Dynamic Controlled Atmosphere (DCA)- A chance for sustainable organic fruit storage

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Abstract

Modern pomefruit storage systems developed from cool storage in air to CA-storage and further to ULO-storage. Recently, DCA storage has been studied more thoroughly. With the development of each new storage method, the threshold for oxygen partial pressures has been lowered. During storage, "oxygen stress" in the fruit can be determined non-destructively from either the chlorophyll fluorescence (DCA-CF), the release of anaerobic products (DCA-Eth), the calculation of the respiratory quotient (DCA-RQ), or the calculation of the CO_2-respiratory (DCA-CD) like FruitAtmo. Oxygen levels can be dynamically changed depending on the stress level of the fruit due to anaerobic metabolism. In very low oxygen storage, respiration is reduced to a minimum, ripening processes are slowed down and fruit quality can be maintained over long time periods. When oxygen is exhausted, anaerobic metabolism occurs, which results in the production of alcoholic compounds like ethanol, acetaldehyde and ethyl acetate, that can cause "off-flavours" in the fruit. The lowest oxygen level tolerated by the fruit is called the anaerobic compensation point (ACP) with values for apple normally between 0.1 and 0.5 kPa O_2. Storage below the ACP will cause anaerobic metabolism. As a result of the ripening inhibiting conditions in DCA-storage, flesh firmness of apples can be more maintained along with the skin green ground colour than in ULO storage. Incidence of physiological disorders, like superficial scald and skin spots, can be reduced as well as fungal diseases. Another important advantage is an increase of aromatic compounds resulting from controlled anaerobic metabolism, which, up to a certain point, can occur without any loss of fruit quality. To guarantee an effective DCA storage, gas tight rooms, homogenous fruit lots (same cultivar, maturity and quality), as well as constant monitoring of the storage atmosphere are required. As long as these factors are kept in mind, DCA-storage can maintain fruit quality with no additional use of chemicals and has a considerable potential to save energy with the use of elevated storage temperatures. The new DCA-CD "FruitAtmo" method has the advantage of ACP determination and oxygen control, but also allows the temperature to be adjusted to the fruit needs. By that it is possible to increase the temperature as showed in the first results in a practical apple storage room, and to cut energy usage by more than 35 % and run refrigeration aircoolers in a defrost free modus. A promising idea for the near future is a "dialogue" with the stored fruits, using a multifactorial system that incorporates different parameters like variety, quality criteria, harvest date and storage conditions. Based on this system an automatic decision-making tool will be developed with the objective to optimize storage conditions to guarantee a maintenance of fruit quality at harvest level and to minimize energy consumption.

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Introduction

In recent decades there has been a breakthrough in fruit storage methods, especially apples. It seeks communication between the store and the fruit (Fig 1). In recent years a cooperation between UFSM, KOB and Frigotec have developed the first dynamic controlled atmosphere “FruitAtmo” method where two factors are dynamically controlled, oxygen and temperature.

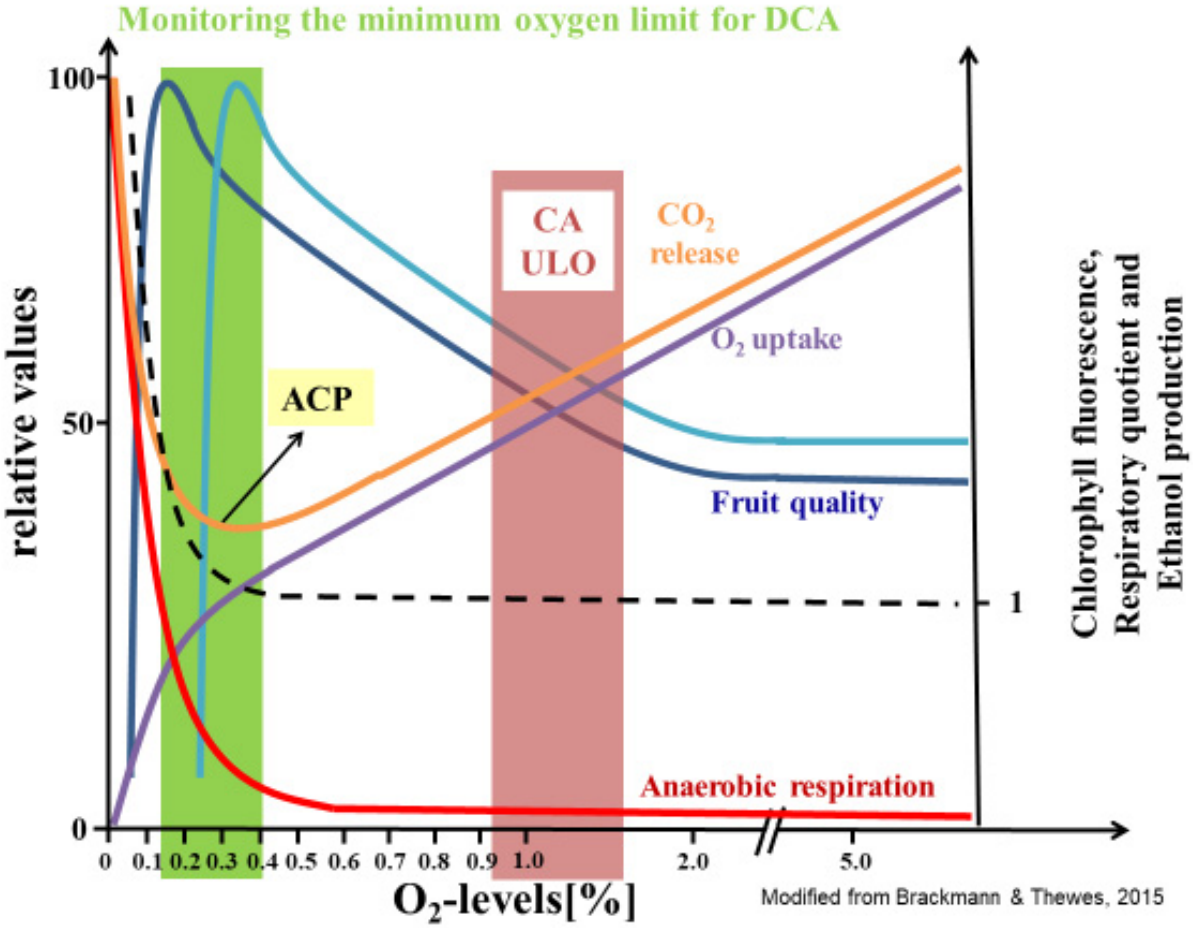

Fig 1: Schematic representation of monitoring the minimal oxygen limit (MOL) for three different DCA methods’: Chlorophyll fluorescence, Respiratory quotient and Ethanol production.

Material and Methods

The ‘Shalimar’ and ‘Red Prince’ apples were harvested at optimal harvest date in an orchard at KOB and stored in different optimal storage condition to compare the new FruitAtmo method. The oxygen concentrations from both varieties are shown in Fig 2.

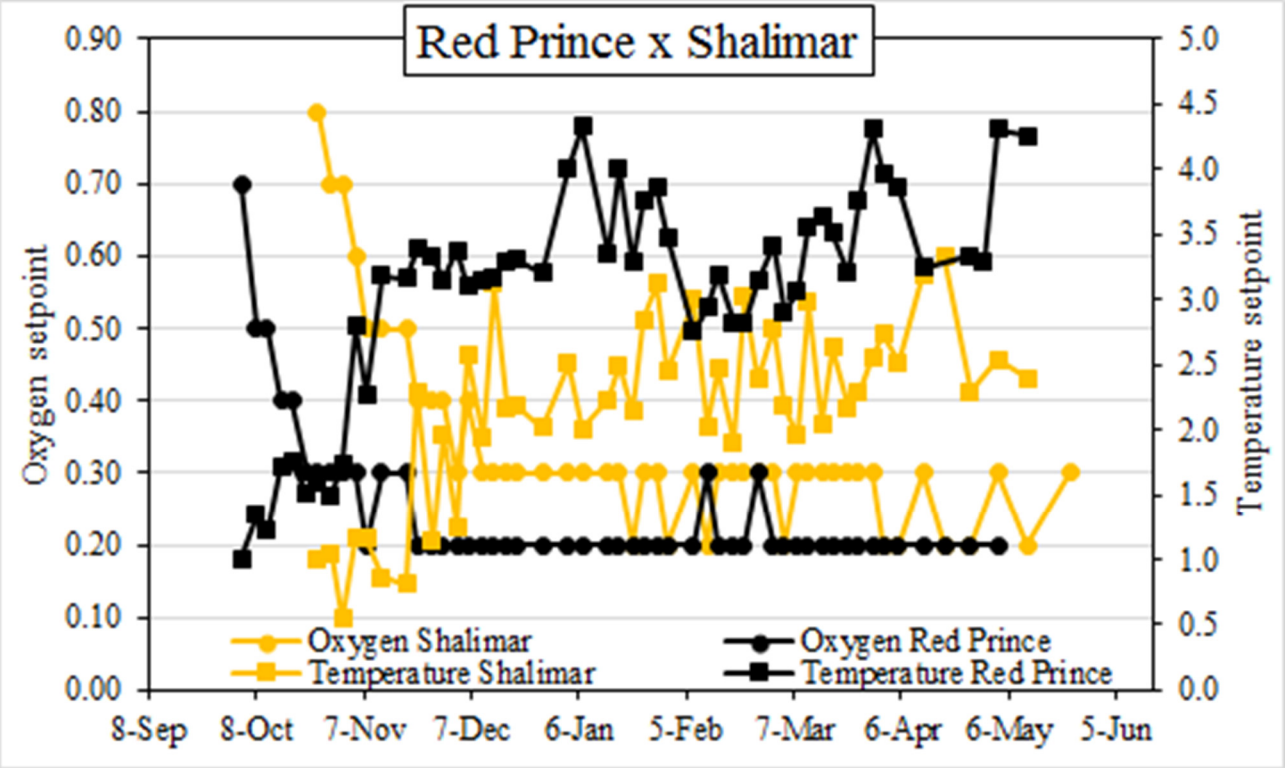

Fig. 2: Oxygen set point variation for 'Red Prince' (11t room) and 'Shalimar' (50t room) apples stored under DCA – FruitAtmo.

Results and Discussion

The lowest oxygen level tolerated by the fruit is called the anaerobic compensation point (ACP) with values for apple normally between 0.1 and 0.5 kPa O_2. Storage below the ACP will cause anaerobic metabolism. As a result of the ripening inhibiting conditions in DCA-storage, flesh firmness of apples can be more maintained along with the skin green ground colour than in ULO storage. Incidence of physiological disorders like superficial scald and skin spots can be reduced as well as fungal diseases. Another important advantage is an increase of aromatic compounds resulting from controlled of anaerobic metabolism which up to a certain point can occur without any loss of fruit quality. To guarantee an effective DCA storage, gas tight rooms, homogenous fruit lots (same cultivar, maturity and quality), as well as constant monitoring of the storage atmosphere are required. As long as these factors are kept in mind, DCA-storage can maintain fruit quality with no additional use of chemicals and has a considerable potential to save energy with the use of elevated storage temperatures. The new DCA-CD "FruitAtmo" method has the advantage of ACP determination and oxygen control, but also allows the temperature to be adjusted to the fruit needs. By that it is possible to increase the temperature as showed in the first results in a practical apple storage room, and to cut energy usage by more than 35 % and run refrigeration aircoolers in a defrost free modus.

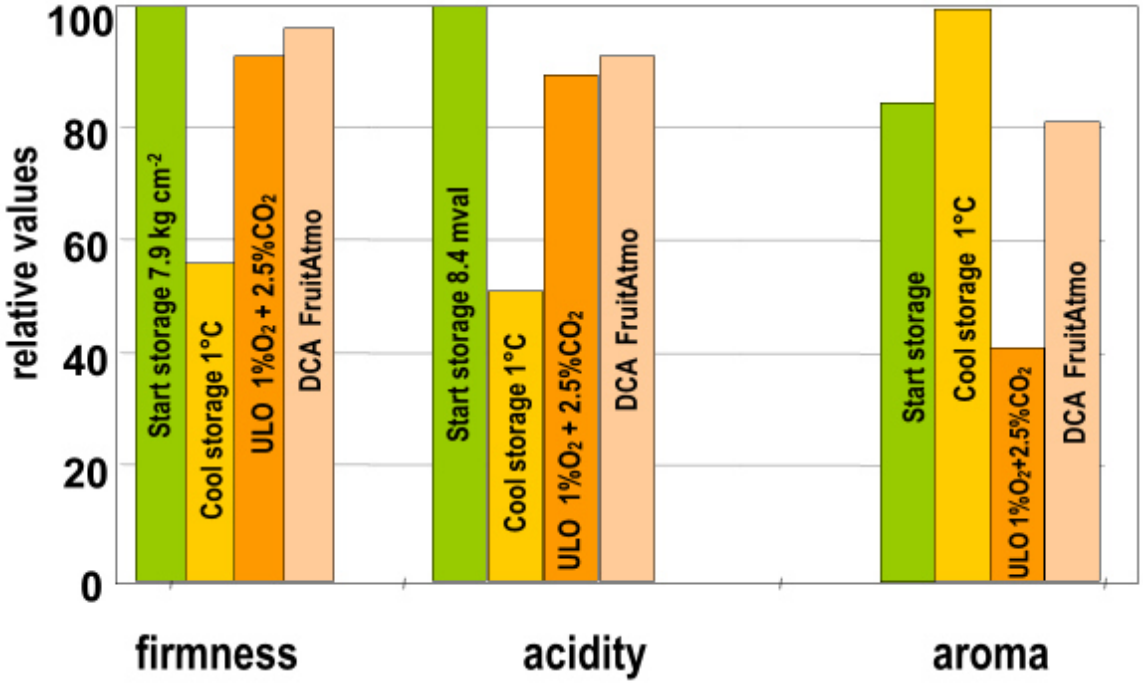

Fig 3: Fruit quality of 'Red Prince' after 9 months of storage plus 7 days shelf life at 20°C

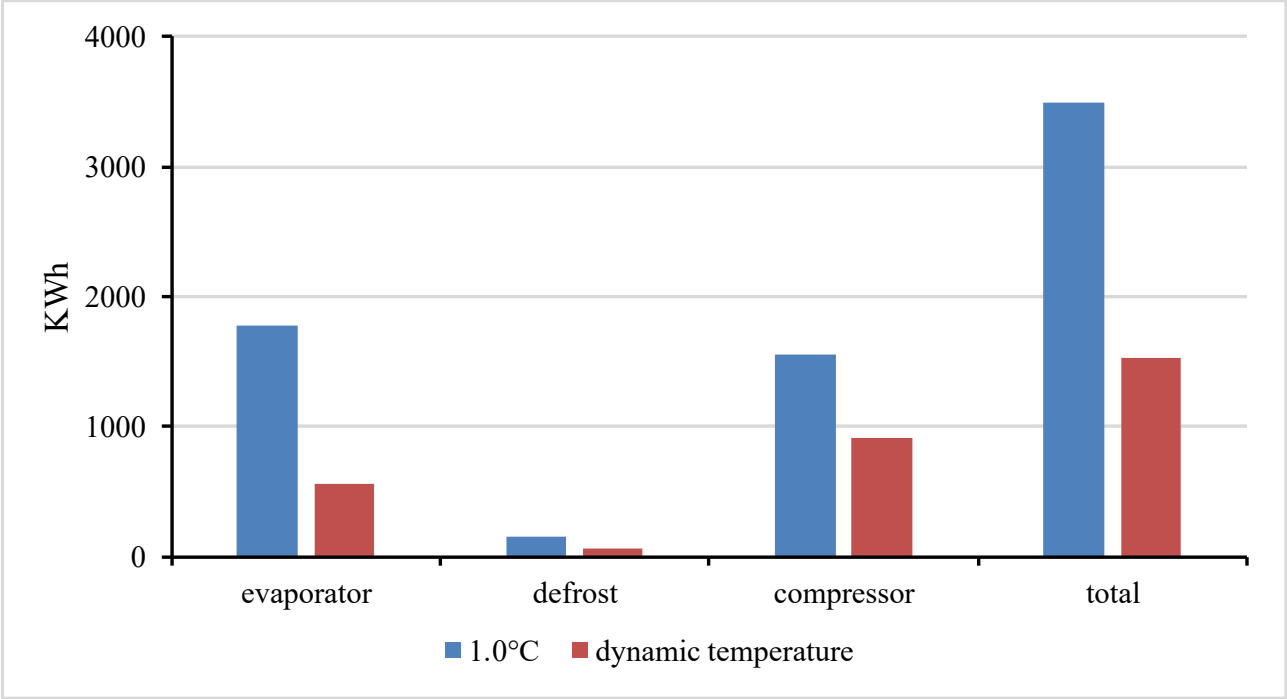

Fig 4: Energy use of 11t commercial CA-room 'Redprince' in 9 months storage

Conclusion

The new DCA method maintains better fruit quality during storage and shelf life at 20°C, adding to this increased aroma content as well as having a great potential to reduce the energy consumption. Previous Results in experimental rooms also showed a reduction in decay occurrence (data not show). Even at extremely low oxygen concentrations there was no physiological disorders to the fruits.

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Citation of the full publication

The paper is in the final stages of writing, has not yet been submitted to the journal, possibly in “Postharvest Biology and Technology”.