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Determination of the respiration index and of the modified atmosphere inside the packaging of minimally processed products

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SUMMARY – In order to study the physiological influence of the different processes involved in obtaining minimally processed products, we studied the respiratory intensity of pomegranate seeds, sliced orange and both together. The storage temperature was 4°C. The pomegranate variety was Mollar (*Punica granatum* L.) and the orange Washington Navel [*Citrus sinensis* (L.) Osbeck]. The gas composition inside the packaging was determined by extracting a volume of gas through a silicone septum attached to the plastic film. Changes in the concentration of O_2 and CO_2 were determined by injecting 5 ml of the modified atmosphere into a Toray LC700C O_2 analyser and a Toray PG-100 CO_2 analyser (Toray Engineering Co., Ltd). Variations over time in the concentrations of these two gases surrounding the products, which were wrapped in two films, one of high and the other of low permeability, were recorded.

Key words: Pomegranate, respiratory intensity, modified atmosphere.

RESUME – *"Détermination de l'indice de respiration et de l'atmosphère modifiée à l'intérieur de l'emballage de produits de quatrième gamme". Afin d'étudier l'influence physiologique de différents procédés utilisés pour obtenir des produits de quatrième gamme, nous avons étudié l'intensité respiratoire pour des graines de grenade, des oranges découpées en tranches, et les deux ensemble. La température de stockage était de 4°C. La variété de grenade était Mollar (*Punica granatum* L.) et la variété d'orange était Washington Navel [*Citrus sinensis* (L.) Osbeck]. La composition en gaz à l'intérieur de l'emballage était déterminée par extraction d'un certain volume de gaz à travers un septum de silicone adhérant au film plastique. Les changements dans la concentration en O_2 et CO_2 ont été déterminés en injectant 5 ml d'atmosphère modifiée dans un analyseur d'O_2 Toray LC700C et un analyseur de CO_2 Toray PG-100 (Toray Engineering Co., Ltd). On a enregistré les variations dans le temps des concentrations de ces deux gaz entourant les produits, qui étaient enveloppés dans deux films, l'un à forte et l'autre à faible perméabilité.*

Mots-clés : *Grenade, intensité respiratoire, atmosphère modifiée.*

Introduction

In recent years, the plant product trade has undergone considerable development due to the introduction of new technologies at the production level as well as in processing, storage and transport. Traders require high quality products that are easy to handle, of a long shelf life and without residues, with a stable price all year round (Alvarez, 1990).

At the same time, the consumer, who has less time for domestic chores, increasingly demands more elaborated products, which leads to the need to tackle new ways of obtaining and marketing products that can be used whole and that require a minimum preparation time. These products are known as minimally processed products. However these products require particular conservation techniques such as refrigeration and packing in modified atmospheres. The drawback of this processing is that it makes the products more perishable thus having to rely on plastic films of different permeabilities.

The purpose of minimally-processed products is to supply the consumer with a product that is similar to a fresh product in aroma, texture and natural appearance, with a long enough shelf life, that is microbiologically safe and that has a high nutritional and sensorial quality.

This study, conducted between 1993 and 1994, has explored the possibility of obtaining an orange or pomegranate dessert, or even a mixture of the two, by mixing both minimally processed products.

Materials and methods

The plant material used was pomegranates (*Punica granatum* L.) of the Mollar de Elche variety and oranges [*Citrus sinensis* (L.) Osbeck] of the Washington Navel variety.

The characteristics of the fruits used in the experiment are indicated in Table 1.

Table 1. Characterisation of pomegranates and oranges used

	Pomegranate	Orange
Fruit weight (g)	338±60.0	250±30.0
Fruit diameter (mm)	89±6.0	85±7.0
Number of carpels	7.2±0.8	9.7±1.8
Thickness of rind (mm)	3.5±0.6	5.5±0.9
Weight of kernels and segments/fruit (g)	231±43.0	221±23.0

The experiments were carried out with plant material, in the case of the pomegranates, supplied by the firm Agrudeco, S.A., from their estate in the catchment area of Albatera (Alicante). At the beginning of November the fruit was harvested once the optimum degree of maturity was reached. Harvesting took place early in the morning and was transported to a refrigerated store at a temperature of 4°C in AINIA, Valencia. They were processed in a processing chamber at 12°C.

The oranges were supplied by a farmer and grown in Sagunto-Valencia; they were also harvested early in the morning and taken to be processed in the same way as the pomegranates.

The pomegranates were removed with a kernel-remover previously developed by our working team from the Higher Polytechnical School of Orihuela. The kernels were washed with plenty of water so that the broken kernels did not impregnate the whole kernels and favour the onset of mould. The broken kernels were eliminated.

The oranges were peeled by hand and cut into 1 cm slices.

They were packed onto impermeable trays with a semi-permeable top. They were also packed into bags with both semi-permeable and impermeable plastic.

The methodology followed in the trials is described below.

Sensorial analysis

An experienced tasting panel was used to assess appearance, taste and texture of the products during the trial period. A hedonic scale from 1 to 10 was used, giving a maximum score of 10 and a minimum of 1. Values under 5 were considered not apt for sale.

Gas analysis

The study of the atmosphere inside the package, as well as the respiration intensity of the plant products involved a periodical analysis of oxygen and carbon dioxide. Both were determined by extracting a volume of gas from the package through a silicone septum adhered to the plastic film situated in the upper part of the package.

The changes in O_2 and CO_2 concentrations were determined by injecting 5 ml of atmosphere in the top space in an O_2 Toray LC700F analyser and a CO_2 Toray PG-100 analyser (Toray Engineering Co., Ltd). The results are expressed in percentages.

The estimation methods of the respiratory intensity were based on the determination of the O_2 consumption or the CO_2 production. For this purpose closed systems can be used based on the modification of the atmosphere by the product in an air-tight container or air flow systems, where the concentrations of gas entering and leaving can be determined inside a plant container that is ventilated with a known flow of air (Kader, 1987; Kays, 1991).

The determination of the respiratory intensity of the plant products (100-150 g) was made following the static method using air-tight sealed containers 0.6 l equipped with a silicone septum, kept at different temperatures and particular intervals of time. In all cases, the periods of time were limited in order to keep the CO_2 concentration below levels that would affect the respiration of the plant tissue. The calculation of the respiratory intensity, either as O_2 consumption or CO_2 production, was made according to the following formula:

$$RI = \frac{([x] - [x]_1) \bullet (V - Vo)}{(t - t_1) \bullet W}$$

where:

x = concentration of O_2 or CO_2 (ml)
V = volume of container (ml)
Vo = volume of product (ml)
t = time (h)
P = weight of product (kg)

Results

Respiration index

The study of the conservation of minimally processed oranges and pomegranates was carried out on pomegranate kernels and peeled, sliced orange 1 cm thick, kept at 4°C.

The respiratory intensity was determined as CO_2 (ml/kg/h) production (Table 2).

Table 2. Mean respiratory intensity (ml of CO_2/kg/h) of pomegranate kernels (Mollar de Elche variety) and orange (Washington Navel variety) in slices, processed

Temperature (°C)	RI (ml CO_2/kg/h) in pomegranates	RI (ml CO_2/kg/h) in oranges
4	30.8±0.4	57.05±1

The respiratory intensity in oranges is much higher, almost double that of the pomegranate, at a temperature of 4°C. This higher RI may be due to the more drastic processing undergone by the orange, as it was cut into slices 1 cm thick, whereas the selected pomegranate kernels remained intact.

The physical stress greatly stimulated the respiratory intensity of fresh fruit and vegetable produce. The magnitude of the increase is, generally, proportional to the severity of the mechanical damage. The increase in respiration intensity due to the plant tissue damage can be divided into two classes: (i) that caused directly by mechanical damage; and (ii) that caused by the infection by organisms such as fungi or virus in the lesion (Kays, 1991). In this case, the mechanical damage to the orange would explain its higher respiration rate.

Moreover, apart from the processing, the orange has a higher respiration rate than the pomegranate.

Influence of the permeability of the package on the evolution of the modified atmosphere

The choice of a plastic film is a determinant factor for obtaining an appropriate balanced atmosphere for the product.

In order to determine the degree to which the container is of influence, 200 g of pomegranate and 200 g of orange were packed separately and 100 g of pomegranate and 100 g of orange were packed together, using air as initial top space. They were stored at 4°C for 10 days. Considering possible damage during transport, for the first package rigid impermeable plastic punnets were used, covered and sealed on top by a semi-permeable plastic.

Besides, 200 g of orange was packed in a plastic bag made of the same semi-permeable plastic that covered the punnets and another 200 g in an impermeable bag. The same was done with the pomegranate.

Very noticeable modifications in the atmosphere were observed, obtaining the following results: (i) in the pomegranate, at 10 days, values of 30% CO_2 and 1% O_2 were observed; (ii) in the orange, at 10 days, values of 60% CO_2 and 0.5% O_2 were observed; and (iii) the mixture pomegranate + orange at 10 days reached values of 50% CO_2 and 0.5% O_2.

The product that, due to its external appearance, was classified by the tasting panel as apt for consumption (with significant delay in browning and loss of turgence of kernels), after 10 days of storage began to smell unpleasant making them unviable for consumption. Furthermore, the added problem posed by the tasting panel was that when orange and pomegranate were packed together, the pomegranate kernels stained the orange slices and therefore the products looked as though they had been squashed together or had been packed for a long time.

The bags of pomegranate and orange presented the following results:

(i) The differences through the use of different plastics were much more obvious in the case of the orange (Fig. 1). Moreover as for the CO_2 production, that reached values of 50% after 10 days and the O_2 consumption that reached values lower than 1% in the same time with impermeable plastic.

(ii) The biggest modifications of the atmosphere, in general, were shown in the impermeable plastic bags.

(iii) In the case of the pomegranate kernels (Fig. 2), however, independently of whether a balanced atmosphere had been achieved or not, the modification of the atmosphere with the semi-permeable plastic was not enough (7% O_2 and 15% de CO_2) to significatively prolong the shelf life of the minimally processed and refrigerated pomegranate. We did not consider 10 days shelf life to be enough even though the tasting panel declared the product valid. Our opinion was that in order for this product to be apt for sale, a shelf life of 15 days is required.

(iv) The high relative humidity that the package reached significantly reduces the loss of weight, maintaining similar conditions of turgency and texture as the initial conditions.

Conclusions

(i) The effect of preparation and handling on the respiratory intensity of the production increases with the severity of the damage caused to the tissue.

(ii) The orange is a fruit characterised by its high respiratory intensity, which implies a priori a potentially shorter life.

(iii) The pomegranate kernels packed in semi-permeable plastic bags reach an equilibrium atmosphere, making the product viable for 10 days. The trials point to the need to use more permeable or selectively permeable plastics, in order to find an equilibrium atmosphere that would extend the shelf life of the pomegranate.

(iv) The combination of orange and pomegranate does not appear to be a viable product as the pomegranate kernels stain the orange.

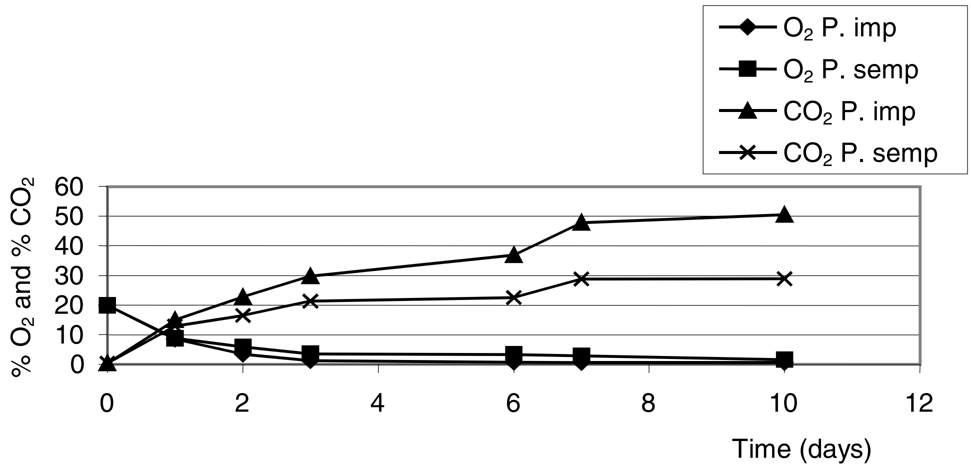

Fig. 1. Evolution of O_2 and CO_2 levels inside bags made of plastic films of different permeabilities containing sliced orange held at a temperature 4°C.

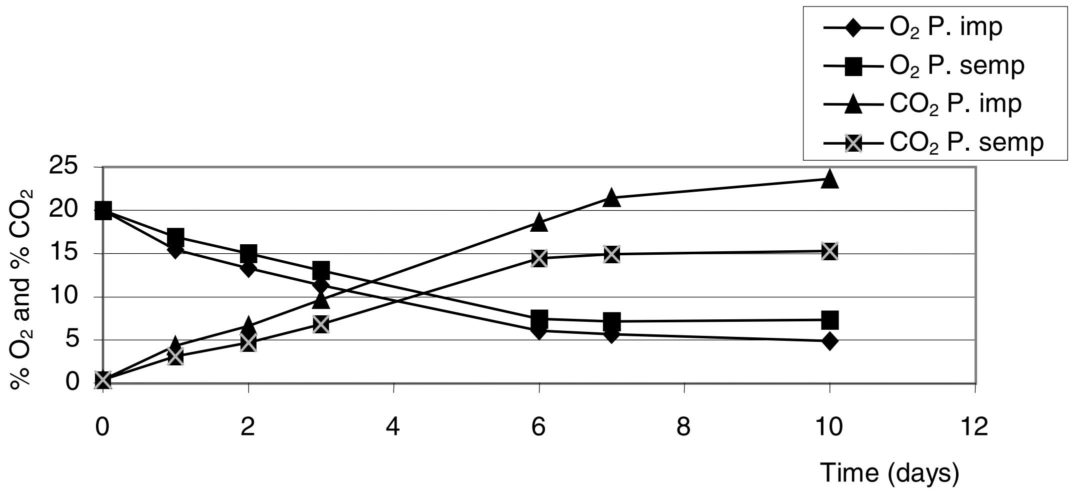

Fig. 2. Evolution of O_2 and CO_2 levels inside bags made with plastic films of different permeabilities that contain minimally processed pomegranates and held at a temperature of 4°C.

Further reading

Alvarez, R. (1990). The use of superchilling and modified atmospheres in fresh fruit packaging - A commercial test. In: *Internacional Conference on Modified Atmosphere Packaging*, England, 15-17 October.

Kader, A.A. (1987). Respiration and gas exchange of vegetables. In: *Postharvest Physiology of Vegetables*, J. Weichmann (ed.). Marcel Dekker, Inc., New York, pp. 25-43.

Kays, S.J. (ed.) (1991). *Postharvest Physiology of Perishable Plant Products*. Van Nostrand Reinhold, New York.