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Characterization of Physalis peruviana by addiction of Malathion through colorimetry

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BACKGROUND
To improve crop efficiency, different pesticides are used to keep plants free of pests, one of the most used is the insecticide Malathion, this compound is toxic to humans when is ingested in large quantities, so it is important to develop a method capable of determining the presence of the compound on fruits that are for human consumption.

OBJECTIVE
Develop a Cape gooseberry analysis, characterizing the skin, pulp and pesticide used on it through colorimetry. In order to obtain the parameters that allow to detect the presence of the same on the fruits harvested.

RESULTS
The analyzed parameters such as Cab Chroma and Hue angle were analyzed, obtaining 47.2 and 76.5 respectively for the fruit, while on contact with Malation, a decrease of 15 Points for the Cab Chroma and 3 ° for the Hue angle was noted.
The parameters with the greatest variation were the luminosity, with a change of 20% and the ratio of green and magenta color ("b") with a change of 33% when the pesticide was added.

CONCLUSION
The *Physalis peruviana* had as main colorimetric characteristics, an average in the Cab Chroma of 47 points, the Hue angle stood at 76°. Whereas, in the addition of the pesticide on the fruit these values decrease in 15 points and 3° respectively. As for the CIE Lab color space, when the fruit presents the insecticide, the values decrease for the "L" and "b" parameters up to 55.1 and 30.7 respectively.

KEY WORDS
CIE Lab, Hue Angle, Organophosphorus, Pesticide.

INTRODUCTION

The *Physalis peruviana* is commonly known as Cape gooseberry, is native from South America, it is widely cultivated in countries like Peru, Colombia, Bolivia, Ecuador, among others. It is a yellow and round fruit, which is protected by a thin shell when it still on the plant. It has a great acceptance local and international markets, due to his high content of vitamins and minerals such as Vitamin C, Iron, Phosphorus, among others [1], [2]. In addition, it is used to treat different diseases such as asthma, depression and Diabetes [3], [4].

To obtain a greater efficiency and production of the crops, different chemical pesticides are used. However, most of the compounds used for this purpose are contraindicated by different organizations such as the Colombian Agricultural Institute (ICA) the United States Environmental Protection Agency (EPA) [5]–[7]. In some Cape gooseberry's crops the insecticide Malathion is used to attack pests such the gray aphid (*Brevicoryne brassicae*), the bedbug pasture (*Collaria columbiensis*), among others [8], [9].

The IUPAC name for the Malathion is diethyl 2 - [(dimethoxy phosphorothioyl) sulfanyl] butanedioate. It is used in crops of Beans, Tomato, Cape gooseberry, Guanábana, Tobacco, among others [10]. Its effectiveness lies in is an organophosphorus compound. These types of compounds are characterized by inhibiting Acetylcholinesterase (AChE), causing an interruption in the cellular respiration cycle and the nervous system.

When ingested in large quantities, it can produce cramps, tachycardia and other failures of the muscular system [11]–[13].

To reduce the amount of pesticide present in the fruits, analytical measurements of the pesticides present are made. One of the most used techniques is the chromatography, in which the sample is passed through a series of analytical steps, in order to isolate the compound of interest. After a physical property is compared with patterns and determine the concentration of it [14], [15]. Because these types of techniques are destructive, the use of techniques such as colorimetry are planted, in which a beam of light impact the sample, while the reflected signal is collected. Subsequently, this emission is analyzed through different parameters [11], [16].

In colorimetry, the parameters most used are the Cab chroma, which indicates the saturation level or intensity of the measured color. The Hue angle, indicates the wavelength that has greater weight in the reflection spectrum, in other words, is the base color of the sample. In addition to these parameters, a color space is used, to replicate the samples regardless of the conditions. The most used is the CIE Lab color space. Where the parameter "L" indicates luminosity, the parameter "a" and "b" are scales between green with magenta and blue with yellow respectively [17], [18].

Based on the above, this paper presents the Cape gooseberry analysis, characterizing the skin, pulp and pesticide used on it through colorimetry. In order to obtain the parameters that allow to detect the presence of the same on the fruits harvested.

MATERIALS AND METHODS

Commercial Malation recommended for fruit crops was used to perform the characterization and the dilution to which it is applied on the crops. The experimental part was carried out on the campus of the New Granada Military University in Cajicá, Colombia. Because it is an area where this type of fruit is harvest and thus ensure that the conditions were similar to those used by a farmer. The Molar concentration and ppm of the commercial insecticide were determined through equations 1 and 2, respectively.

$$C_1\left[\frac{mol}{L}\right] = \frac{C_1\left[\frac{g}{L}\right]}{MW\left[\frac{g}{mol}\right]} \quad (1)$$

$$C_1\left[\frac{mg_A}{kg_{sln}}\right] = \frac{C_1\left[\frac{g_A}{L}\right]}{\rho\left[\frac{g_{sln}}{mL}\right]} * \frac{1\,L}{1000\,mL} * \frac{1000\,mg_A}{1\,g_A} * \frac{1000\,g_{sln}}{1\,kg_{sln}} \quad (2)$$

Where MW was the molecular weight and ρ was the density. The initial concentration of Malathion of Chlorpyrifos was 604 g / L. However, the Malation solution applied to the fruit was diluted with distilled water. To obtain the final concentration of the pesticide, the equation 3 was used, because the initial and final mass of solute present in the solution was the same.

$$C_1 * V_1 = C_2 * V_2$$

$$\frac{C_1 * V_1}{V_2} = C_2 \quad (3)$$

To obtain an adequate characterization of the Cape gooseberry, a sampling was carried out for 5 different market places in Bogotá, in which a total of 2500 g of fruit was collected. It was then refrigerated and packaged for use on the Cajicá campus. Of the picked fruit, the fruit that no present damage or signs of decomposition was chosen (

Fig. 1). In order to analyze the fruit, 4 similar piles of 500 grams each one were made. For the first heap the fruit skin was analyzed, in the second the pulp when it was cut, in the third the pulp when was peeled, while in the fourth group was added 0.1 mL of pesticide on each Cape gooseberry.

Fig. 1: Cape gooseberry used for colorimetry.

Colorimetry:

For the colorimetric analysis, a non-contact spectrophotometer Flame-S Ocean Optics was used (Fig. 2, No. 2), with detector DET2B, with a detection range of 200 to 1100 nm, a light source DH-2000-BAL was used with Deuterium and tungsten lamp (Fig. 2, No. 1). A 400 µm premium grade reflectance fiber was used with solarization-resistant, with a wavelength range similar to the detector used.

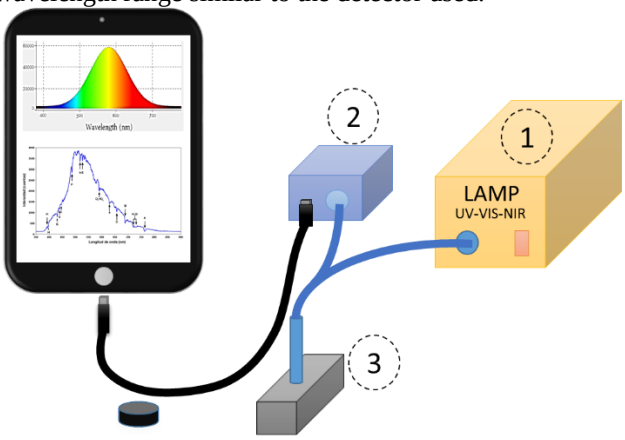


Fig. 2: Assembly managed for the experiment.

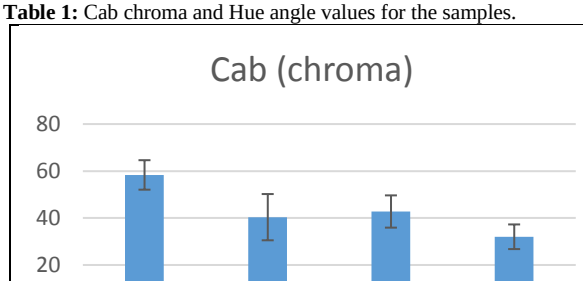
In order to characterize the Cape gooseberry and the pesticide, the parameters Cab chroma, Hue angle and CIE Lab color space were used. These were obtained through Ocean View software and analyzed in Matlab R2016a®, where the average and the standard deviation of each sample were taken. In addition, the reflection spectra were taken to complement the color space analysis.

RESULTS AND DISCUSSION

The Cab chroma and the hue angle parameters with the concentrations of the solutions used, were shown in

Table 1 for which the standard deviation for each measurement was presented. In the case of the Cab chroma, the deviation was shown with the horizontal black error lines.

Table 1: Cab chroma and Hue angle values for the samples.



Blackberry's Sample	Hue angle
Skin	75,433 ± 1,093
Cut Pulp	76,250 ± 4,263
Peeled Pulp	77,822 ± 2,809
Pulp + Malathion	73,535 ± 2,478
Pesticide ($C_{10}H_{19}O_6PS_2$)	

Commercial Malathion (M)	1.828
Commercial Malathion (ppm)	5.64 E+05
Applied Malathion (M)	0.026

The standard deviation for the Hue angle was not significant, so that the data found determined the base color of the Cape gooseberry, which was 76° on average. This mean includes all the possible forms that had the fruit, in order to prevent a false measure. When adding Malathion of concentration 0.026 M on the same, the value decreases in approximately 3 degrees. As for Cab chroma, the average value for the Cape gooseberry was 47, while when adding the pesticide this value decreases by 15 points, which causes a decrease in color saturation, due to the fact of the intrinsic color and properties of the pesticide used.

Regarding the CIE Lab color space, a search was made for the parameters that had the greatest variation at the time of characterization of the fruit before and after the addition of the pesticide. From these it was found that the parameter "a", the variation between the green and magenta colors, does not present significant variation. Reason why, it was decided work with the other parameters. In Fig. 3, two - dimensional graphics of the "L" parameters and "b" for all samples were shown.

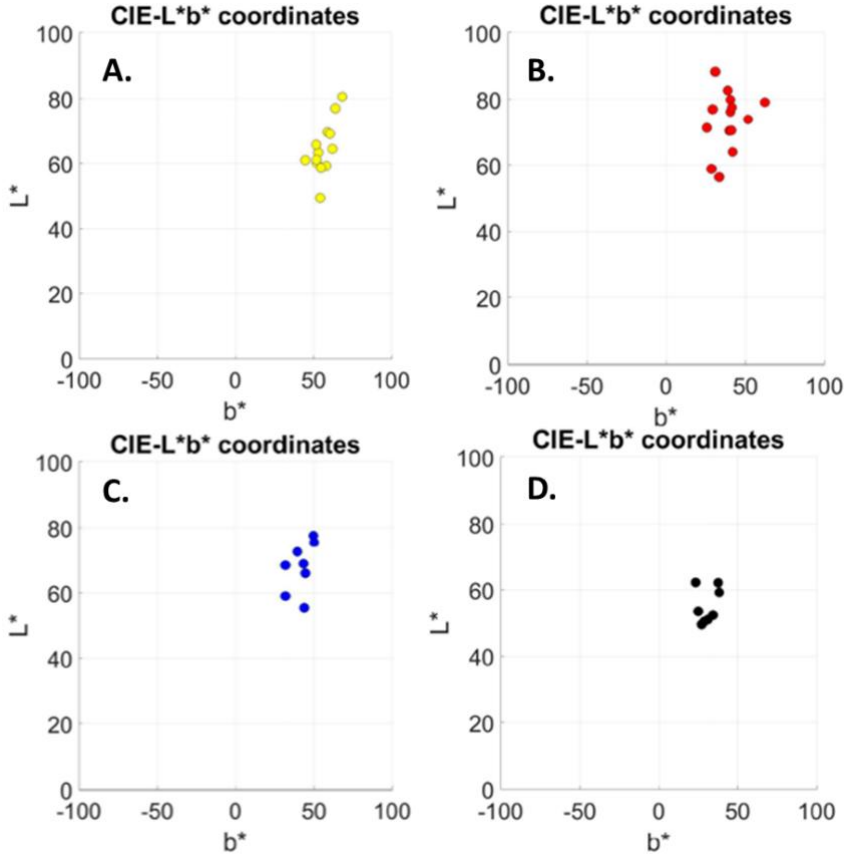


Fig. 3: Samples analyzed in the CIE Lab color space, A. Skin, B. Cut pulp, C. Peeled pulp, D. Pulp + Malathion (0.026 M).

In Fig. 3, the characterization found for each part of the fruit of the Cape gooseberry was observed, however, a wide variation for the parameter "L" in all samples of the fruit was found. This was due to the unique maturity and the tonality of each Cape gooseberry in specific. The skin and the cut pulp presented the bigger variation in the data, that was due to the imperfections that were present in the fruit, while in the cut pulp, this variation was made for the seeds presents in the fruit. For the shell an average of 64.6 was obtained, while for the cut and peeled pulp 73.4 and 68.0 were obtained on average, respectively, whereas when Malation was added, this value decreased to 55.1. This same pattern was observed for parameter "b", where adding the pesticide was decreased by 10 points on average. This analysis was supplemented with the average of the reflection spectra of each sample analyzed, these were shown in Fig. 4.

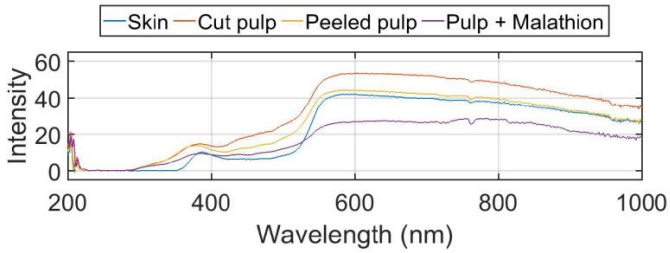


Fig. 4: Spectra of the samples used.

The spectra of the analyzed samples did not have defined peaks or valleys, however, they present a pattern, where from 530 nm the intensity increases, this was due to the intrinsic color of the fruit. When Malathion was added to the sample, a decrease in intensity occurs after 530 nm, whereas for the infrared zone the intensity was similar.

For the extreme values of the equipment existed an increase of the variation of the spectra, mainly due to the intrinsic characteristics of the same. Also, there was a semi valley at the 770 nm approximately, which increase when the insecticide was added. The mixture and the evaluation of all these parameters made a method in order to determine the presence of the pesticide in Cape gooseberry.

Conclusions:

At present, the use of chemical pesticides has been increased by the need to increase the efficiency of crops, this cause an increase in the number of people intoxicated by the ingestion of these compounds. Reason for which the characterization of the fruit Cape gooseberry was carried out and how his colorimetric properties change with the addition of Malathion, being a practical and portable method to detect the presence of pesticide directly in harvested fruits.

The *Physalis peruviana* had as main colorimetric characteristics, an average in the Cab chorma of 47 points, the Hue angle stood at 76 °. Whereas, in the adition of the pesticide on the fruit these values decrease in 15 points and 3° respectively. As for the CIE Lab color space, when the fruit presents the insecticide, the values decrease for the "L" and "b" parameters up to 55.1 and 30.7 respectively.

The insecticide Malathion is an organophosphate compound widely used in the industry, due to his effectiveness against pests. However, it is also characterized as a toxic compound that can cause damage to the muscle system. The analysis was performed using a solution of Malathion 0.026 M. For the reflection spectrum, a decrease in intensity of approximately 10 points after 530 nm was determined. With the mix of all the colorimetric properties, it was possible determine the presence of this pesticide on the fruit of Cape gooseberry.

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