EVALUATION OF UV PROTECTION OF FABRICS DYED WITH NATURAL DYE EXTRACT OF RAMBUTAN PEEL (*Nephelium lappaceum L.*).

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ABSTRACT

Its epicarp (peel) and the seed of Nephelium lappaceum L., known as Rambutan, correspond respectively to 37-62% and 4-9% of the whole fruit that are discarded. In order to propose a valorization of rambutan peel as a source of bioactive compounds, the present study aimed to determine part of these bioactive compounds and to evaluate the UV protection of fabrics dyed with dye extract of the residue under study. The resulting values of the analyses were 2579,25 mgAGE/g (phenolic content); 7,21 mg/mL (IC50 antioxidant activity assay); 94,20% (concentration of polymeric anthocyanins in color); The UV transmittance and absorbance values obtained were satisfactory in the fabrics dyed with the dye extract, as they transmit less radiation and absorb more, promoting greater sun protection. In conclusion, the epicarp dye extract of Nephelium lappaceum L. has a chemical composition rich in the bioactive compounds analyzed and proved to be a good pigmenting agent that, in addition to giving color to the tissues, promoted protection against UV rays. According to the results presented, the material can have several applications in the textile, cosmetics, food and health industries.

Keywords: Rambutan. 1. Bioactive compounds 2. Dye extract 3. UV protection 4. Residue 5.

1 INTRODUCTION

Nephelium lappaceum L. (Figure 1), known as Rambutan, belonging to the Sapindaceae family, the ripe fruit of Rambutan has a red exocarp and trichomes, having an aril attached to a single seed[9]. This fruit attracts attention due to its exotic appearance and refreshing taste. The rambutan fruit is mainly consumed fresh, however, its inedible epicarp (skin) and the seed, which correspond respectively to 37-62% and 4-9% of the whole fruit are discarded[2]. While the seed is commonly used in the formulation of chocolate sangrias[6], the skin of the fruit has not been exploited[5].

Figure 1 Nephelium lappaceum L. fruit.

One of the biases in the use of waste may be the development of natural dyes. Natural dyes derived from fauna and flora are safer because they are non-toxic, non-carcinogenic, and biodegradable. As the trend around the world is moving towards the use of eco-friendly and biodegradable commodities, the demand for natural dyes is constantly increasing.

In order to propose a valorization of rambutan bark as a source of bioactive compounds, the present study aimed to determine phenolic compounds, antioxidant activity, polymeric color concentration and the obtaining of a natural dye for the dyeing of plant tissues from an aqueous extract of this residue.

2 MATERIAL & METHODS

Fruits of Nephelium lappaceum L. (Rambutan), in the mature stage, were purchased in local stores in Belém/PA and, after botanical identification, the peels (exocarp) were removed, washed in running water and taken to a circulating air oven at 50 ºC for 36 hours and then crushed. The crude aqueous extract was obtained by maceration of the crushed material of the dry exocarps in a ratio of 1:10 (plant material:solvent) for 72 hours. Subsequently, two filtrations were made to obtain a clear extract.

Total phenolics were determined using the Folin-Denis reagent and the standard gallic acid curve[7]. To prepare the standard calibration curve, a standard solution of gallic acid 200 mg/L was used, and from it, dilute concentrations of 20, 40, 60, 80 and

100 mgAG were prepared. in triplicate, and the absorbance was measured for the standards and for the samples at 765 nm, expressing the results as mg of gallic acid/100 mL of extract/L.

To analyze the antioxidant activity[1] of the extract, 1,95 mL of DPPH solution (60 µM) was added to 0,5 mL of the extract. The mixtures were maintained in the absence of light for 30 minutes and then the readings at the intervals of 0, 15, 30, 45, 60 minutes were performed in the UV-Vis spectrophotometer at the wavelength of 517 nm. The procedure was performed in triplicate and a blank test was prepared by adding 1,95 mL of methanol to 0,5 mL of the extract. As a control, a mixture of 1,95 mL of DPPH solution with 0,5 mL of methanol was used.

The percentage of polymeric color[4] of the concentrated extract was determined from the concentrated extract, one with bisulfite solution and the other with distilled water. The dilutions were submitted to absorbance readings of 420 nm (brown pigments), 520 nm (monomeric anthocyanins) and 700 nm (correction of readings).

The color of the aqueous extract was determined by colorimetry in a CR-410 colorimeter with direct reading of L* (luminosity), b* (contribution of yellow) and a* (contribution of red). The variables of the CIE (International Commission on Illumination) L*C*h* system were also obtained, represented in cylindrical coordinates, making it possible to evaluate the chromatic tonality angle (h*) and the Chroma (C*).

The fabrics chosen for color testing were cotton, wool and microfiber gabardine. To prepare the material to receive dyeing, it was purged with natural detergent, which was produced with natural coconut soap bar (200g), water (3L), alcohol (50ml) and bicarbonate (30g). For the purging process, the alum mordant was also added, in an amount corresponding to 10% of the weight of the tissues. The mixture of detergent and mordant was heated until it reached 80°C, then the tissues were inserted and remained in this solution for 1 hour.

The purged tissues, still soaked in the biting solution, were submerged in the dye solution at a temperature of 60°C for 30 minutes. After this process, the fabrics were washed until the wash water was clear and dried at room temperature.

Before the test is performed, the equipment is stabilized and calibrated with a reference, in order to ensure that 100% of the radiation is reaching the material under analysis. The analysis was performed in the wavelength range of 290 to 400 nm, which comprises the region of ultraviolet radiation A (315 to 400 nm) and B (290 to 315 nm).

3 RESULTS & DISCUSSION

For the calibration of gallic acid standards in trilicate, the equation y = 0,0064X+ 0,0043, r2 = 0,99 was obtained, presenting a very good value for the linear correlation coefficient. According to the USDA (2014)[12], for fruits to be considered rich in phenolic compounds, they need to have a minimum of 110 mg EAG/100g, the extract showed a high total phenolic content of 2579,25 (mg AGE), higher than expected by the USDA and also to the results obtained in the literature, of 877,11/g[13] and 762[11] mg AGE/g.

The extract reacted with DPPH radical with absorbance stabilization in 60 min. The inhibition ranged from 26,9 to 43,2 (AA), the IC50 (7,21 µg/mL) was obtained from the equation of the DPPH curve, a result that proves the high antioxidant activity of the extract, since the higher the consumption of DPPH• by a sample, the lower its IC50 and the higher its antioxidant activity[8]. The result obtained is close to that found in the literature, of 9,67 (µg/mL)[10] with the use of the same solvent extractor.

The concentration of polymeric anthocyanins in color is high, corresponding to 94,20%. The antioxidant potential found may be correlated with the high concentration of anthocyanins. No studies were found with polymeric color analysis applied to the material object of the study for comparative analysis.

In the CIE system, the color is defined on three perpendicular axes; the a* axis, from green (-a) to red (+a); the b* axis, from blue (-b) to yellow (+b) and L*, from black (0%) to white (100%). In this sense, it is possible to observe that the extract presented a dark tone, (L* 14,72) since it was below 50, it may have been caused by the dehydration process that may have caused a darkening reaction triggered by heat[3]. The numerically positive values of a* (1,36) and b* (9,05) showed shades of red and yellow, respectively.

The difference between the textures can be identified in terry cotton (TC), plain cotton (PC), gabardine microfiber (GM) and wool (W) fabrics in Figure 2, where the samples are next to each other.

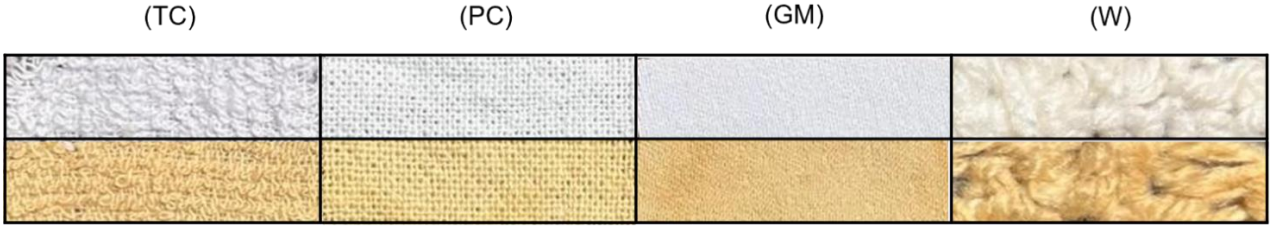

Figure 2 Fabrics before and after dyeing

The contrast in performance between the materials can be observed more precisely in Table 1.

Table 1 Absorbance (%) and transmittance of tissues in the UV range.

Absorbance	Plain cotton	Terry cotton	Wool	Microfiber gabardine	**Transmittance**	Plain cotton	Terry cotton	Wool	Microfiber gabardine
UVA B	1,736	2,121	3,728	2,542	UVA B	1,544	0,862	0,010	0,321
UVB B	1,796	2,106	3,943	3,241	UVB B	1,103	1,057	0,008	0,032
UVA T	2,506	2,253	3,657	3,733	UVA T	0,425	0,078	-0,001	-0,004
UVB T	2,874	2,064	2,946	3,915	UVB T	0,086	0,025	-0,004	0,011

UV transmittance and absorbance values are satisfactory in all fabrics. Because they transmit less radiation and absorb more, they promote greater sun protection, since, if a greater portion of radiation is absorbed less, it will be able to pass through the material, the less radiation is absorbed, the more radiation would reach the user's skin leaving him unprotected. The results prove the efficiency of protection of the extract to dyed fabrics.

4 CONCLUSION

In conclusion, the aqueous extract of the epicarp of Nephelium lappaceum L. has a chemical composition rich in bioactive compounds, such as high antioxidant activity, phenolic compounds and polymeric color concentration. The material analyzed also proved to be a good pigmenting agent that, in addition to giving color to the fabrics, promoted protection from UV rays. According to the results presented, the material can have several applications in the textile, cosmetics, food and health industries.

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