IOP Conf. Series: Journal of Physics: Conf. Series **792** (2017) 012023 doi:10.1088/1742-6596/792/1/012023

Measurement of the transmittance of edible films of aloe vera (barbadensis miller) and cassava starch using optical fibers trifurcated

L Díaz[1], J Reales[2] and C Torres[1]
[1]Grupo de Óptica e Informática (LOI), Universidad Popular del Cesar, Valledupar, Cesar, Colombia.
[2]Grupo BIAT, Universidad Popular del Cesar, Valledupar, Cesar, Colombia.

E-mail: leonardodiaz@unicesar.edu.co

Abstract. In Colombia, especially in the Atlantic Coast it is produced and marketed the costeño cheese, an indigenous product of the gastronomy of this region, but the prolonged exposure of this product to the environment leads to microbial contamination and non-enzymatic rancidity. For this reason the transmittance of an edible coating based in aloe vera gel and cassava starch to preserve costeño cheese was evaluated using trifurcated optical fibers. The results become a tool for the selection of treatments in making edible films and their subsequent use in coatings for various types of food products.

Introduction

The consumer demand for innocuous food with use of materials environmentally friendly packaging have prompted industries and researchers to develop new strategies for processing, handling and packaging. Therefore, the edible films and based proteins, lipids and polysaccharides coatings are being studied and applied to food products as a potential packaging material that can act as a barrier against water vapor, gases, volatile compounds and serve as carriers of antimicrobial substances, antioxidants, flavorings and vitamins, which can increase the quality, safety, functionality and product lifetime [1].

In Colombia there are a variety of dairy products such as cheese costeño, considered a consumer commodity in the Colombian Caribbean region and a great source of protein. It is in fresh the main form of consumption, which is why their shelf life is short because of its high moisture content, so they look for new alternatives for their conservation, without losing quality and provide consumers a safe food. An alternative for preserving of the cheese is the application of an aloe vera gel based edible coating containing antioxidants and antimicrobial properties.

This paper shows transmittance measurements of edible films based gel of Aloe Vera (barbadensis miller) and cassava starch for use in the coating of costeño cheese.

IOP Conf. Series: Journal of Physics: Conf. Series **792** (2017) 012023 doi:10.1088/1742-6596/792/1/012023

Methodology

The measurement of absorption-based fiber-optic sensors is achieved by comparing the light power output from the absorbing sample with the initial light power input into the sample; the stability of light power input to the absorbing sample is critical to the accuracy of the sensor [2]. The gel samples used in the study were extracted from leaves of aloe vera (barbadensis miller) from an intensive cultivation in the Island farm, which is located in the municipality of Valledupar Cesar and stabilized at the Popular University of Cesar in the pilot plant of fruit and vegetables. The optoelectronic mounting used the absorption and reflection properties of the materials under study [3].

When Light passing through a material can be absorbed by interaction with the molecules and atoms of the host material or with impurities and defects. At a given wavelength λ; the intensity of the light passing through the material is attenuated as an exponential function of its path length x .

This is expressed by the Beer–Lambert law:

$$I_\lambda(x)=I_\lambda(0)\exp\left(-\alpha_\lambda[M]x\right), \quad (1)$$

Where $I_\lambda(x)$ is the light intensity at a distance x , $I_\lambda(0)$ the incident light intensity at $x=0$, α_λ the absorption coefficient and $[M]$ the concentration of the absorbing material. Absorption-based fiber-optic sensors work on this principle [2].

1.1. *Preparation of stabilized Aloe Vera gel*

To determine the optimal concentration of each of the components included in the edible film, was made a design completely randomized, where he was studied the concentration of aloe vera gel (Aloe barbadensis miller) and cassava starch. The coating composition consists of 1% glycerol as a plasticizer, distilled water and the concentration of aloe vera gel and cassava starch according design of experiments. The design was carried out according to Table 1.

Tabla 1. Design of Experiments

Treatments	**Aloe Vera Gel (%)**	**Cassava Starch (%)**
T_1	5	3
T_2	15	3
T_3	25	3

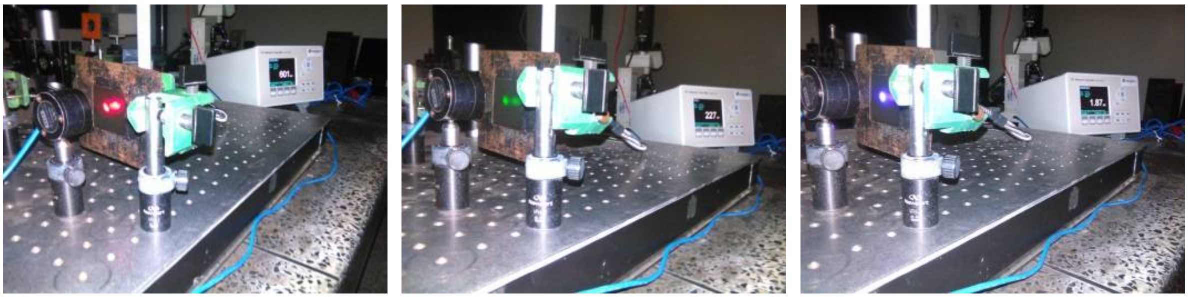
1.2. *Preparing film*

Cassava starch is mixed with half distilled water with constant stirring in a heating plate and stirring of mark IKA C-MAG HS7 Model: ETS-D5, submitting at heating at a temperature of 70 °C until reach the gelatinization. On the other hand the aloe vera gel is mixed with glycerol and the remainder of distilled water and added slowly until the whole mixture reached a temperature of 75 °C for 3 minutes to avoid loss of the biological properties of the gel. The thickness of the films was determined using an micrometer analogous brand StarrettCo with measures 25 mm and 1", with rotating spindle and precision of ± 0,004 mm or ± 0,00015", with an average of 12 random measurements of the surface of each film sample according to [4]. Before testing the films, a visual inspection was performed to ensure that the films have a continuous and homogeneous surface, ie, had no cracks after the drying process, or submit insoluble particles or open pores, then movies they were stored in desiccators at

25°C and relative humidity of 58% measured with a thermo-hygrometer brand Fisher Scientific (NaBr saturated solution), until use.

1.3. *Measuring the transmittance of the films*

The transmittance of the thin films of about 80 µm thick were determined preliminarily by absorption using trifurcated optical fibers, three lasers with wavelengths 632.8 nm, 532 nm, 405 nm, lower powers at 10 mW and an optical power meter (Newport) model 1928-C. See Figure 1. The procedure was performed under the same lighting conditions, temperature and measuring distances between light source (laser) the samples (films) and detector, taking as variable of interest to measure the intensity variations generated by analyzing the samples after it a light beam impinges in them.



a) b) c)

Figure 1. Measuring the transmittance of the films. a) λ= 632.8 nm b) λ= 532 nm c) λ= 405 nm

Results

The transmittance measurements for each treatment used in the manufacture of edible films are presented in Figures 2, 3 and 4. In Fig. 2 T1 and T3 are those that present higher transmittance compared to T2.

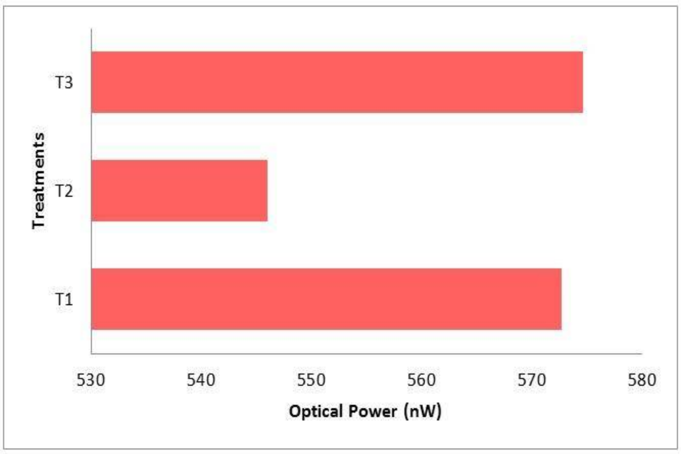


Figure 2. Transmittance at 632.8 nm.

Upon interaction between the beam and the film, part of the incident radiation was absorbed for each wavelength used, so that the emergent beam intensity is different from that of the incident beam. According to the ANOVA performed for test data subjected to the wavelengths used, there are no statistically significant differences. However, when examining the data transmittance at 532 nm was found that there is statistically significant difference between treatments. This is the attributed to the affinity and particular characteristics to this lambda with the compounds present in each treatment, thus presenting an optical absorption by the films. The treatment that presents higher transmittance was the T3.

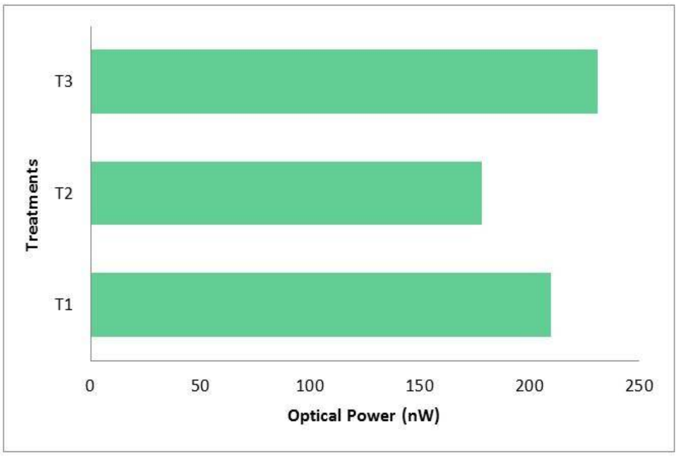


Figure 3. Transmittance at 532 nm.

To determine which treatment is with more transmittance, must take into account that a transparent object is one that transmits light with relatively little absorption [5]. In the Figure 4, it is observed that the treatment T2 has little transmittance in comparison with T3.

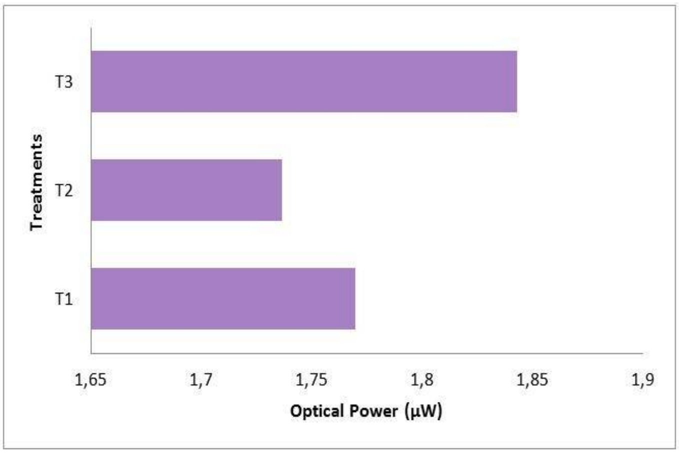


Figure 4. Transmittance at 405 nm.

According to the above, the treatment T3 has a greater transparency when comparing the results obtained for the wavelengths used, is better appreciate the variations of optical power in the graphics, which impacts advantages in terms of marketing in the sense that if this formulation is used to coat the foods like fruits and cheese, the film formed is practically imperceptible and the concentration of this gel allows better use of their properties for food preservation [6].

Conclusions

Were performed of transmittance measurements a several treatments of edible films aloe vera and cassava starch for coating cheese costeño using trifurcated optical fibers. Are notable the variations of optical power obtained according to the analyzed samples. These variations were the decision criterion in determining the best treatment to be used as coating of costeño cheese, in our case, treatment T3 meets the best features. This research becomes a tool for the selection of treatments in making edible films and their subsequent use in coatings for various types of food products.

Acknowledgments
The authors thank at the University Popular of Cesar for their support in this research.

References

[1] Galus S and Kadzińska J 2015. Food applications of emulsion-based edible films and coatings *Trends Food Sci. Technol.* **45**(2), 273-283
[2] XuaY, Barrie-Jonesa N, Fothergilla J C and Hanningb C D 2001 Error analysis of two-wavelength absorption-based fibre-optic sensors *Opt. Lasers Eng.* ***36*** 607–615
[3] Díaz L, Morales Y, Mattos L and Torres C O 2013 Detection of wavelengths in the visible range using fiber optic sensors *Proceedings SPIE.* **8785** 87852L
[4] Khoshgozaran-Abrasa S, Hossein M., Hamidya Z and Bagheripoor-Fallahb N 2012. Physicochemical and color properties of chitosan based-films as a function of Aloe vera gel incorporation *Carbohydr. Polym*. **87**, 2058– 2062
[5] Alvarado-González J S, Chanona-Pérez J J, Welti-Chanes J S, Calderón-Domínguez G, Arzate-Vázquez I, Pacheco-Alcalá S U, Garibay-Febles V and Gutiérrez-López G F 2012 Optical, microstructural, functional and nanomechanical properties of Aloe vera gel/gellan gum edible films. *Rev. Mex. Ing. Quím.* **11**(2), 193-210
[6] Cerqueira M, Sousa M, Macedo I, Rodriguez R, Souza B, Teixeira J and Vicente A 2010 Use of galactomannan edible coating application and storage temperature for prolonging shelf-life of ‘‘Regional” cheese. *J. Food Eng.* **97** 87-94