Evaluation of titanium oxide in order to avoid the development of biofilms

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Final degree project
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Introduction

Inasmuch as the presence of biofilms in the Food Industry is one of the most important problems, both technological and Public Health, it is important to avoid the development of these biofilms in food contact surfaces or, if they are already established, it is important to destroy them. Various materials with biocides have been developed, but it is still necessary to prove its safety. One variant that could achieve good results is the use of TiO_2, which under UV irradiation and a specific humidity, can generate a photocatalytic reaction that can attack and break the outer membrane of the bacterial cell, being able to inactivate free microorganisms or attached in biofilms.

Materials and methods

Six different surfaces:

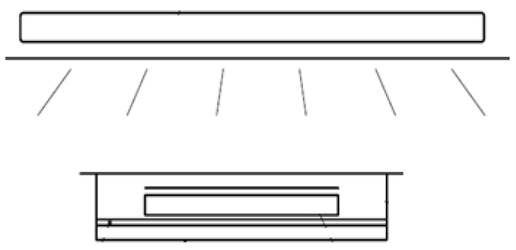
- Acrylic polymer with TiO_2
- Treated ceramic
- Food coating paint with TiO_2
- Food coating paint with TiO_2 + antimicrobial additive
- TiO_2 coated slide
- TiO_2 (D<20µm) coated slide

Inoculation (film adhesion method)

Escherichia coli → $6.7x10^5$cells/ml - $2.6x10^6$cells/ml

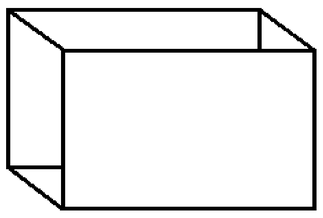
UV treatment

ISO 27447



Dark treatment

ISO 27447



Measurement of number of living bacteria

TEMPO

Calculations

Film adhesion method

Results

The following table shows globally the average of the logarithmic reduction of *Escherichia coli* in different surfaces after the UV treatment.

Surfaces	**Average of logarithmic reduction**
Acrylic polymer with TiO_2	2,46
Treated ceramic	2,67
Food coating paint with TiO_2	1,94
Food coating paint with TiO_2 + antimicrobial additive	4,36
TiO_2 coated slide (surface inoculation)	0,86
TiO_2 coated slide (film inoculation)	1,68
TiO_2 (D<20µm) coated slide (surface inoculation)	1,79
TiO_2 (D<20µm) coated slide (film inoculation)	1,58

Not only the results have proved that there is an own UV antimicrobial activity, which is difficult to separate from the activity of the fotoactivation of the titanium oxide, but also the results indicate that, in some cases, the microbial load reduction of the materials that were studied, was not significantly different from the UV irradiation itself.

It is also shown that the particle diameter is an important factor. The results reveal that having a particle diameter of 10-20 µm the efficiency was higher than the larger sizes of the particle diameter (40-60 µm). Nevertheless, it is detected a huge influence of the UV irradiation and a high variability in the results.

Conclusions

1. Titanium oxide is a substance which shows photocatalytic activity, although this activity is dependent on the particle size and assay's conditions.

2. The test conditions need to be improved to reduce the samples variability and to control the dehydratation that occurs during the evaluation period.

3. The type of the evaluated material can play a direct role in the photocatalytic efficiency of the metal oxides, although it is necessary to study it in more detail in order to confirm this conclusion.

4. When substances with photocatalytic activity are used, it is really important to monitor the presence of other biocides, because its presence can completely nullify the action of metal oxides.