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The study of color changes of chosen species of wood from South America caused by transparent coatings and light action

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Abstract: *The study of color changes of chosen species of wood from South America caused by transparent coatings and light action.* Over recent years, interest of tropical wood species increases, caused by its specific properties. Aesthetics of the material is most important, especially color. Wood is prone to serious discoloration because of coating process or sunlight exposure. The aim of study was described influence of these factors on color stability of amarant, gombeira, ipe, jatoba and tauari wood, used mainly for flooring. It is proved, with the spherical spectrophotometer, uncoated wood became darker under the working of varnishes and photo-aging. Varnishes of wood (lacquers, wax, shellac) does not protect it against discoloration, but causes color evening (wood color is more even on the whole surface).

Keywords: tropical wood, amarant, gombeira, ipe, jatoba, tauari, wood color, light action, wood coatings.

INTRODUCTION

Over recent years increasing popularity of exotic wood species is visible (over a dozen fold - Kozakiewicz 2006). Floors made of exotic wood species change its color over external factors (Kozakiewicz 2005) – especially UV. This creates serious problems especially in case where floor is partially covered or blinded. The color of the wood can be changed through appropriate technical means such as coating of varnish or oil paints, which can completely cover the natural color of wood, but also provide a protective coating, designed to preserve the wood against external factors. Transparent lacquering increases natural color intensiveness, but emphasizes all pattern and color defects.

Despite of tropical wood color descriptions, professional literature lacks unbiased color change data made with colorimeter (not organoleptic). Aim of the following work was to determine change of color coated wood *Hymenea courbaril* Linn. (jatoba), *Couratarii* sp. (tauari), *Peltogyne pubescens* Benth. (amarant), *Tabebuia* sp. (ipe), *Melanoxylon brauna* Schott. (gombeira) under light action.

MATERIALS AND METHODS

Five present in Poland wood species from South America were selected for the work (nomenclature in accordance to PN-EN 13556:2005) standard): jatoba (*Hymenea courbaril* Linn.), tauari (*Couratarii* sp.), amarant (*Peltogyne pubescens* Benth.), ipe (*Tabebuia* sp.), gombeira (*Melanoxylon brauna* Schott.), often used for flooring. Detailed description and characteristics are provided by Kozakiewicz (2005a, 2008, 2009), Kozakiewicz i Mogilnicki (2005), Kozakiewicz i Saks (2005). Before tests samples were planed and sanded. Radial section of more uniform pattern was selected, in opposite to coarser tangential section. Wood moisture content ranged from 8% up to 12 %. Boards were cut into test samples of 70 x 70 x 10 mm dimensions. Samples were sorted into groups (except group A – standard samples and group B – uncoated wood samples after light action), in every group surfaces were finished with various coatings produced by various manufacturers:

- group C - two-component water-based polyurethane lacquer,
- group D - one-component polyurethane lacquer,
- group E - nitrocellulose lacquer,
- group F - polyurethane lacquer,
- group G -wax,

– group H - shellac lacquer.

Materials were used in accordance to producers suggestions, coated samples were exposed indoors to direct sunlight for one year.

Discoloration analysis was based on international CIE L*a*b* model. Beginning from the samples preparation samples were isolated from sunlight in aim to preserve natural color. Color tests were made before coating, after coating and after sunlight exposition. X-Rite SP-60 spherical spectrophotometer was used for the test. Color indexes were calculated basing on the component values:

total color difference:

$\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$, where

ΔL^* - lightness difference

Δa^* - red color difference (a>0)

Δb^* - yellow color difference (b>0)

saturation:

$C^*_{ab} = (a^{*\ 2} + b^{*\ 2})^{1/2}$

hue:

$H^* = arctg(b^*/a^*)$

From the obtained data (5 measurements on a single sample) averages were calculated. In consequence of the lacking standard on wood discoloration presented work bases on PN-ISO 7724-1:2003, PN-ISO 7724-2:2003, PN-ISO 7724-3:2003 standards, regarding lacquer discoloration.

RESULTS

Obtained results for amarant, gombeira, ipe, jatoba, tauari wood are presented in figures 1-4. Basing on the detailed analysis of the gathered data one may conclude that coated exotic wood changes its color over time, which is caused by exposure to light. Lightness values drop in comparison to control samples (group A), which means that wood becomes darker. Greatest luminance change of amarant, ipe and gombeira wood showed up in group D (one-component polyurethane lacquer), lowest change was in the C group (two-component water-based polyurethane lacquer). In case of jatoba wood greatest lightness change was in the C group (two-component water-based polyurethane lacquer), and the smallest change was observed for samples one-component polyurethane lacquer-coated (group D). As the results of tests for tauari wood, the most darkened samples from group F (polyurethane) and the lowest samples from group B (samples subjected to light action, no painting and paint coatings).

Analysis of the remaining two color parameters shows that saturation and hue of tropical wood change under long sunlight exposition. Color saturation (chroma - C*) jatoba and tauari wood has become stronger for all groups studied. In the case of ipe and amarant wood, chrome coating increased the paint systems of the groups B, F and G and fall (surface samples became pale) for samples from groups C and D. In case of gombeira wood, saturation fall for samples from all groups.

Studies show that the average value of hue (H*) for the wood species tested decreased, which means that it has changed color. On the basis of this parameter can be determined (not only the human nose) that samples jatoba wood changed its closer to red-brown. In the case of tauari wood, it was observed that samples with similar color to yellow, they take a bit darker shade of yellow, and the biggest difference in tone was noted for samples from group E (nitrocellulose lacquer). The biggest difference of hue parameter for amarant wood are characterized by a samples from group D (one-component polyurethane lacquer-coated). In

case of the samples gombeira and ipe wood with color is similar (dark brown), the biggest hue parameter change was observed in the E group.

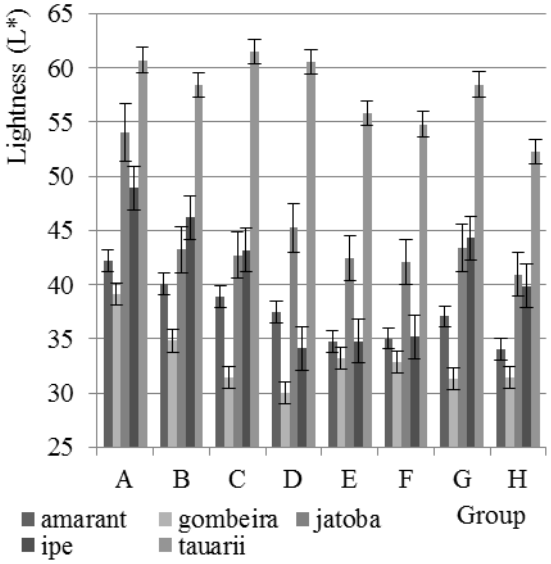

Fig. 1. Lightness of amarant, gombeira, jatoba, ipe and tauarii wood after coating and light action

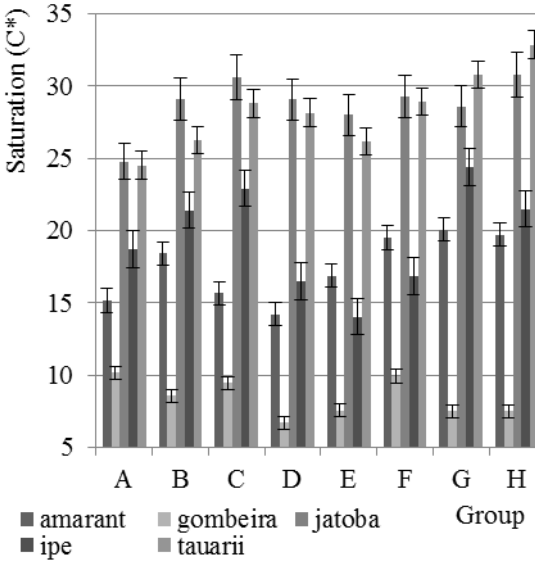

Fig. 2. Saturation of amarant, gombeira, jatoba, ipe and tauarii wood after coating and light action

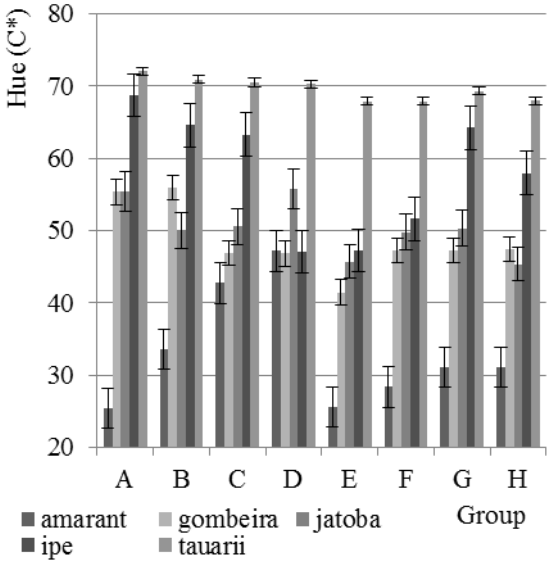

Fig. 3. Hue of amarant, gombeira, jatoba, ipe and tauarii wood after coating and light action

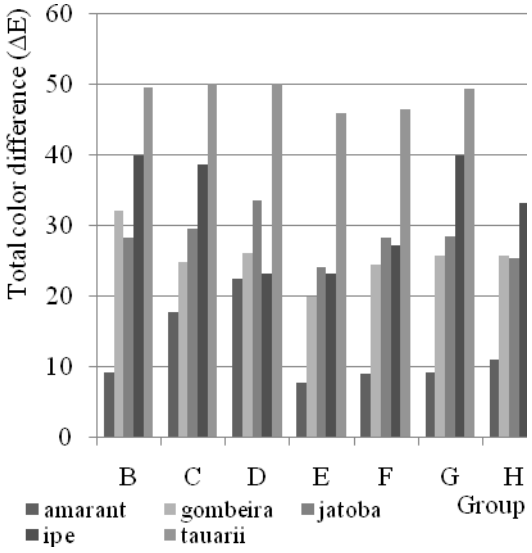

Fig. 4. Total color difference of amarant, gombeira, jatoba, ipe and tauarii wood after coating and light action

For comparison of different coatings, total color difference criterion and color stabilization was set. Color stability degrees were set on the basis of five step scale (Mielicki 1997) shown in tab. 1.

Tab. 1. Color stability (Mielicki 1997)

Color difference ΔE	**0±0,2**	**0,8±0,2**	**1,7±0,3**	**2,5±0,4**	**3,4±0,4**	**4,8±0,5**	**6,8±0,6**	**9,6±0,7**	**13,6±1,0**
Color stability	5	4-5	4	3-4	3	2-3	2	1-2	1

On the basis of the classification presented in tab. 1, it can be stated that among the investigated species of wood, there is no correlation (the color of each species covered by the same painting and varnish coatings, reacts differently to exposure to natural sunlight). In the case of amarant, jatoba and gombeira wood the highest degree of color stability was characterized by a group of samples nitrocellulose lacquer coated (group E). The most durable wood tauari color samples was characterized by a group of shellac lacquer coated (group H), and gombeira wood samples coated of one-component polyurethane varnish (group D).

CONCLUSION

Tests performed on three wood species amarant, gombeira, ipe, jatoba, tauari from South America, based on color change determination under coating and light action influence, allow to conclude as follows:

1. Wood coatings (lacquer, wax, shellac) and sunlight exposure cause wood discoloration. Color changes have same properties in all wood species tested, degree of the change is dependent on coating type.
2. Coated wood shows more discoloration than uncoated one.
3. After coating with lacquer, wax and shellac and light action wood turned darker (lightness decreased).
4. Lacquering, waxing and shellac lacquering of wood does not protect it against discoloration, but causes color evening (wood color is more even on the whole surface).

REFERENCES:

1. KOZAKIEWICZ P., 2005: Drewno w budownictwie – podłogi. Przemysł Drzewny nr 6, s.6-11. Wydawnictwo Świat.
2. KOZAKIEWICZ P., 2005a: Jatoba (*Hymenaea courbaril* Linn.) – drewno egzotyczne z Ameryki Południowej. Przemysł Drzewny nr 9-10, s.25-28. Wydawnictwo Świat.
3. KOZAKIEWICZ P., 2006: Właściwości i zastosowania drewna egzotycznego w Polsce. Uszlachetnianie powierzchni drewna, cz. I (Dodatek specjalny do czasopisma Lakiernictwo), s. 10-17.
4. KOZAKIEWICZ P., 2008: Ipe (*Tabebuia* sp.) – drewno egzotyczne z Ameryki Południowej i Środkowej. Przemysł Drzewny nr 11, s.41-44. Wydawnictwo Świat.
5. KOZAKIEWICZ P., 2009: Amarant (*Peltogyne* sp.) – drewno egzotyczne z Ameryki Południowej. Przemysł Drzewny nr 9, s.11-14. Wydawnictwo Świat.
6. KOZAKIEWICZ P., MOGILNICKI W., 2005: Tauari (*Couratari* sp.) – drewno egzotyczne z Ameryki Południowej. Przemysł Drzewny nr 9-10, s.21-24. Wydawnictwo Świat.
7. KOZAKIEWICZ P., SAKS M., 2005: Gombeira (*Melanoxylon brauna* Schott.) – drewno egzotyczne z Ameryki Południowej. Przemysł Drzewny nr 11-12, s.29-.32 Wydawnictwo Świat.
8. MIELICKI J., 1997: Zarys wiadomości o barwie. Wyd. Fundacja Rozwoju Polskiej Kolorystyki. Łódź.
9. PN-EN 13556:2005 Drewno okrągłe i tarcica. Terminologia stosowana w handlu drewnem w Europie.
10. PN-ISO 7724-1:2003 Farby i lakiery – Kolorymetria – Część 1: Podstawy.
11. PN-ISO 7724-2:2003 Farby i lakiery – Kolorymetria – Część 2: Pomiar barwy.
12. PN-ISO 7724-3:2003 Farby i lakiery – Kolorymetria – Część 3: Obliczanie różnic barwy.

Streszczenie: *Badanie zmian barwy pod wpływem działania lakierów i światła drewna wybranych gatunków z Ameryki Południowej*. W ostatnich latach obserwuje się rosnące zainteresowanie drewnem tropikalnym. O popularności decydują m. in. walory estetyczne tego materiału, a przede wszystkim barwa. Barwa drewna może ulegać wyraźnym zmianom pod wpływem powłok lakierniczych i działania światła. W niniejszej pracy zbadano wpływ tych czynników na barwę pięciu rodzajów drewna egzotycznego z Ameryki Południowej (amarant, gombeira, ipe, jatoba, tauari), stosowanego m. in. w postaci materiałów podłogowych. Surowe drewno ściemnało pod wpływem działania światła i lakierowania. Lakierowanie drewna nie zabezpieczyło go przed dalszymi zmianami barwy, jednak wyrównało kolorystykę.

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