QUALITY PRESERVATION OF STORED DRY FRUIT BY CARBON DIOXIDE ENRICHED ATMOSPHERES

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Abstract:
Methyl bromide has been used for controlling dry fruit pests in storage. To develop an alternative treatment which would prevent insect development and preserve fruit quality a controlled atmosphere of 60-80% carbon dioxide was used within a 151 m^3 plastic chamber partially filled with 30 tons of dates stacked in crates on pallets. At the initial purge phase the desired carbon dioxide concentration was obtained in the chamber within one hour by introducing the gas under high pressure. An intermittent maintenance phase was then applied for 4.5 months using approximately 0.8 kg carbon dioxide per day. At the end of storage, quality of the treated dates was compared to controls stored at -18° C. No significant difference was found between the treated dates and controls. The insect population was effectively controlled and reinfestation prevented. This technology is proposed for the treatment of stored dates, and may also be applicable to other dried fruits, to control pests and maintain quality.

Introduction

Dried fruits are subject to infestation by insects during and after harvest. Several species of nitidulid beetles are particularly associated with dried fruits being both field and storage pests. In Israel dates are fumigated with methyl bromide (MB) upon arrival at the packing plant which effectively controls infestation. The conventional date preservation method after fumigation is cold-storage at -18°C. This is most suitable for soft-fruit sensitive cultivars but it is energy consuming and expensive. Although limited work has been carried out to determine the influence of CAs on date quality, under laboratory conditions and in field tests at ambient temperatures we showed that carbon dioxide (CO_2) significantly delayed browning and sugar formation, and extended shelf life. The possibilty of using controlled atmospheres (CAs) as an alternative to fumigants in general and MB in particular as well as their potential for maintaining quality during prolonged storage provided the incentive for this study which describes the use of a gastight plastic liner especially designed for the CA storage of dates in Israel.

Materials and methods

The gastight flexible structure **This structure was erected on a shaded asphalt-paved site and kept at the ambient temperatures prevailing in the Bet-Shaan valley in Israel. The completed structure resembled a cube. It was equipped with a ball valve welded to the lower front end for the introduction of CO_2 and a screw-on valve 100 mm diam. welded in one corner at the top for pressure release. The cube measured 4.2 m high by 6 m wide and 6 m long with a volume of 151 m^3. These**

dimensions enabled the storage of 72 crates on pallets each measuring 1 m x 1 m x 2.1 m high.

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Test for gastightness **Initial tests for gas tightness were carried out before loading with 72 empty crates to hold up the structure. In this manner the cube was tested without dates three times with improvements in the gastight seal made between each test, and then once again with dates inside. A suction fan was used to create a negative pressure, thus enabling gastightness to be tested using the pressure decay method. A transducer (Celesco) was used to monitor the pressure. The tests were carried out by creating an initial negative pressure of 40 to 60 mm water column, after which the ball valve was closed and the rate of rise in pressure was measured.**

Quantity of dates stored: **The dates were stored in the cube in bulk (in boxes of 10 kg or crates of 400 kg on pallets) or packed (250 g capped plastic cups) on pallets . To load the dates into the cube the top section of the cube was cut and separated in order to enable removal of 30 empty pallets which were replaced with 30 pallets containing dates of var. Hallawi, Hadrawi, Zahidi, Derei and Ameri. The cube was partially loaded with 30 tonnes of dates and then sealed, while the remaining space in the cube was filled with 42 pallets without dates.**

CA treatments - CO_2 gas purge and maintenance: **During the purge phase the upper valve was opened in order to prevent build-up of gas pressure. Liquid CO_2 was allowed to flow into the cube from the lower valve which was connected in sequence to inverted 24 kg capacity CO_2 gas cylinders (emptied into the cube within 4 min). During the maintenance phase CO_2 concentration was controlled using an O_2 analyzer equipped with control relays capable of operating in the presence of high concentrations of CO_2. The analyzer was set to activate a solenoid valve attached to the CO_2 cylinder when the O_2 concentration within the cube rose above the set point. Rate of CO_2 flow was determined by a pressure regulator set at a flow rate between 450 and 940 mL/min. In addition to continuous measurement of O_2 concentration, the CO_2 concentration was measured daily with a portable gas analyzer.**

Sampling and test of date quality: **Dates were sampled before closing the cube, after one month and after 4.5 months at the end of storage. Tests included: a) presence of insects and molds according to Israel standard 1251 (Dried Fruits -Dates); b) skin blistering; c) sugar formation; d) water activity (a_w); and e) color changes (only on var. Zahidi).**

Results and Discussion

Gas concentration in the cube: **CO_2 concentrations over a storage period of about 4.5 months showed that the level of CO_2 remained about 85% for the first 10 days and then fell to 60%, while the O_2 level was about 4% at the outset and rose to 7%. These O_2 concentrations were used as set points in the monitoring system.**

Amount of gas required to create the CO_2 based controlled atmosphere: **A total of 180 kg CO_2 (equivalent to 98.6 m^3 of gas at 30°C) was used. This is equivalent to an initial CO_2 concentration of 92%. Actually, at the outset an average concentration of 87.8% was recorded.**

Balance of the CO_2 loss during storage: **To maintain a constant concentration for 4.5 months of storage, four CO_2 cylinders were used, equivalent to a consumption of 0.8 kg**

of CO_2 per day (equivalent to 438 L CO_2/day). Based on the specification of the liner for CO_2 permeation, and the calculated surface area of the cube, the calculated loss of CO_2 through the plastic cover is 202 L CO_2/day. The differences between the theoretical amount of gas that should be supplied (202 L CO_2/day) and the actual amount of CO_2 that entered the cube (438 L/day) point to the existence of undiscovered leaks.

Date quality: **Tests for presence of insects and molds revealed no development during storage in the cube. Water activity of dates remained low from beginning to end of storage in the range of 0.55 to 0.64 a_w. No significant change in blistering of peel nor in sugar formation on all the tested varieties of dates was observed after 4.5 months of storage.**

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