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Respiration of Thomson Seedless grapes and Gas concentrations in Quama packages

Report number B452 / 20 November 2000

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1 Respiration rate of Thompson Seedless grapes

1.1 Introduction

In order to make proper estimations and predictions of the development of the gas concentrations in an MA-package, respiration rates and behaviour have to be known. Grapes are known to have relatively low respiration rates compared with other products. To our knowledge, no reliable data was available concerning the reaction of grapes to altered gas concentrations; to obtain this essential data, an experiment was carried out.

1.2 Method

The grapes used for this test were Thompson Seedless from Greece. The grapes were not treated with SO_2. The start of the trial was 4 days after harvest. The respiration measurements were carried out at two temperatures: -0,5 °C and 10 °C. These two temperatures cover the range of temperatures in which the package has to function.
The respiration rate was measured using the headspace method: the concentrations of O_2 and CO_2 were measured immediately before closing the gas supply and after a period with closed gas supply. In this period the gas-concentration changes only 0.2 %. The effect of this small alteration of the gas concentration on the respiration rate is negligible. The respiration measurements were carried out 5 times at each temperature. By comparing the individual respiration measurements, changes in respiration in time were investigated.
The O_2 uptake and CO_2 production can be calculated given the weight, volume and specific weight. This was done for 12 conditions (shown in Table 1) at both temperatures. All these data were used to estimate the parameters of the respiration model (shown in Table 2). The complete data set was used to evaluate differences in respiration rate within the batch of grapes.

O_2 concentrations	CO_2 concentrations	
	0 %	**15 %**
0 %	0 O_2 – 0 CO_2	0 O_2 – 15 CO_2
1 %	1 O_2 - 0 CO_2	1 O_2 – 15 CO_2
2.5 %	2.5 O_2 - 0 CO_2	2.5 O_2 – 15 CO_2
6 %	6 O_2 - 0 CO_2	6 O_2 – 15 CO_2
20 %	20 O_2 - 0 CO_2	20 O_2 - 15 CO_2

Table 1 Gas concentrations used in the experiment.

1.3 Results

The estimated values of the parameters of the respiration model are summarised in Table 2. The fit between the model with the estimated parameters and the measured values is higher than 80%. This means that there are no large differences in respiration rate within the batch of grapes used for the measurements.

Parameter	10 °C	-0,5 °C
Maximum O_2 uptake [nmol/kg.sec]	58.70	16.51
Maximum CO_2 production [nmol/kg.sec]	42.90	12.31
O_2 concentration at which the O_2 production is half of the maximum O_2 production [%]	7.15	1.20
CO_2 production at 0 % O_2 [nmol/kg.sec]	36.29	10.32
O_2 concentration at which the CO_2 production is half of the maximum CO_2 production, Kmc O_2 ferm	1.47	1.67
The average ratio between O_2 consumption and CO_2 production	0.72	0.72
Fit	85 %	84 %

Table 2 The estimated values of the parameters of the respiration model.

Measurement	10 °C		- 0,5 °C	
	O_2	CO_2	O_2	CO_2
1	19.2	35.2	5.69	7.81
2	15.6	30.7	8.78	12.76
3	11.7	27.3	9.52	15.35
4	13.5	28.1	8.82	14.95
5	14.9	30.1	6.43	12.45

Table 3 Differences in respiration rate [nmol/kg.sec] in time.

Table 3 shows that only the first measurements show a slight deviation from the other four measurements. This might be caused by the short adaptation time between storage under altered gas concentrations and the first measurement. During the remainder of the trial (15 days 10 °C, 31 days –0,5 °C), the respiration rate remains stable.

1.4 Conclusions

As expected the measured respiration rates are low. The effect of the Kmc O_2 ferm (see Table 2) is, however, very large on the build-up of MA-conditions in a package.
Respiration rates remained stable during the trial.
There were no large differences in the respiration rate within the batch of grapes used in the trial.

2 MA conditions in Quama Package

2.1 Introduction

At the start of this trial, only the maximum uptake of O_2 and release of CO_2 could be estimated from the preliminary results of the first trial. The effect of changed gas concentrations on uptake of O_2 and release of CO_2 were estimated on the completed data set. The packaging experiment was started before the respiration rate trial was completed, the speed of build-up and the reaction of grapes on altered gas concentrations was not known at that moment. For this reason, only after the start of trial 2a could the gas concentrations in the MA-packages be calculated correctly.
The complete respiration parameters of grapes makes it possible to calculate the build-up of MA-conditions in an MA-package. These effects were checked in this experiment. After completion of these trials, the results of both the respiration rate trial and the packaging trial could be compared.

2.2 Method

The grapes used for this trial were Thompson Seedless from Greece. The grapes were harvested three days before they were packed. The grapes were packed in three types of Quama packages (38.8 cm x 28.8 cm x 12.5 cm, L x W x H) with different permeation characteristics. Type I had the lowest permeation rate and type III had the highest permeation rate. The temperature of the grapes was 5 °C at arrival at ATO and during packing. After packing, grapes were stored at –0,5 °C and 10 °C.
During storage, the gas concentrations in the packages were measured on days 2, 5, 7, 14 and 21. The gas concentrations were measured with a Chrompack CP 2002 gas chromatograph. Because only a 5 ml sample was taken for each analysis, the effect of taking gas samples is negligible. As agreed, the quality of the grapes was not recorded.

2.3 Results

The development of MA-conditions in the Quama packages is shown in Figure 1 (-0.5 °C) and Figure 2 (10 °C). The calculated gas concentrations at these temperatures are plotted as well.

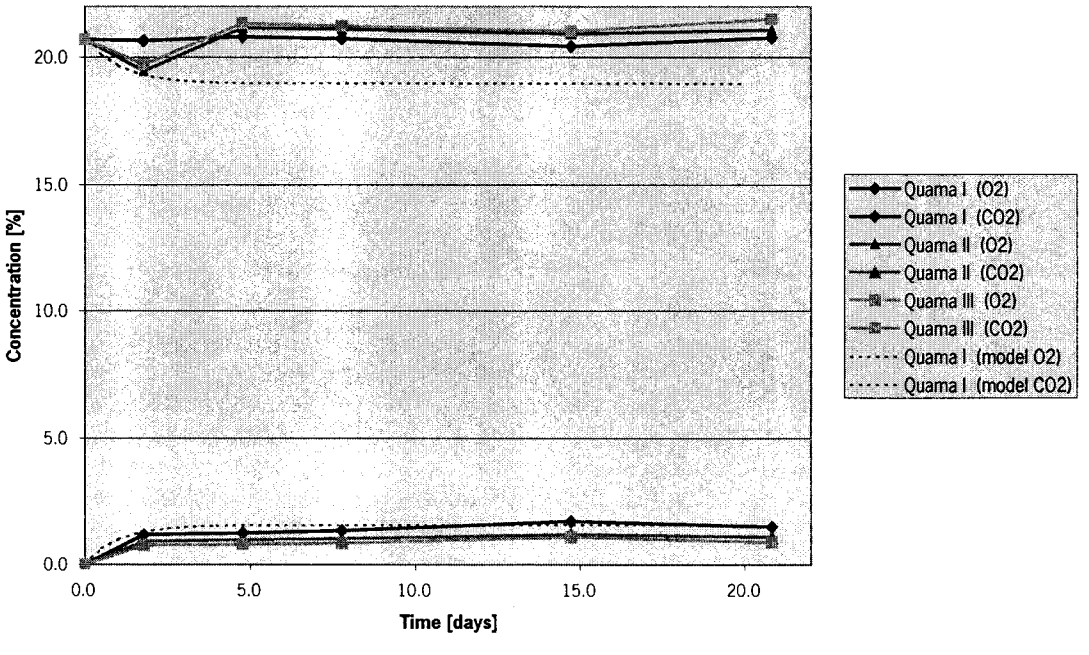

Figure 1 Gas concentrations in Quama packages at –0,5 °C.

For the calculation of the gas concentrations in the package, the actual information such as box dimension, permeation of the box, packed amount, temperature and, of course, respiration parameters are used.

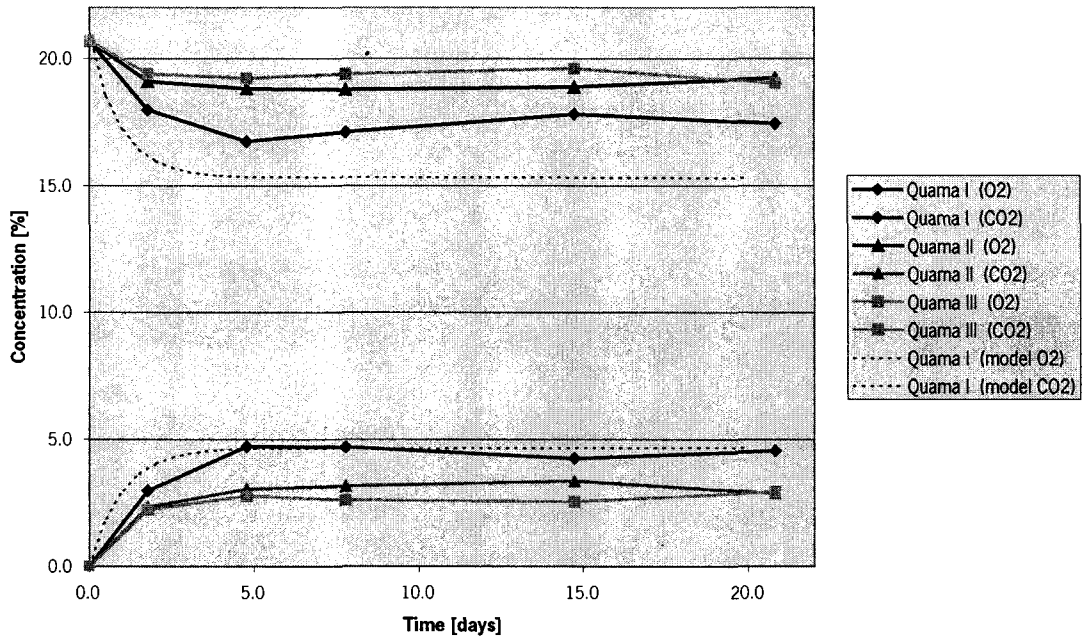

Figure 2 Gas concentrations in Quama packages at 10 °C.

2.4 Conclusions

As shows from the figures there is a good fit between the model and the measured CO_2 concentrations. The model slightly underestimates the O_2 concentrations. This will not limit, however, the use of the model for the selection of boxes, because CO_2 is the most important gas with regard to quality aspects. A possible underestimation of O_2 concentrations reduces the risk of selecting a box leading to anaerobic conditions. The good fit between the two experiments also indicates that differences in respiration rates between different batches of grapes are not too large for the model to be used in predicting gas concentrations in a package.

After three weeks, the experiment was terminated because the gas concentrations in the different Quama packages at both temperatures were stable.

The achieved CO_2 concentrations in the Quama packages are too low to have a substantial effect on the quality of grapes which are packed without a SO_2 sheet for slow release. The leakage of the Quama packages should be decreased to have a higher build-up of CO_2 in the package.