Photocatalytic Oxidation & Ultraviolet Irradiation

A study on the elimination power of *AiroCide* of ethylene, mold and bad odours inside cold rooms.

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The presence of harmful elements that affect stored fresh produce inside cold rooms is a well known problem to the industry. Within these harmful elements, the organic volatile compounds (named VOCs from now on) represent one of the biggest worries. VOCs existence is a consequence of the stored produce own metabolism, and mold spreads through the air in a spore form; and also the ethylene, that although we can include it within the VOCs group, it should be separately considered due to its condition of vegetable hormone and because it is a direct cause of the fresh produce ripening process. There are some technologies available in the market to lessen these problems. The majority of these technologies are based in the use of strong oxidants in order to destroy the compounds, and among them we find the Photocatalytic Oxidation with Titanium Dioxide (TiO_2) in conjunction with Ultraviolet Irradiation (UV). In this study, we are presenting the results obtained after a few tests conducted in the SAT 9821, CFM group in Balsapintada, Murcia (Spain) utilising the AiroCide PPT device, in two different cold rooms filled with peppers and melons respectively.

Picture 1

Picture 1.- AiroCide PPT ACS-100 device used during this study.

Objectives & Method

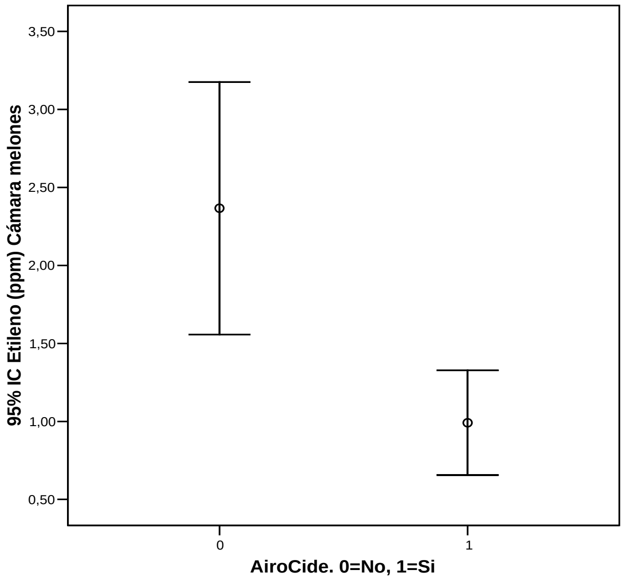
Three parameters are to be measured in this study. The ethylene concentration, the count of colony forming units (CFUs), and the presence of VOCs. Ethyle is measured due to its vital role played in the produce ageing processes, direct responsible of cold room shrinkage; the CFUs are measured due to the infection and contamination experienced in stored produce, and finally, VOCs are to be meassured too. These compounds which are usually originated from the stored produce own metabolism, create the strong smells we find when entering any cold room, and we can tell just by the particular smell what kind of product is in store. The VOCs can easily spoil the quality of stored produce when absorved by other fruits or vegetables. The elimination of such VOCs can be used as a guide of the air cleansing efficiency of the AiroCide inside the cold rooms. In order to understand this statement we must explain further what is the oxidating process. To ilustrate this example we can use the ethylene. To be able to oxidise ethylene until we get CO_2 y H_2O it is necessary to follow certain steps, and these steps will lead to creating byproducts, which can be even more poisonous that the original product. These byproducts, in the case of ethylene, are ethylene oxide, formaldehyde, or methanol, depending on the oxidative characteristics of our medium, but all of them involving sanitary risks. The larger the size of the molecule to destroy, the more difficult the situation becomes, which also increases the possibility of producing more byproducts. Measuring of VOCs allows us to determine if this reducting system actually reduces the levels of VOCs present in the area of study, and also whether byproducts are formed as a result of the oxidation process or not.

Three differentiated methods were used for taking the samples, a constant electrochemical detecting air sampler brand Bioconservación was used in the ethylene case, with a measuring range of 0 and 100 ppm. An average calculation out of five different concentration readings was made in order to estimate the ethylene concentration in the air. For CFUs count, we used a high volume air sampler brand Graseby on petri dishes of SMA culture specifically advised for fungal growth. One rehearsal sampling was performed in each cold room to be able to establish the necessary sampling period of time in order to get significant results. Each sample was taken twice, therefore results are the average calculation of both readings. Finally, VOCs were measured on granular (3 pore range) activated carbon filtering tubes to guarantee the highest range of VOC picking at one single pass. The tubes were later tested through thermal desorption and gas chromatography with mass spectrometer (GCMS) for compound identification.

Results & Discussion

Below we present the results obtained from the measured ethylene concentrations inside the cold room containing melons, the CFUs counts in the cold room filled with peppers and the VOCs levels in both cold rooms.

Graph 1 shows the average values and the confidence interval of 95% for ethylene concentrations before and after using the AiroCide unit in the cold room containing melons. Please note the dramatic reduction of this compound. Melon is a climateric fruit and, depending on the variety, a big ethylene source.



Graph 1

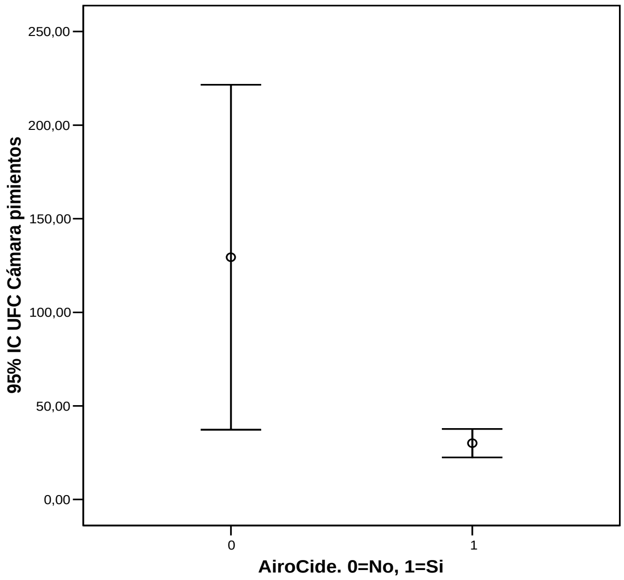
95% Ethylene (ppm) - Melon Cold Room

Graph 1.- Average figures and confidence interval of 95% for ethylene concentrations before and after installation of the AiroCide PPT unit.

Graph 2 presents the CFU count results inside the pepper cold room throught the duration of the study. The figures represent the average count of CFUs and the confidence interval of 95% before and after using the AiroCide device. Once more we see a dramatic reduction in the obtained CFU's count.

Ethylene Gas Reduction - The average value before using the AiroCide was of 2.3667 ppm on 6 sampling petri dishes. After installing the AiroCide system, this average value turned to 0.9917 on a total of 12 sampling dishes.

These values represent a reduction of **58.1**%

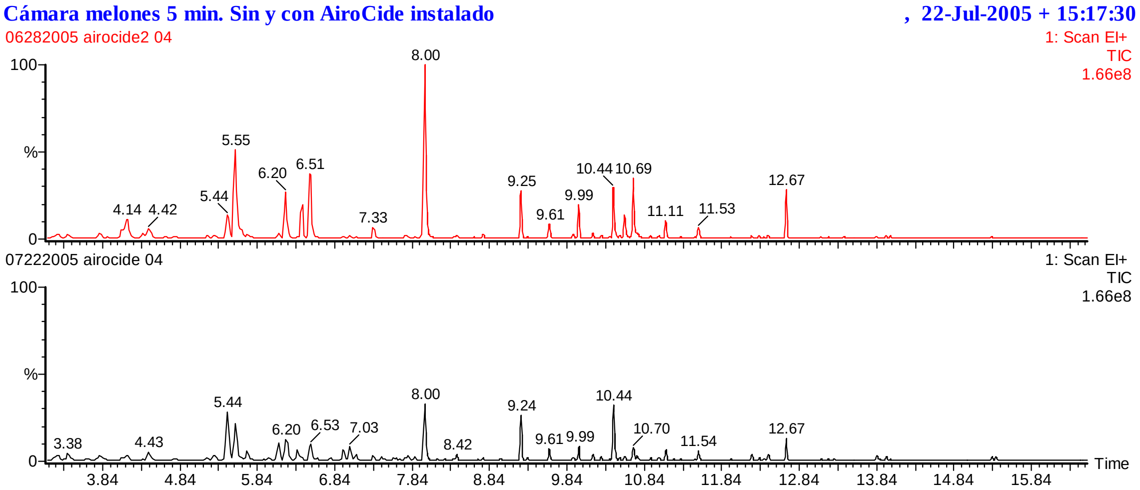


95% CFU - Pepper Cold Room

Graph 2.- Average figures and confidence interval of 95% of CFU's count inside the pepper cold room before and after using the AiroCide device.

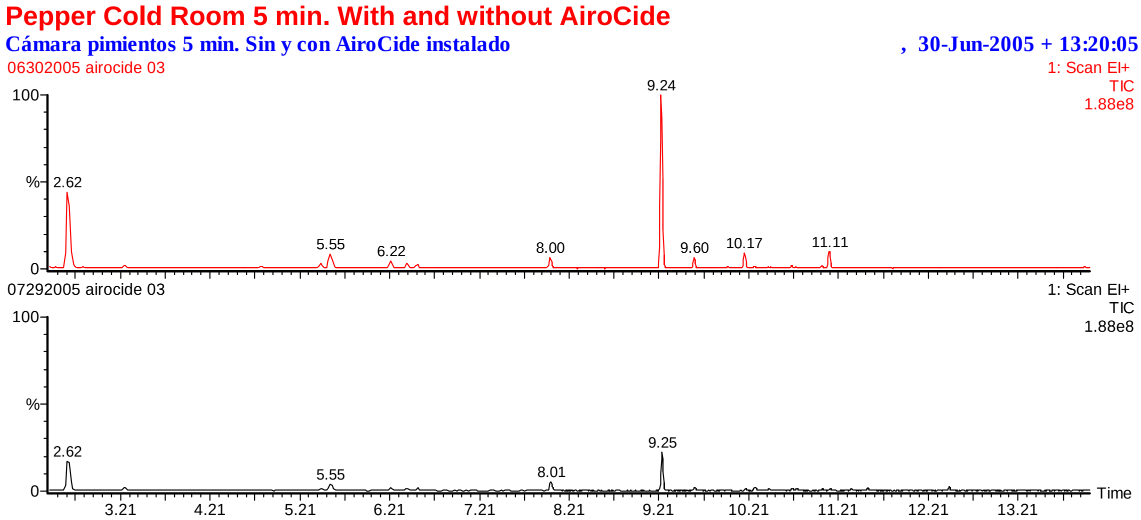
Graphs 3 and 4 show the resulting chromatograms from the melon and pepper cold rooms respectively before and after the use of an AiroCide. When comparing graphs 3 and 4, we can observe that the compunds found in both melon and pepper rooms are completely different. We can see that compounds are more abundant in the melon cold room than in the pepper one, and this fact allows us to foresee the kind of atmosphere we are to encounter inside a cold room based on its contents. Comparing figures 3A and 3B we can observe that the predominant peaks in graph 3A have decreased significantly in graph 3B, due to the cleansing effect of the Airocide PPT. Also we note that the existing compounds coincide in both chromatograms, although in lower levels, and there are no new byproducts found as a result of the photocatalytic activity.

Melon Cold Room 5 min. With and without AiroCide



Graph 3.- Resulting chromatograms inside the melon cold room. **A.-** Before using AiroCide PPT. **B.-** After using AiroCide PPT.

Graphs 4A and 4B indicate a similar result in the pepper cold room, with a general peak reduction found before and after installation of the AiroCide device inside the room. The obtained results prove that the device efficiently reduces the existing concentrations of the typical smells of the different stored products without the emision of any byproduct during the oxidating process that takes place inside the reactor.



Graph 4.- Resulting chromatograms inside the pepper cold room. **A.-** Before using AiroCide PPT. **B.-** After using AiroCide PPT.

Conclusions

The *AiroCide PPT* has proven to efficiently remove ethylene, CFUs and VOCs concentrations in cold storage indoor air as well as that it is applicable to different stored produce.

In addition, *AiroCide* is a clean device with no harmful effect to the indoor environment where it performs, as the oxidating process happens inside a tightly closed reactor bed kept inside the unit, resulting in a zero emision of byproducts in the process.

Thanks:

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