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Case Study: The Use of Low-Oxygen, ECO_2 Controlled Atmosphere Method to Control Insects in Sesame Seed and Dried Figs from Greece

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Abstract: The international industry is under high pressure to seek a preventive method to control insects in food commodities that does not lead to any quality reduction of the products. Especially the organic food industry is seeking an effective method that does not leave chemical residues.

The ECO_2 Controlled Atmosphere (CA) treatment is known and used worldwide by many companies and is a very effective method to control insects in all stages of development in food commodities, without using toxic chemicals and negative effect on the quality of the products. CA is currently used to control insects in sesame seed from Greece. Both conventional as well as organic sesame seed is treated with CA. The CA method used is based on low – oxygen in combination with increased temperatures (e. g. 35 Celsius). To prove and document the effectiveness of this method, an experiment was conducted by controlling *Tribolium* and *Sitophilus* (Greek origin) in Sesame Seed and Dried Figs.

Introduction

The objective of this experiment was to prove and document the effectiveness of CA during exposure to sesame seeds and dried figs to control Tribolium and Sitophilus insects.

The experiment was carried out in one of the ECO_2 facilities in Antwerp (Belgium), where sesame seeds and dried figs from two different Greek companies where treated. Extra thermometers and oxygen sensors where placed in various spots to control and document the parameters of the experiment. After treatment the experiment showed 100% control of insects in all stages.

After proving the effectiveness of this experiment, the Greek company decided to construct 6 Controlled Atmosphere chambers (5 of 147 m^3 and 1 of 294 m^3) at their factory in Thessalonica for the treatment of their yearly volume of sesame seeds.

Materials & Methods

Equipment

The experiment was conducted in a climate controlled room, constructed by the company ECO_2 and connected to the ECO_2 converter system, creating the Controlled Atmosphere. The facility is located in Antwerp, Belgium. The volume of the room is 310 m^3. The experiment products and insects species were placed inside the room after which it was closed and hermetically sealed. Inside air is circulated through the ECO_2 converter which creates low – oxygen air of < 1% O_2. Inside room temperature was increased to 2 835 degrees Celsius for optimum insect activity. Extra temperature and oxygen sensors where used for extra data recording.

Products

Products of two different Greek companies where treated during this experiment; one pallet of sesame seeds imported from India and one pallet of sesame seeds from Greece and dried figs from Greece. All products came in normal packaging. The sesame seeds came palletized with external wrapping which was taken off the packaging (Fig. 1). The dried figs came in 2 boxes of 12 kgs each, commercially packed (Fig. 2).

Fig. 1 Pallets of sesame seeds

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2. *AgroSpeCom Ltd*, 3, *N. Kountourioti str.*, 546 25 *Thessaloniki*, *Greece*

Fig. 2 Boxes with Dried Figs

Insects

The experiment was performed using most developmental stages (adults, larvae and eggs) of a mixture of several pest species that commonly infest the food products being tested, originated from Greece (Table 1). Insects were placed in the pallets of sesame seeds (Fig. 3.) and in the two boxes of the Dried Figs. Test insects (Fig. 4.) from the same species where held at the Laboratory of AgroSpeCom for control.

Table 1. Insect species, stage, placement during experiment

Code	Insect	Stage	Placement
1	Tribolium	Larvae	Sesame company A
2	Tribolium	Larvae	Sesame company B
2	Tribolium	Larvae	ASC Lab
4	Tribolium	Eggs	Sesame company B
5	Tribolium	Eggs	Sesame company A
6	Tribolium	Eggs	ASC Lab
7	Sitophilus	Larvae	Sesame company A
8	Sitophilus	Larvae	Sesame company B
9	Sitophilus	Larvae	ASC Lab
10	Sitophilus	Eggs	Sesame company B
11	Sitophilus	Eggs	Sesame company A
12	Sitophilus	Eggs	ASC Lab
13	Tribolium	Adults	Sesame company A
14	Tribolium	Adults	Sesame company B
15	Tribolium	Adults	ASC Lab
16	Sitophilus	Adults	Dried Figs box 1
17	Sitophilus	Adults	Sesame Cargill
18	Sitophilus	Adults	ASC Lab
O	Tribolium	Eggs	Dried Figs box 2
OO	Tribolium	Larvae	Dried Figs box 2

Fig. 3 Insects placed in bag of Sesame Seeds

Fig. 4 Insect tubes

Treatment Set up

The two pallets of sesame seeds were placed in the climate controlled room (Fig. 5 & 6.). One box of dried figs was placed on each pallet. Extra data recorders were placed at the following positions:

1 data logger per carton box of dried figs (applied in center of the product)

1 data logger per pallet sesame seeds (applied in center of pallet and bag of product)

After the treatment set up, the door of the climatic room was closed and treatment was started on – line via remote control.

The experiment was conducted in November 2007 which is winter season in Europe. Upon arrival of the experiment, temperature of the products was 11℃. In 2,5 days of CA treatment the product temperature reached the ideal treatment temperature of 32℃. Simultaneously during heating up of the products, the oxygen is decreased to < 1% in the room ensuring 100% control of the insects.

Results

Low-Oxygen, Controlled Atmosphere treatment of the sesame seed and dried figs, experi

Fig. 5 Climatic Controlled Chambers

Fig. 6 Experiment set up

mental infested with Tribolium and Sitophilus, caused 100% mortality of the three developmental stages tested. Total treatment duration (including heating and decrease of oxygen) was 5,5 days (Fig. 7). No negative effects on the quality of the products were observed or reported by the two companies.

After the treatment all insect bioassays were kept at 25℃ for a period of 2 months at the Laboratory of AgroSpeCom, showing 100% mortality.

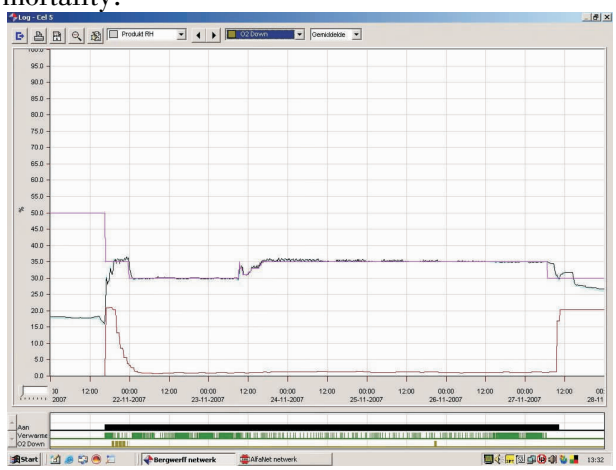

Fig. 7 Treatment graphic (black line = inlet temperature, blue line = room temperature, red line = O_2 concentration, pink line = set point temperature)

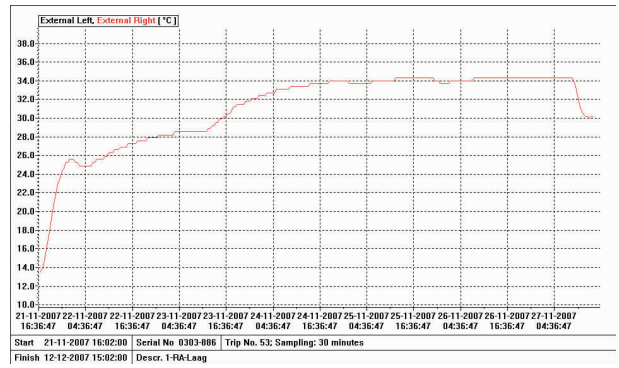

Fig. 8 Extra temperature data logger in box of dried figs

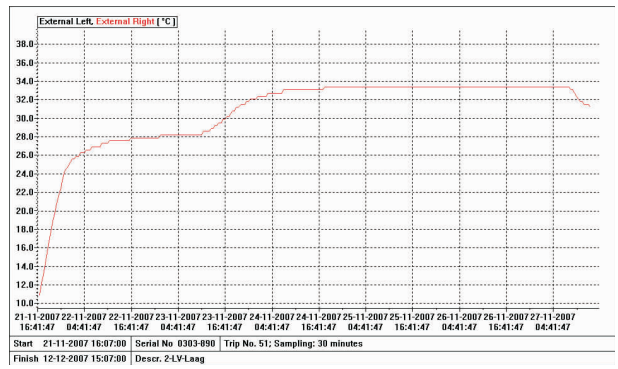

Fig. 10 Extra temperature data logger in pallet of sesame seed

Conclusions

The use of Controlled Atmosphere has several advantages compared with existing methods for chemical insect treatments on products:

Insects usually do not die inside the product. The insects try to escape the low oxygen atmosphere by moving out of the product toward the sides of the chamber, thus moving out of the product.

There is no use of insecticides and thus no residues.

The method is environmental friendly.

The system can be used without waiting for a fumigator.

Each treatment is certified by an internationally recognized certificate of treatment.

No insect resistance is found with the use of Controlled Atmosphere.

There is very low danger for the working personnel.

Controlled Atmosphere treatments are currently carried out by ECO_2 in ECO_2 facilities and customer facilities constructed by ECO_2 worldwide (14 countries) which totally have more than 105 treatment rooms.