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Color physical characterization by Tristimulus Colorimetry to inside the *Annona Muricata* fruit

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ABSTRACT

Background: Nutritional and medicinal properties have been found, and demonstrated the Annona Muricata fruit, has aroused great interest in his study mainly to implement in treatment of chronic diseases such as cancer. The color analysis is generally applied for the study of maturity and identifying features in food fundamentally different fruits. ***Objective:*** Obtaining physical characterization of color by tristimulus colorimetry for the interior of the soursop, in the Annona Muricata fruit. ***Conclusions:*** Positive correlation coefficients were obtained between L* and b* of 0.4181, between a* and b* of 0.4534 and between a* and (h) of 0.6947. From the analysis (PCA) between chromatic and psychometric parameters of color, it found two main components representing a 98.31% all of the information. It was found a positive correlation in luminosity and the b * parameter, representing the color change from blue to yellow, and between a* which represents green to red and their polar component, hue (h).

KEY WORDS

Annona Muricata, tristimulus colorimetry, space CIELAB, RGB.

INTRODUCTION

Guanabana or Annona Muricata as it is known by its scientific name is a tropical fruit which at present it is found great interest because of its medicinal properties [1], [2]Economic development on this tree of fruit has led to the use of the seeds and leaves for the pharmaceutical industry [3].

The plant of this fruit considered medicinal in several countries their use it is common as an alternative to treat people with gastrointestinal or gastric cancer, [4]. In Colombia, the Annona Muricata is a fruit widely consumed as fresh fruit and juices. At a medicinal level is used as anti-diarrheal, anti-diabetic and antiviral, to treat malaria and antiphrastic and insecticidal, [5].

Root, stem, leaf and fruit of the Annona Muricata are rich in flavonoids, alkaloids isoquinoline and Annonaceous acetogeninas, [6], [7]; it has been studied and shown that the latter kill's cancer cells with great success and become resistant to chemotherapeutic drugs, [8], [9].

The color is a perception and a subjective interpretation; there may be several references, to call it. For measurement and representation of a single quantized value, there are sets of tristimulus values in space (CIE-XYZ) indicating the percentages of red, green and blue, which describe it, however it has been shown that this space does not match for differences of color perceived by humans, because it is an extremely no uniform appreciation [10].

Therefore, a space (CIELAB) in which local and global linearization used without compromise the uniformity of perception was proposed. It is shown in rectangular coordinates in brightness parameters L *, and chromaticity a * and b *. The polar components of those latter, defining two different color components (Chroma, c) and (Hue, h); those are a specification relevant for the psychophysical color analysis,[11].

Some work related to the analysis of color to various fruits are been developed. In [12], the analysis of digital imaging and tristimulus colorimetry conducted a chemistry and colorimetric characterization for various crops of Jamaica. An application to evaluate the stability of color in fruit extracts was developed in [13], where the results concluded that the most stable extract was in grape tree (M. cauliflower) because they present minor variations in the Chroma (c). Similarly, in [14] a system of computer vision performed for measuring food color in the CIELAB space with satisfactory results, the comparison with a digital colorimeter gave an acceptable measurement.

For the physical-chemical analysis and state of maturity properties, are been developed studies and applications for different fruits, some of them [15]in tropical fruits such as passion fruit,[16] in mango, papaya and banana and for [17]granadilla.

In these, it found a color relationship with the state of maturity and the physicochemical properties to the fruits studied by the chromaticity coordinates and image processing.

Obtaining physical characterization of color by tristimulus colorimetry for the interior of the soursop, it is the main objective of this work, in order to identify the relationship between the variables in the CIELAB space, as well as their rectangular components.

Methods:

For the development of this work an experimental study where were obtained tristimulus colorimetry parameters in the CIELAB space, with a spectrometer, and Ocean View software for visualization and data acquisition was performed.

The acquired data related to the physical characterization of color inside the *Annona Muricata* selected for the study. In Fig. ***1***, the image illustrated the analyzed fruit.

Fig. 1: Photo of Annona Muricata selected.

With the rectangular coordinates representing the CIELAB space as brightness (L*), and the chromaticity (a *, b *), it can describe a color by its position in space; where [-L, L] goes from black to white, [-a, a] represents from green to red and [-b, b] from blue to yellow. Both the rectangular coordinates as its polar components obtained during the study for a posterior analysis.

Table 1 shown the data obtained inside the sample in Annona Muricata.

Table 1: Color parameters Annona Muricata.

	Annona Muricata Coordinates				
	L*	a*	b*	c	h
1	94,832	-2,980	-4,347	5,270	-124,433
2	78,229	-1,310	-5,504	5,686	-103,386
3	101,881	-3,050	-4,332	5,298	-125,151
4	96,622	-3,161	-5,212	6,095	-121,233
5	81,104	-4,298	-5,985	7,368	-125,681
6	93,859	-2,924	-5,060	5,844	-120,019
7	85,513	-4,012	-7,365	8,387	-118,581
8	107,947	-4,386	-6,320	7,693	-124,764
9	103,618	-3,124	-3,801	4,920	-129,416
Average	93,734	-3,249	-5,325	6,285	-121,407
Deviation	10,266	0,934	1,116	1,226	7,513

A correlation performed to identify the relationship of the data presented in Table 1, obtaining the correlation coefficients in Table 2.

Table 2: Correlation coefficients.

	L*	a*	b*	c	h
L*	1	-0.3032	0.4181	-0.2473	-0.6624
a*	-0.3032	1	0.4534	-0.6879	0.6947
b*	0.4181	0.4534	1	-0.9578	-0.3179
c	-0.2473	-0.6879	-0.9578	1	0.0386
h	-0.6624	0.6947	-0.3179	0.0386	1

Principal component analysis

A principal component analysis (PCA)carried out in order to perform a multivariate analysis itto establish the relationship between the color parameters in the CIELAB space, and thus confirm the correlation coefficients obtained previously.

The principal component analysis (PCA) is a multivariate technique for the simultaneous analysis of several variables. Through this, variables that account for most of the variability of the data contained are identified, the correlation is studied in dimension variables and a reducedanalysis to new variables, which constitutes a main component, [18].

From the main components, it seeks to represent and interpret the relationship between the most representative variables of the study and discard those that are not.

Analysis of Results:

The psychometric color parameters were graphed with RGB in the MATLAB software, obtaining the results presented below.

Fig. ***2*** presented, the relationship between the coordinates a * and b *.

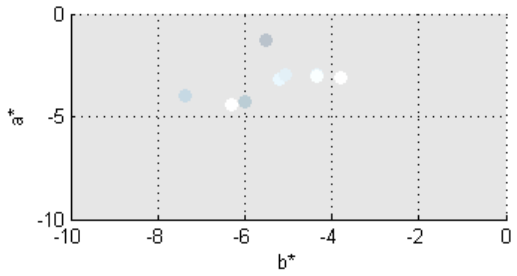

Fig. 2: Graphic of coordinates a * and b *

Data related to parameters a* and b*, were grouped in the plane of CIELAB space coordinates of the negatives, corresponding to gray tones.

Fig. ***3***shown the relationship between the coordinates L* and a*.

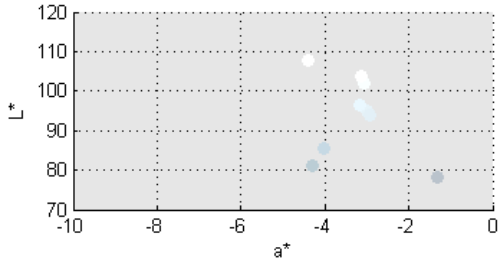

Fig. 3: Graphic of coordinates L* and a *

The data related to L and a* parameters, clustered in the plane of CIELAB space of coordinates positive in brightness, and the negative of a* corresponding to white and gray.

Figure 4 shown, the relationship between L * and b* coordinates.

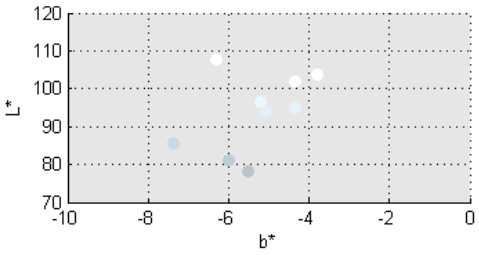

Fig. 4: Graphic of coordinates L* and b*

Data related to the L* yb * parameters were grouped in the plane of the CIELAB space coordinates of the positive in brightness, and negative in b * corresponding to white and gray.

Fig. ***5*** presented, the relationship between the coordinates L *, a * and b *.

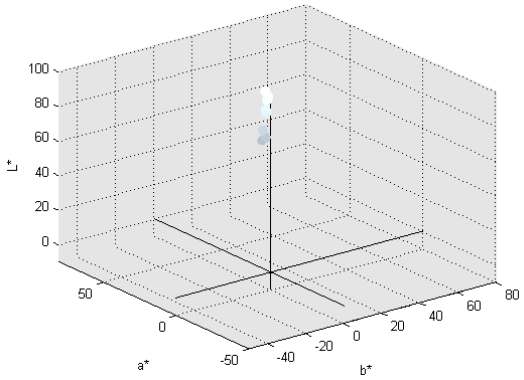

Fig. 5: Graphic of coordinates L*, a * and b *

Through the graphs obtained can be identified and physically characterize the interior color of the Annona Muricata. In all graphs, it was observed that the majority of the data were grouped regarding study parameters, which clearly identifies the expected white tones.

From the analysis (PCA) between chromatic and psychometric parameters of color, it found two main components representing a 98.31% all of the information.

The results obtained in the analysis (PCA) are presented below. InFig. ***6***, the graph of the two main components of the analysis is shown.

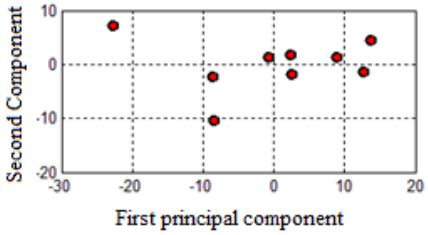

Fig. 6: Graph principal components.

Five main components were calculated, however qualification for the last three ones were not sufficiently relevant to take account in the results.

Fig. ***7***Shows, the percentage of information corresponding the two main components obtained.

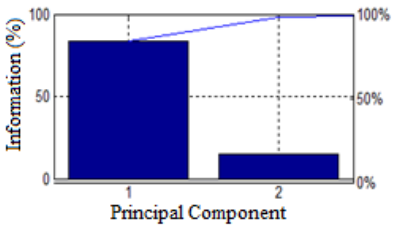

Fig. 7: Percentage of information on each component.

The 83.42% of the data belong to the first principal component, while 14.89% belong the second and the remaining percentage belongs from third to fifth one. With the above, it was allowed to establish the first two components as analysis variables.

Fig. ***8***presents the plane of representation of color psychometric parameters in relation to the two principal components.

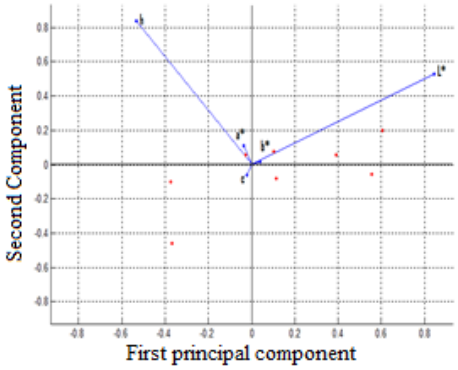

Fig. 8: Parameters in the plane of the principal components.

In the plane, (L *) and (b*) are located in the first quadrant, (a *) and (h) in the second one and in the third quadrant the parameter (c).

The location of (L *) and (b *) that coincide in the first quadrant, can be related to the positive correlation coefficient of 0.4181 found between these variables, to demonstrate the correlationbetween these two parameters color which belong to the same quadrant.

Similarly the parameters (a *) and (h) that coincide in the second quadrant shows the correlation between these of 0.6947; while (c) belong to the third quadrant in the plane of Figure 8. This parameter obtained a negative correlation coefficients with the main parameters (L *, a * and b *), and a positive correlation coefficient of 0.0386 with h.

Conclusions:

From an experimental study of color in conjunction with data analysis and principal component, relationships between the chromaticity coordinates and polar components in the CIELAB space were established, finding a positive correlation in brightness and the b * parameter, representing the color change from blue to yellow, and between a* which represents green to red and their polar component, hue (h).

The principal component analysis showed a total of five components for the representation of 100% of data , however, only the first two components contained a 98.31% of information therefore they only required of these for interpreting the relationship of color parameters for this case study.

With the physical characterization of the color of the Annona Muricata, it can establish that representative variables are the brightness, Chroma, and hue. The psychometric variable (c) do not show a positive correlation relevant to the analysis however the only positive factor was with hue, which is explained because both are polar components of chromatic parameters.

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