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# Surface quality of the *Ficus* sp. wood veneers submitted to finishing treatments

## Calidad de la superficie del *Ficus* sp. chapas de madera sometidos a tratamientos de acabado

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### ABSTRACT

The objective of this investigation was to evaluate the roughness, wettability and the surface color of *Ficus* sp. genus before and after the process of manual sanding and application of a finishing product (stain). The roughness and color were determined before and after the sanding process and after applying the stain using Surftest SJ 400 Mitutoyo and ColorEye XTH spectrophotometer. The wettability was evaluated by measuring the contact angle between the water drop and the surface of the veneers, using a goniometer Krüss DSA30. The roughness of the veneers, subjected to 180, 240, and 320 sandpaper, decreased after the sanding process and remarkably after stain application. The contact angle was over 90° for all treated samples. Regarding the colorimetry, there was a decrease in L\* average values after sanding. After applying the stain, there was a change in color of the wood, from grayish-white to yellow-olive.

**KEYWORDS:** contact angle, CIELab, colorimetry, wettability, wood, roughness.

### RESUMEN

El objetivo de este trabajo fue evaluar la rugosidad, humectabilidad y el color de la superficie chapas de madera del género *Ficus* sp. antes y después del proceso de lijado manual y la aplicación de un producto de acabado. La rugosidad y la colorimetría se determinaron antes y después del proceso de lijado y después de aplicar el acabado, usando un espectrofotómetro Surftest SJ 400 Mitutoyo y ColorEye XTH. La humectabilidad se evaluó midiendo el ángulo de contacto entre la gota de agua y la superficie de las chapas, utilizando un goniómetro Krüss DSA30. La rugosidad de las chapas disminuyó después del proceso de lijado y más expresamente después de la aplicación del acabado; el lijado se realizó con papel de lija granos 180, 240, y 320. El ángulo de contacto fue de más de 90° para todos los tratamientos con el producto. En cuanto a la colorimetría, hubo una disminución en los valores medios de L\* después de lijado y, después de aplicar el acabado, hubo un cambio en el color de la madera, de color blanco grisáceo a amarillo-oliva.

**PALABRAS CLAVE:** ángulo de contacto, CIELab, colorimetría, humectabilidad, madera, rugosidad.

### INTRODUCTION

The *Ficus* genus, from the Moraceae family, has around 750 species distributed mostly on the tropical and subtropical areas of the world, among which Brazil hosts 64 (Berg and Vilaviccencio, 2004). The species of this genus occur in the entire Brazilian territory and their heart wood and sapwood are differentiated by the color. The heart wood is whitish, with grayish tones, with an impercepti-

ble smell and taste, mean basic density, straight or irregular grain, coarse texture, being most used for veneers with decorative purposes (Instituto de Pesquisas Tecnológicas do estado de São Paulo, 2015).

Overall, the woody species destined to the production of decorative veneers are obtained from tropical areas, since they usually provide technological properties

and appearance favorable to be used as decorative coating. However, to assure the success of application of these veneers, their surface quality is extremely relevant.

The surface quality of the woods can be influenced both by their inherent properties (anatomical, chemical and physical ones), and the processing and machining conditions. According to Kilic, Hiziroglu and Burdurlu *et al.* (2006), the quality of the wood surface is one of the most important parameters influencing further manufacturing processes such as finishing or strength of adhesive joint. Lucas Filho (2004) claims that the surface structure is considered an important quality parameter concerning aesthetical aspect.

The evaluation of the parameters that can determine objectively the surface quality of the woods are extremely important and deserve to be studied in order to obtain the adjustment of the processing variables and choosing the adequate woods to avoid waste and contribute directly to the quality of the final product.

Among those parameters, the roughness, wettability and the colorimetry are described by the literature as the characteristics of the wood that provide objective results and enable diagnosing the surface quality in a concise and direct way.

By definition, according to NBR ISO 4287, the roughness consists of the set of micro-geometric deviations characterized by the small peaks and valleys existent in a surface (Associação Brasileira de Normas Técnicas, 2002). Such irregularities can be determined by measuring the height, width and shape of the peaks and valleys that result from their anatomical characteristics or that are produced during the wood machining (Teles, 2014).  $R_a$  is quantitative measurable parameter widely applied to analyze roughness profile and qualify woods. It consists on the arithmetic mean of the absolute values from the profile deviations, part of a series of determinations used to evaluate and classify the wood regarding its quality, mostly when designed for finepurposes such as furniture manufacturing.

As in other engineering fields, the interest on researches regarding the superficial roughness increased on the

wood processing industry due its direct effect over the product quality (Jakub and Martino, 2005). The capacity to measure and control the surface roughness, which varies in a large scale as a result of the methodological differences on the wood processing, using tools or machines, is very important for several applications (Yildiz, 2002).

In addition to the roughness, the wettability is another parameter that contributes to determine the surface quality. According to Gray (1992), the wettability consists on the ease and effectiveness in which a liquid can spread over a solid surface. Similarly, Berg (1993) defined the phenomenon as macroscopic manifestations of molecular interactions between liquids and solids in contact by an interface. Myers (1990) reports that the measurement consists on determining the angle between the tangent plan at the liquid surface and the tangent plan at the solid surface.

Such macroscopic manifestation between intermolecular forces that act through a solid-liquid interface, needs a better understanding when it comes to wood surfaces, where several liquids or materials can be deposited, as finishing, preservation or even on the gluing process. The wettability evaluation of the wood by determination of the contact angle is difficult, since the wood surface shows a certain roughness, inherent to its anatomic structure. Besides, its chemical composition and porous, heterogeneous and anisotropic surface attribute hygroscopic characteristic to the wood (Scheikl and Wälinder, 2001). However, although there is a difficulty due the aspects mentioned, determining the contact angle is one of the most used methods to evaluate the wettability of the wood surface (Carvalho, 1990; Coelho, 2005), which directly helps to determine the quality.

Another technique to determine the wood quality is the colorimetry, which consists on the quantitative and qualitative measurement of the colors, allowing to objectively register a color and translating it as a numeric data (Lavischi, Janin and Uzielli *et al.*, 1989). One of the most used systems for color measurement is the CIEL\*a\*b\*1976, method that defines the color sensation and is based on



three elements: clarity or luminosity; tonality or matrix; and the saturation or chromaticity (Teles and Costa, 2014; Camargos, 1999; Camargos and González, 2001).

## OBJECTIVES

The objective of this study was to evaluate the roughness, the wettability and color of the surface of wood veneers from the *Ficus* sp. genus, before and after the manual sanding and application of a finishing product.

## MATERIAL AND METHODS

### Preparation of the Specimens and Finishing Process

The trials were performed in the Wood Technology Laboratory of the Department of Forestry from the University of Brasilia. Veneers of *Ficus* sp. were acquired in Brasilia's wood market, Federal District, Brazil, whose measurements were 60 cm × 200 cm × 0.055 cm (width, length and thickness, respectively). From such veneers, 24 specimens, measuring 15 cm × 30 cm × 0.055 cm approximately, were prepared and analyzed (Fig. 1) and divided into 8 treatments (Table 1). Afterwards, they were allocated purposely in an open environment without control of temperature and moisture, aiming to simulate the same storage conditions provided by the local furniture industries.

The samples were submitted to sanding and finishing using the stain Osmocolor semi-transparent product (0.25% of 3-Iodo, 2-Propynyl-butyl-carbamate [IPBC] and 99.75% of inert (resins, vegetable oils, inorganic pigments, mineral fillers, aliphatic and aromatic solvents derived from petroleum) from the Montana chemistry S.A.). The sanding was performed manually, using the 180, 240 and 320 sandpaper, largely used for finishing in the furniture industry. The treatments were carried out only on the less rough side of the veneers. The sanding was composed of 10 cycles for each sample, considering that each cycle corresponded to the back and forth movement of the sandpaper, performed by the same person in all treatments. Three layers of stain were applied in the sanded surfaces using a brush with synthetic bristles, as specified by the manufacturer, between each layer, only three sanding cycles were performed (back and forth) to avoid wearing the wood veneer and removing the product.

After each treatment, the roughness, wettability and colorimetry of the samples were evaluated.

### Roughness

The veneers roughness was determined before and after each treatment, using the Surftest SJ – 400 – Mitutoyo equipment in accordance to the JIS B 0601 (Japanese Industrial Standards, 2001) standard, with a 0.8 mm course and 8 mm evaluation course. The equipment, allo-

TABLE 1. Treatments used to evaluate the surface quality of the wood veneer of *Ficus* sp.

Abbreviation	Treatments
CW	Control (without sanding or product application)
WSd-S	Sample without sanded + product application (stain)
Sd180	Sample sanded with a 180 grain
Sd180-S	Sample sanded with a 180 grain + product application (stain)
Sd240	Sample sanded with a 240 grain
Sd240-S	Sample sanded with a 240 grain + product application (stain)
Sd320	Sample sanded with a 320 grain
Sd320-S	Sample sanded with a 320 grain + product application (stain)

cated in a plane surface, measured the roughness perpendicularly to the fibers in order to obtain Ra parameter (arithmetic mean of the line profile deviations). The measuring was performed in five different positions (Fig. 1, arrows) about on the surface of each specimen. To assure that the measuring was performed in the same points, a paper template was confectioned and allocated over the table in front of the aforementioned equipment.

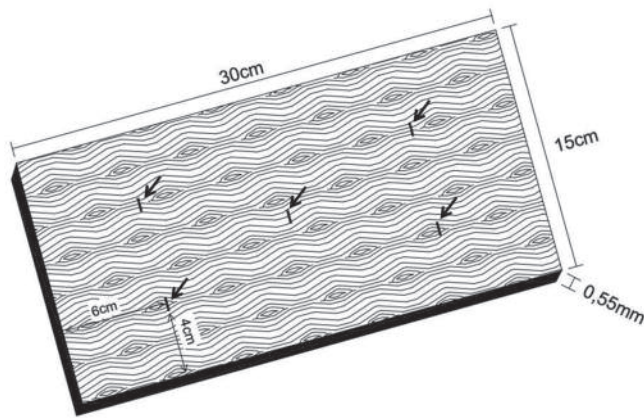


FIGURE 1. Illustrated scheme of the specimens of the *Ficus* sp. veneers. The arrows indicate the data collecting points.

### Wettability

The wettability of the veneers surface was evaluated by measuring the contact angle of the sessile drop, using a Krüss DSA30goniometer and aDSA30 software. Such measurements were performed in the same points from the roughness trial. It is highlighted the possibility to perform the wettability trial after applying the product. Due the lower thickness of the veneer, it was not possible to measure the contact angle correctly without applying the stain.

The liquid used to measure the angle was distilled water. The volume of the drop deposited over each proof body was 13  $\mu$ L and the measurements of the liquid angle regarding the wood surface were performed every second, for 60 seconds. The final contact angle was determined from the arithmetic mean of the contact angles, measured

in 30s and 60s breaks, according to the methodology described by Melo, Del Menezzi, Souza and Stargerlin (2013).

### Colorimetry

Color analyses was carried out using a Spectrophotometer Color Eye XTH from the XRite with a D65 illuminant and a 10° angle, linked to a computer. After the sanding and stain application, the measurements were performed using 15 random points, distributed through the veneer surface to evaluate the colorimetric parameters ( $L^*$ ,  $a^*$ ,  $b^*$ ,  $C$  and  $h^*$ ), defined by the Commision Internationale L'Eclairage - CIE in 1976, in accordance to the methodology proposed by Gonçalves (1993). To verify the changes on the color of the wood before and after the treatments ( $\Delta E$ ), the equation 1 was used:

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad (1)$$

Where  $\Delta E$  is the variation in color between the treatment and the control;  $\Delta L$  is the luminosity variation;  $\Delta a$  is the  $a^*$  parameter variation (colorimetric parameter for the red-green axis); and  $\Delta b$  is the  $b^*$  parameter variation (colorimetric parameter for the yellow-blue axis).

To classify the total variation of the color ( $\Delta E$ ), the perception levels proposed by Hikita, Toyoda and Azuma (2001), as shown in Table 2.

### Statistical analysis of the data

TABLE 2. Ratings for the total variation of the color ( $\Delta E$ ) of the wood.

Color Variation ( $\Delta E^*$ )	Rating
0.0 – 0.5	Negligible
0.5 – 1.5	Slightly perceivable
1.5 – 3.0	Notable
3.0 – 6.0	Appreciable
6.0 – 12.0	Very appreciable

Source: Hikita et al. (2001).



The research was executed applying a randomized experimental design (RED), with 6 repetitions per treatment, considering that for each repetitions five reading points were used to analyze the  $R_a$  parameter for roughness and wettability (contact angle) and 15 random points, well-distributed through the surface to evaluate the colorimetric parameters.

To evaluate the effects of the treatments over the surface quality of *Ficus* sp. veneers, the data obtained was submitted to the analysis of variance by the ASSISTAT software, 7.7-beta version. For significant values of F, the Duncan test was applied at 5% of probability, to determine the differences between the treatments.

## RESULTS AND DISCUSSION

### Roughness

The roughness profile for the *Ficus* sp. veneer without treatment (Fig. 2) exhibited valleys with  $-55 \mu\text{m}$  depth and peaks reaching  $35 \mu\text{m}$  of height. The variation of width and height between the peaks and valleys demonstrates an accentuated roughness on the wood veneer surface.

The average values for roughness ( $R_a$ ) of the *Ficus* sp. veneers, before and after the sanding process and after applying the stain are presented in figure 3.

The mean value for roughness of the *Ficus* sp. wood veneer ( $R_a$ ) without treatment was  $8,94 \mu\text{m}$ . Such rough-

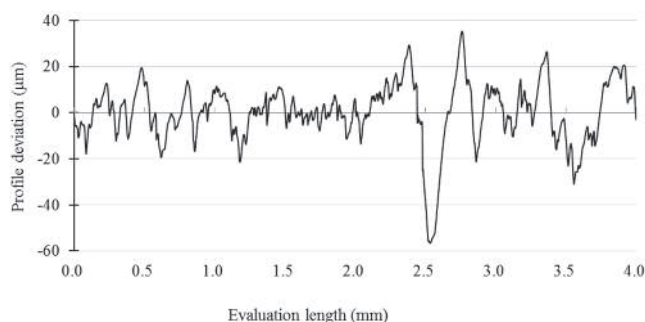


FIGURE 2. Roughness profile of the *Ficus* sp. wood without treatment (CW: Control without sanding and without product).

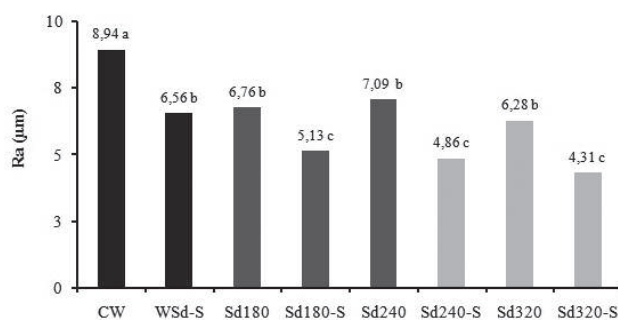


FIGURE 3. Roughness of the *Ficus* sp. veneer surface submitted to different finishing treatments. Averages followed by the same letter do not statistically differ by the Duncan Test at 5% significance.

ness is lower than in other species such as *Schizolobium amazonicum* Huber ex. Ducke (Melo *et al.*, 2013), *Simarouba amara*, *Couratari* sp. and *Dipteryx odorata* (Teles, 2014). Such results suggest that the roughness is a variable characteristic among the species, because it is influenced, among other factors, by the anatomical composition, wood density and by machining processes and parameters, as seen in other works (Lopes, Nolasco, Tomazello Filho and Dias, 2014).

By submitting the veneers to the sanding process, it was observed a decrease in the roughness value for the three sandpapers used. However, statistically speaking, significant differences were not observed. Although, the result is contrary to the results found by Burdurlu, Usta, Ulupinar, Aksu and Erarslan (2005) and Kilic *et al.* (2006), in which the increasing the number of the sandpaper grain influences the obtaining of softer or rougher surfaces, more detailed studies in the matter must be performed, since there are several sanding processes, which affect the roughness directly. This research used thin wood veneers, which might have caused the lack of significant effects. It was detected a decrease in the roughness due the sanding process, despite the lack of differences among the results, it demonstrates the importance of the sanding during the intermediary treatment of the wood, for example during the treatment of the veneers to



be used on the panel industry. According to Piao, Winandy and Shupe (2010), a lower roughness enables an intimate contact between the pieces, providing a better adherence between the veneers, which increases the resistance of the glue line.

After applying the stain, it was observed an accentuate decrease on the roughness of the sanded veneers (Sd180-S, Sd240-S and Sd320-S), differing statistically from the roughness of the sanded sampled that did not receive the finishing product (Sd180, Sd240 and Sd320). Although significant differences were not observed between the Ra values in the set with finishing products, it was perceived a small trend, in which the increase of the sandpaper grain decreased the roughness, after applying the stain. By comparing the same set with the control (CW), the decrease of the roughness after applying the finishing product was 43% for the samples sanded with the 180 sandpaper, 46% for the 240 sandpaper and 52% for the 320 sandpaper. The veneers in which the product was applied (WSd-S) presented a decreasing of 27% when compared to the control. This result demonstrates that applying the finishing product after the sanding process improves the surface quality significantly.

The roughness profile of the sanded veneers (Figure 4a) and, after applying the stain (Figure 4b), presented a significant reduction on the peaks and valleys when compared to the control (Figure 2). On the samples sanded and with the stain, the level of uniformity was more accentuated, presenting a maximum peak of 14 $\mu$ m and valley of 11 $\mu$ m, except in a specific point, that presented a 40 $\mu$ m valley. This result highlights that the surfaces are not rough, and consequently, have a better quality.

### Wettability

Figure 5 presents the average values of the contact angle between the sessile water drop and the *Ficus* sp. wood veneer, after applying the finishing product. It is highlighted that it was not possible to measure the contact angle between the sessile drop and the veneer surfaces before and after the sanding process due the elevated absorption rate of the veneers associated to the low thickness.

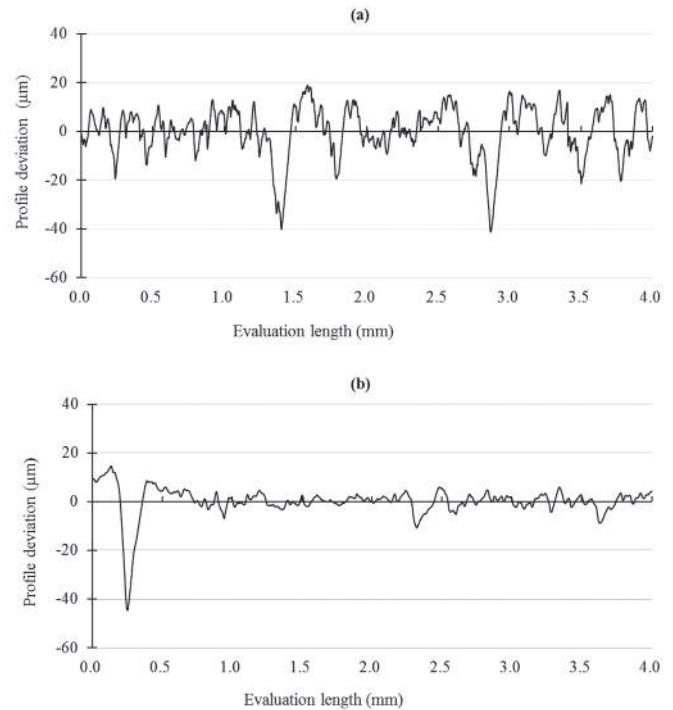


FIGURE 4. Roughness profile of the *Ficus* sp. veneer: (a) after the sanding process (Sd320) and (b) after applying the stain (Sd320-S).

After applying the finishing product, all veneers presented a contact angle over 90°. The average value of the veneers without sanding, with stain application (WSd-S), was statistically lower, which did not present a significant difference (Fig. 5). Therefore, to decrease the wettability of the wood, it is possible to use any of the analyzed sandpapers; the 180-sandpaper is specially recommended, due its availableness and lower price, when compared to others.

Yuan and Lee (2013) affirm that contacts under 90° correspond to elevated wettability, while the contact angles over 90° correspond to low wettability. Therefore, it is possible to affirm that the stain treatment was efficient to decrease the wettability of the veneers for all the sandpapers tested.

By comparing the wettability and roughness tests, it was possible to observe that the veneers from the Sd320-S treatment presented the lower roughness and higher contact angle (95.45°), the WSd-S samples presented values of

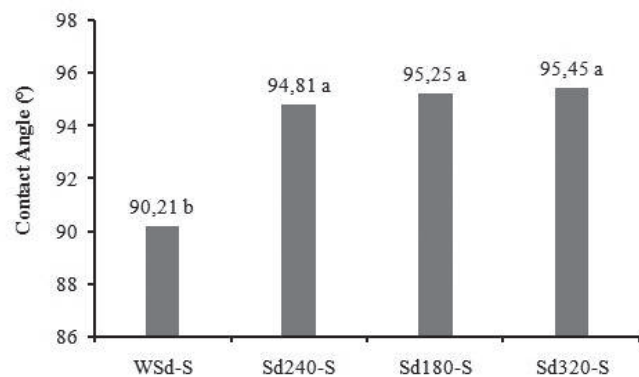


FIGURE 5. Average values of the contact angles of the *Ficus* sp. veneers after applying the stain. Averages followed by the same letter, do not differ statistically, by the Duncan Test, at 5% of significance.

6.56  $\mu\text{m}$  and 90.21°, respectively. This research is in accordance to the statements made by Piao *et al.* (2010),

because the higher the roughness, the higher the hydrophilicity of the surface, hence the lower the contact angle.

### Colorimetry

Table 3 presents the average values of the colorimetric parameters ( $L^*$ ,  $a^*$ ,  $b^*$ ,  $C$  and  $h^*$ ) obtained for the *Ficus* sp. wood before and after the sanding process and stain application.

Based on the classification proposed by Camargos and González (2001), the *Ficu* ssp. wood veneer in its natural state (control) has a white-greyish coloration, characterized, specially, in the  $b^*$  coordinate. After applying the product, the samples became yellow-olive due the decrease of the clarity values ( $L^*$ ), increasing the  $a^*$  coordinate (responsible for the red color), moreover, due the substantial increasing on the values of the  $b^*$  coordinate (responsible for the yellow color).

TABLE 3. Average values and pattern-deviation of the colorimetric parameters of the *Ficus* sp. veneers in all treatments studied.

Treatments	Statistics	Colorimetric Parameters				
		$L^*$	$a^*$	$b^*$	$C$	$h^*$
CW	Average	81.73a	2.88c	26.85c	27.01c	83.87a
	Pattern Deviation	2.61	0.37	1.05	1.05	0.76
Sd180	Average	81.21ab	2.57c	24.35d	24.49d	83.98a
	Pattern Deviation	1.89	0.27	1.04	1.05	0.61
Sd240	Average	79.15bc	2.66c	24.00d	24.15d	83.67a
	Pattern Deviation	4.32	0.36	1.25	1.25	0.85
Sd320	Average	77.45c	2.60c	23.76d	23.90d	83.76a
	Pattern Deviation	4.14	0.29	1.24	1.25	0.62
WSd-S	Average	59.20e	15.41a	47.62b	50.06b	72.04c
	Pattern Deviation	7.09	1.83	4.89	5.07	1.42
Sd180-S	Average <sup>1</sup>	62.87d	14.81b	48.54ab	50.76ab	73.01b
	Pattern Deviation	6.07	1.63	4.77	4.92	1.26
Sd240-S	Average <sup>1</sup>	62.95d	14.93b	48.53ab	50.78ab	72.88b
	Pattern Deviation	5.34	1.44	4.25	4.37	1.19
Sd320-S	Average <sup>1</sup>	65.02d	14.79b	49.67a	51.83 <sup>a</sup>	73.42b
	Pattern Deviation	5.34	1.61	4.33	4.50	1.17

<sup>1</sup>The values marked with the same letter, on the same column, inside each colorimetric parameter, for each treatment, do not differ at 5% of significance by the Duncan test.



By analyzing separately the samples set formed by the treatments without the product (Sd180, Sd240 and Sd320), in the sanded samples, it was observed that the averages of the  $b^*$  coordinate presented lower values when compared to the control. This fact is proved by the Duncan test, where such coordinate presented values that are statistically different. This decrease, which is also followed by the luminosity ( $L^*$ ), can be due the friction of the sandpaper with the wood, generating powdered waste and the possible “burning” of the wood. On the same set, values for  $a^*$  and  $b^*$ , it was verified the lack of statistical differences between the sandpapers. Therefore, the different sandpaper grains do not affect the red and yellow coloration existing in the wood. However, since there is a decreasing on the clarity values averages among the sandpapers, it is suggested using the 180-sandpaper, in case it is desirable for the wood not to significantly lose the clarity.

By analyzing the sample set with the product (WSd-S, Sd180-S, Sd240-S and Sd320-S), it was observed a considerable increasing on the values of the coordinates  $a^*$  (red) and  $b^*$  (yellow) when compared to the control, which is corroborated by the significant difference given by the Duncan statistical test. The most accentuated increasing for  $b^*$  might indicate that the product contains great amount of yellowish pigments or there was an interaction with the wood to form such pigment. The yellow-olive color of these samples is explained by this fact.

Observing the  $L^*$  values inside the same set (sanded only), it was verified the lack of significant differences among the samples. As for the set with the product, it was observed a difference among the samples that only received the product (WSd-S) and the sanded ones (Sd180-S, Sd240-S and Sd320-S). Since the  $L^*$  value of the last three samples when compared to the first (WSd-S), and since there is not a significant difference between them, it is possible to infer that the 180-sandpaper is enough to keep the clarity of the samples after applying the product. Similarly, these results can be observed for the parameter  $a^*$  (red). The results found in this research are similar to the ones found by Gonçalves, Félix, Gouveia, Camargos and Ribeiro (2010), where the author, analyzed the effect of

the ultraviolet radiation on the *Cordia goeldiana* Huber wood color, after receiving finishing products. The author observed a significant alteration on the natural color of the wood after applying the products, darkening the samples due the decreasing the luminosity parameters and increasing the  $a^*$  and  $b^*$  pigments.

Figure 6 corroborates with the values described on Table 3, showing the reflectance curves of the control and the treatments before and after the sanding process and after applying the stain. All the treatments modified the original spectral curves, since the samples were treated with the sandpaper and finishing product presented a reflectance percentage considerably lower than the other treatments. The 180-sandpaper (Sd180) presented a reflectance curve similar to the control (CW), as confirmed on table 3.

Table 4 presents the variations on the colorimetric parameters caused by the seven treatments. Such variations corroborate to the values presented on table 3; therefore, it is possible to state that by observing the negative  $\Delta L$  value, the WSd-S treatment darkened the samples the most.

The total color variation ( $\Delta E$ ) is higher for veneers treated only with the finishing product (WSd-S) and treated with the sandpaper plus the finishing product (Sd180-S, Sd240-S and Sd320-S). Such alterations on the color

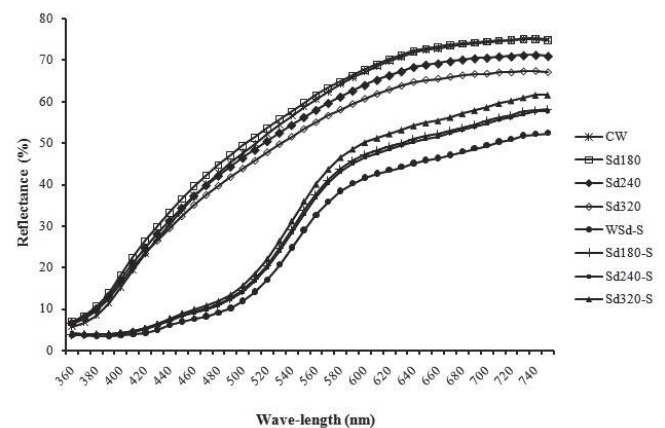


FIGURE 6. Color reflectance in function of the wavelength of the *Ficus* sp. wood submitted to the treatments.

TABLE 4. Variations on the color parameters of the *Ficus* sp. wood veneers, submitted to different treatments.

<i>Treatments</i>	$\Delta L^*$	$\Delta a^*$	$\Delta b^*$	$\Delta E$	<i>Classification</i>
Sd180	-0.52	-0.31	-2.5	2.57	Noticeable
Sd240	-2.58	-0.22	-2.85	3.86	Appreciable
Sd320	-4.29	-0.29	-3.09	5.3	Appreciable
WSd-S	-22.54	12.53	20.76	33.11	Very appreciable
Sd180-S	-18.87	11.93	21.68	31.12	Very appreciable
Sd240-S	-18.79	12.05	21.68	31.11	Very appreciable
Sd320-S	-16.71	11.9	22.81	30.68	Very appreciable

were classified as “very appreciable”, in accordance to the perception table proposed by Hikita *et al.* (2001).

The variation of the color of different wood species can not only be explained due to the variation of the chemical composition, but also due to aspects characteristic of their surfaces, such as roughness (Haupmann *et al.*, 2013). According to De la Rei (1987), brightness, as well as color saturation, is influenced by roughness. Therefore, it is possible to observe in this work, that there was a tendency to decrease the  $L^*$  parameter (loss of luminosity) after application of the treatments (Table 3) that collaborates with the tendency of decrease of the roughness for these same treatments (Figure 3), suggesting a direct relation between the color and the roughness of the *Ficus* sp. wood veneer. However, more in-depth studies surrounding this type of correlation deserve to be realized.

## CONCLUSIONS

This research using *Ficus* sp. wood veneers allows concluding that:

- The veneers roughness decreased significantly after the sanding process, and, more remarkably, after applying the finishing product (stain).
- The contact angle between the sessile water drop and the veneers surface was over  $90^\circ$  for all treatments that received the finishing product, decreasing the hydrophilicity of the veneers under that condition.

- The veneers color in its natural state was classified as white-greyish and after applying the product, the color was modified into yellow-olive. It was due the significant increasing on the parameters  $a^*$  (red) and  $b^*$  (yellow), and accentuated decreasing of the  $L^*$  variable (luminosity).
- The sanding process and application of the finishing product (stain) were capable to modify significantly the characteristics of the roughness, wettability and color of the *Ficus* sp. veneers, increasing its surface quality.

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