Influence of constant electric field impact on the intensity and structure of the secondary luminescence of selected industrial Cannabis products

A Miernik¹, T. Juliszewski¹, E. Popardowski¹, K. Trzyniec¹, S Kovalyshyn² and B Wiśniowski¹

¹ Faculty of Production and Power Engineering, University of Agriculture in Krakow, Balicka Av. 116B, 30-149 Cracow, Poland
² Lviv National Agrarian University, Dublany, Ukraine

E-mail: anna.miernik@urk.edu.pl

Abstract. The purpose of the experiments was to determine the size and structure of ultra-weak luminescence before and after the electric field. Photon emission tests were carried out in the Laboratory of Experimental Research Techniques of Raw Materials and Biological Products with PCA accreditation in the subject measurement procedure.

1. Introduction

It is commonly believed that there is only one type of cannabis - cannabis (Cannabis sativa L. var. Indica). They owe their great popularity primarily to their applications - mainly hallucinogenic and healing. However, this species also includes hemp (Cannabis sativa L. var. Sativa), also known as fibrous. Hemp is resistant and also perfectly adapts to various climatic conditions. They grow on almost any soil and, above all, are resistant to various pests and do not require the use of plant protection products. Hemp has a short growing season and rapid growth [1]. Hemp is widely used. The health benefits of clothing made of natural fibers are of particular interest. Clothes made of linen and hemp fibers, due to high hygroscopicity, pleasant structure, good air circulation and no tendency to accumulate electrostatic charges, ensure high comfort of use. These products create a unique microclimate for the skin. This clothing prevents the occurrence of oxidative stress. It is not only hemp fiber that is increasingly used in various areas of life. Hemp seeds can also be used widely. They contain 20-25% protein and 28-35% oil, rich in unsaturated fatty acids essential for health. The presence of protein, phytic acid, choline, trigonellin, lecithin, chlorophyll, vitamin K and tocopherols in hemp seeds is characteristic. The precious essential oil can be obtained from hemp panicles by distillation with steam. The quality of this oil is determined by the content of mono- and sesquiterpenes. Terpenes contained in hemp oil show bacteriocidal properties. This effect is mainly demonstrated against gram-positive bacteria (Staphylococcus and Streptococcus). Cannabis produces specific compounds called cannabinoids. Studies have shown the existence of over 60 different cannabinoids, but of these THC is the most known for its psychoactive and healing effects [1]. The phenomenon of photon emission has been discovered in many microscopic and macroscopic systems, including in lipid systems [2-5].
Biological systems emit very low light without any external stimuli. This phenomenon is now commonly referred to as ultra-weak photon emission. There are two types of ultra-weak photon emission - spontaneous and induced. All products contain biomacromolecules and molecular oxygen that contribute to changes in bioluminescence as a result of oxidative processes. [6]. The phenomenon of photon emission allows to determine the quality of food. Determining the quality of the food is the most important element allowing a product to be placed on the market. However, it is still a huge problem for food evaluation technology. Currently, the traditionally used laboratory methods to determine product quality use techniques that require large amounts of time and money [7-9]. Such research was conducted, among others, by Trzyniec et al. [9], Nawara et al. [10] and Gałązka-Czarnecka et al. [11]. One of the concepts of food quality testing was developed by the biophysicist F.A. Poop [12]. This concept is based on measuring the emission of photons emitted from food products and biological raw materials. The emission is not visible to the naked eye because this emission has a lower energy threshold than the sensitivity of the human eye. According to Poop, all living organisms emit radiation of low intensity and wavelength in the range of 300 to 800 mm. The aim of the study was to determine the size and structure of secondary luminescence generated by industrial hemp with different specifications and degree of processing. In addition, a characteristic of photon emission as a function of material exposure time was prepared, as well as a characteristic of the emission value in the case of excitation generated by a constant electric field with a voltage of 2 kV and 3.3 kV. The scope of the work included the measurement of photon emission from 20 cannabis samples with different food and production specifications.

2. Materials and methods

The tests were carried out at the Laboratory of Experimental Research Techniques for Raw Materials and Biological Products on a photon emission measurement stand, accredited by the Polish Center for Accreditation as a proprietary procedure. 5 g of hemp products: dried, emulsion and oil were weighed. The materials were exposed to a constant electric field with a voltage of 2 and 3.3 kV. Immediately after the material was exposed to an electric field, the photon emission of the material was recorded. The photon emission is measured by using a photomultiplier tube. The photomultiplier tube (Figure 1) consists of a photocathode emitting electrons under the influence of the electromagnetic radiation of the dynod system falling on it, multiplying the number of electrons thanks to the secondary emission phenomenon; electron opt. an input system generating an electric field focusing electrons from the photocathode on the first dynode, the anode and additional electrodes.

![Figure 1. Diagram of a photomultiplier (Hamamatsu)](image)

The research was carried out using a measuring system consisting of elements that enable registration of photons on the basis of electromagnetic radiation emitted from organic matter. In order to reduce the dark current of the photomultiplier, it is cooled. A proprietary measurement system was used to carry out the research, which enables the registration of the number of photons emitted from food products (Figure 2).
To subject the tested material to the effects of a constant electric field, a laboratory stand was used (Figure 3) consisting of: a high voltage pulse generator in the voltage range with a voltage adjustable in the range from 0 to 30 kV, a control system enabling the change of the frequency of pulses and the time interval between them, a chamber in which the discharge takes place and in which there are two flat electrodes, between which the test material is placed.

3. Results

Analyzing the number of recorded photons in the total counting time of 1800 seconds, a significant variation was observed between the cannabis products selected for the study (Figure 4). An upward trend in the response of the organic substance in the form of photon emission to the constant electric field forcing was observed for all tested products. In the case of hemp products constituting the control sample, the highest value of photon emission was recorded in the case of hemp oil - 290 photons / 1800 seconds of measurement. A high number of photons was observed for the hemp emulsion 240 photons / 1800 seconds of measurement. The lowest photon emission was recorded for dried hemp - 186 photons / 1800 seconds of measurement. In the case of stimulation of samples with a constant electric field with a voltage of 2 kV, an increase in the number of emitted photons from all cannabis products was observed compared to the control samples. The highest value was recorded in the case
of hemp oil - 366 photons / 1800 seconds of measurement. A high number of photons was recorded for the hemp emulsion 260 photons / 1800 seconds of measurement. The lowest photon emission was recorded for cannabis, 256 photons / 1800 seconds of measurement. In the case of exposure to the samples with a constant electric field with a voltage of 3 kV, an increase in photon emission was also observed compared to the samples stimulated with a constant electric field with a voltage of 2 kV and controls. The highest value was recorded in the case of hemp oil - 646 photons / 1800 seconds of measurement. A high number of photons was recorded for the hemp emulsion 303 photons / 1800 seconds of measurement. The lowest photon emission was recorded for dried cannabis 288 photons /1800 seconds of measurement.

![Figure 4. The photon structure at individual measurement time intervals for each test hemp products variety](image)

The total number of photons emitted by the drought was (Figure 5) for the control: 186, for the 2kV field: 256, and for the 3.3kV field: 288. The highest value of 45 occurs during the first three minutes of the measurement, it occurred during the measurement for field 3, 3kV. In the subsequent time intervals, the emission for all three measurements was written in the pattern of a sinusoidal plot. The lowest value that was registered was 15 for the control measurement in the range of 1-200 s.
Figure 5. Photon emission characteristics for the time function for cannabis drought

The total number of photons emitted by the hemp cream (Figure 6) was for the controls: 240, for 2kV: 260, and for 3.3kV: 303. The highest value of 46 is in the 1000-1200s interval, it occurred during the measurement for the 3.3kV field. In the later time intervals, the emission for all three measurements was written like a parabola. The lowest value that was recorded was 18 for the measurement of a 2kV bay in the 1-200s range.

Figure 6. Photon emission characteristics for the function of time for the hemp emulsion
The total number of photons emitted by the hemp oil was (Figure 7) for the control: 290, for 2kV: 366, and for 3.3kV: 646. The highest value of 92 falls on the range 1-200s, for the measurement 3.3kV. The lowest value that was recorded was 26 for the control measurement and for the 2kV bay.

Figure 7. Photon emission characteristics for the function of time for hemp oil

4. Conclusion
It was found that stimulation with a constant electric field influences the photon emission, causing its increase. The use of various voltage parameters modifies the structure of the photon emission, making it possible to identify the degree of interaction. Comparing the control trials with the tests stimulated with a constant electric field, an increase in the photon emission of all tested products was observed. On the other hand, comparing the two parameters of the electric voltage used, higher photon emission was obtained in the case of electric field stimulation with a voltage of 3 kV.

References
[1] Kiewski R Pniewska I Kubacki A Strzelczyk M Chydy M Oleszak G 2017 Konopie siewne (Cannabis sativa L.) - wartoścowa roślina użytkowa i lecznicza Post. Fitoter 18(2) 139-144
[2] Oziembłowski M Dróżdż M Kielbasa P Dróżdż T Gąsiorski A Nawara P Tabor S Ultrasłaba luminescencja (USL) jako potencjalna metoda oceny jakości żywności tradycyjnej, Przegląd Elektrotechniczny 93 (2017) n. 12 131–134.
[3] Trzyniec K Kielbasa P Oziembłowski M Dróżdż M Nawara P Posyłek Z Leja R Using photons emission to evaluate the quality of apples. Przegląd Elektrotechniczny (2017) nr 12 s. 183-187.
[4] Borc R Jaśkowska A Dudziak A Ultrasłaba emisja fotonowa z układów żywych, Politechnika Lubelska (2015) ISBN 978-83- 7947-164-5.
[5] Laager FM Becker NM Park SH Soh KS 2009 Effects of Lac operon activation, deletion of the Yhha gene, and the removal of oxygen on the ultraweak photon emission of Escherichia coli, Electromagnetic Biology and Medicine 28 pp. 240– 249.
[6] Cifra, M and Pospíšil, P 2014 Ultra-weak photon emission from biological samples: Definition, mechanisms, properties, detection and applications. Journal of Photochemistry and Photobiology B: Biology 139 2–10
[7] Kordowska-Wiater M, Sosnowska B, Waśko A, Janas P. 2002. Ocena jakości mikrobiologicznej wybranych mrożonych owoców jagodowych. Żywność 4(33).

[8] Jakubowski T. 2018. The reaction of garden cress (Lepidium sativum L.) to microwave radiation. Applications of Electromagnetics in Modern Techniques and Medicine (PTZE), IEEE Xplore digital library, s. 81-84.

[9] Trzyniec K, Popardowski E, Juliszewski T, Baran D, Miernik A. 2019. Wykorzystanie ultrasłabej emisji fotonowej do klasyfikacji i oceny jakości czekolad. Przegląd Elektrotechniczny 95, 12, 229-232.

[10] Nawara P, Trzyniec K, Dróżdż T, Popardowski E, Juliszewski T, Zagó尔da M, Miernik A. 2020. Analiza możliwości identyfikacji parametrów jakościowych oliwy przy wykorzystaniu ultrasłabej luminescencji wtórnej. Przegląd Elektrotechniczny 96, 2, 117-120.

[11] Gałązka-Czarnecka I, Korzeniewska E, Czarnecki A, Sójka M, Kielbasa P, Dróżdż T. 2019. Evaluation of Quality of Eggs from Hens Kept in Caged and Free-Range Systems Using Traditional Methods and Ultra-Weak Luminescence. Applied Sciences, 9, 2430; doi:10.3390/app912430.

[12] Popp FA. 2010. Przekaz jedzenia, czyli co nas odżywia. Wydawnictwo Virgo Warszawa.