining the behaviour of onions [6].

Ascorbic acid (AA) is a major vitamin in the bulb [17] but is degraded rapidly in light, heat and freezing conditions [5,6]. According to Molco and Padova [9], the AA content of onion bulbs irradiated with 0.07 kGy and stored at room temperature was similar to that of untreated bulbs after up to 5 months storage. Murray [10] found that onions treated with 0.02 to 0.06 kGy in the presence of air resulted in the conversion of some ascorbic acid to dehydroascorbic acid without having much effect on the nutritional value.

The purpose of this study was to investigate the rate of AA degradation as function of the dose of gamma radiation, and its subsequent variation during long term storage at 18 and 4 °C.

MATERIAL AND METHODS

Onions: Onion bulbs *Allium cepa* L. cv Rouge AMPOSTA were produced in an experimental plot, Mascara, Algeria, harvested in August and dried in the field for 15 days. They were then sorted for uniformity and absence of physical defects and packed in lots of 12 kg in commercial (PVC) trays.

Irradiation: Irradiation was carried out at the Commissariat de Développement des Techniques Nouvelles, Algiers with an experimental

irradiation facility. The radiation source of 200 kCi was ^{60}Co, and the doses were 0.10, 0.15 and 0.30 kGy with the time of exposition of 20, 30 and 55 min and a temperature of 20 °C. Fricke dosimeter (FWT-70-40M) have been used for process control.

Storage: Immediately after ionising treatment, onion bulbs were stored either at room temperature (20 °C) and 75% RH, and in refrigerated room (4 °C) and 75% RH.

RESULTS AND DISCUSSION

Effects of γ irradiation on AA content

Immediately after ionising treatment, AA loss was proportional to radiation dose (Table 1). The degradation was due mainly to radiolytic products which release oxygen molecule (O_2) responsible for oxidising AA to dehydroascorbic acid (DHA). This reaction with oxygen confers to ascorbic acid a protective action and the effects of irradiation are reduced. However, the action as free radical acceptor of AA remains unclear and further studies on this aspect are required to determine the molecular structure involved in this protective reaction. The rate of degradation of AA calculated from raw data was represented by the D value and was estimated graphically at 3.19 (Fig. 1). Statistic study (at $\rho < 0.05$) showed that, 0.10 and 0.15 kGy treatments were not different, but 0.30 kGy was different for both 0.10 and 0.15 kGy treatments.

Table 1. Effect of γ irradiation on ascorbic acid content of onion bulbs *Allium cepa* L.

	Irradiated (kGy)			
	Untreat	0.10	0.15	0.30
Ascorbic Acid (mg 100 g^{-1} FW)	10.64±1.04	9.50±0.98	9.25±0.80	8.51±0.91
% losses		10	13	20

Ascorbic Acid (AA) assay: Extraction of AA was carried out according to the A.O.A.C method [1]. Samples of 25 g fresh onion tissue were homogenised for 2 min in 100 ml of aqueous 3% (w/v) metaphosphoric acid solution. The slurry was centrifuged for 10 min at 1100 g and the supernatant filtered through Whatman 4 paper. This solution was analysed for AA content by the 2.6 dichlorophenol indophenol volumetric method [1].

Decimal Reduction Dose (D) calculation: D value was calculated according to the following equation:

$$a = \frac{\log B - \log A}{D}$$

where a - slope of the regression curve log (AA) = f(dose), and, with $A = 10B$, we obtain:

$$D = \frac{-1}{a}.$$

Statistical analysis: Experiment was performed in triplicate and repeated in two successive harvesting seasons (1995 and 1996). Statistical analysis (ANOVA test) of the data was done by XLStat Pro© 4.0 software.

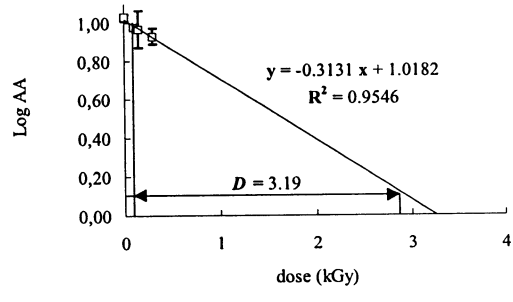

Fig. 1. Dose effect of γ irradiation on degradation rate (D) of ascorbic acid (AA) in onion bulbs.

Ghods *et al.* [2] observed similar results with irradiated onions, where 30% of AA was lost following 0.03 kGy treatment. Graham and Stevensen [3] observed 20% loss of AA in potatoes irradiated with 0.15 kGy. Lewis and Mathur [6] reported no significant difference immediately after irradiation of onion bulbs with 0.15 kGy.

Changes in ascorbic acid during storage

During the first 12 weeks of storage, temperature had little effect on AA (Fig. 2). Subsequently, at 20 °C AA decreased to 4.52, 4.56, 4.81 and 5.18 mg 100 g^{-1} of fresh weight respectively in untreated and 0.10, 0.15, and 0.31 kGy (Fig. 2b). At 4 °C, AA decreased to 5.92, 6.53, 6.08 and 5.92 mg 100 g^{-1}, respectively.

Between the 12th and 24th week of storage, AA increased in untreated and irradiated bulbs at both temperatures. However, the final AA concentrations observed were lower than the initials and ranged from 15 to 30% less at 20 °C, and from 0 to 20% less at 4 °C.

The increase may have been due to the desiccation of onion bulb tissue during sprouting, and partly to reversal of the oxidation of AA. Thus, a small amount DHA would be reduced to AA as suggested by the presence of sulphydril compounds (aromatic precursors) which are a reducing compounds.

Several authors have noted a decrease in AA in both stored irradiated or untreated onions or over vegetable crops, e.g., potatoes, garlic [6, 11,12,16] during storage. Increases of AA content was reported by Matkovics [7] in both irradiated and untreated onions but only after 2 storage months under optimal conditions and during the 4 last storage months. Grahams and Stevensen [3] reported a similar increase in potatoes stored 5 months at 12 °C. The stability of AA is dependent on other factors involved in its reactivity as reaction kinetics [4] and water activity (Aw) [5].

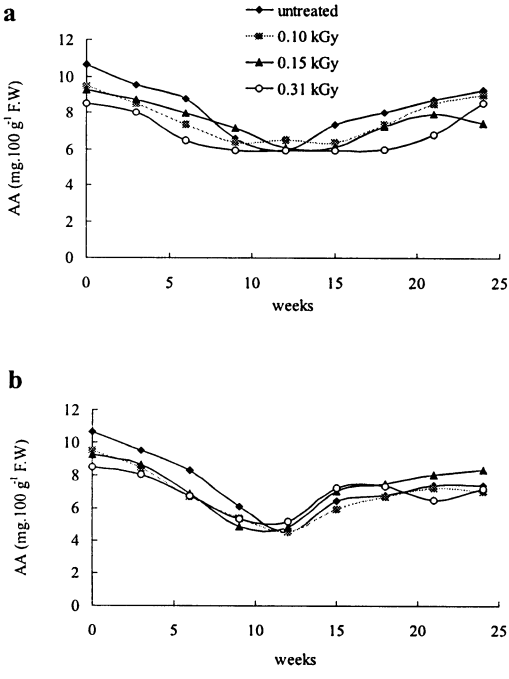

Fig. 2. Variation of ascorbic acid (AA) content of irradiated onion bulbs during storage at 4 °C (a) and 20 °C (b).

CONCLUSION

The ascorbic acid content of fresh onion bulbs was affected by gamma radiation. However, the changes observed during storage in irradiated bulbs were similar to those of untreated bulbs stored under both temperatures, but with higher losses at 20 °C.

It appears that the stability and variation of AA during storage in onion bulbs do not depend only on the irradiation treatment and doses, but also on environmental factors of storage such as temperature.

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