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Δa* and Δb* of walnut wood (*Juglans nigra* L.) treated with acid and alkaline buffers

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Abstract: *Δa* and Δb* of walnut wood (Juglans nigra L.) treated with acid and alkaline buffers*. A study on parameters a* and b* of walnut wood (*Juglans nigra* L.) by buffer treatment has been carried out. Eight types of buffers were used in the tests. Four acid (pH = 2.0, 3.0, 4.0, 5.0), one neutral (pH = 7.0), and three alkaline (pH = 8.0, 9.0, 10.0). The parameters a* and b* of the samples were measured using a Datacolour 600 spectrophotometer prior and after buffer treatment which lasted 1h and 24h. It was detected that the samples after treatment with the acid buffer became more red, while samples after treatment with the alkaline buffer less red. Moreover the walnut samples after treatment with acid and alkaline buffers became yellower.

Keywords: walnut wood *Juglans nigra* L., acid buffer treatment, alkaline buffer treatment, color change

INTRODUCTION

Wood as material has its specific pattern and colour characteristic for each species. Colour of wood does not depend upon the main structural components (i.e. cellulose, lignin or hemicellulose which are colourless or nearly so) but rather upon the minor components (extractives) (Imamura 1989). The hue of wood in a natural way undergoes alternations and intensity. This phenomenon depends on species and conditions in which wood exists as well as the means it is protected (Chang and Cheng 2001; Mitsui et al. 2001; Tolvaj and Mitsui 2005, Tolvaj et al. 2014). Usually hue of wood becomes darker (Kubovski and Kacik 2104, Pesze and Tolvaj 2012) which often means that hue changes shade, depending on colour e.g. dipper brown. Exotic wood is often selected for production of floors, terraces and furniture owing to its excellent hardness, resistant to degradation and higher dimension stability in comparison to European wood species. The advantage of exotic wood is also unique and wide, from almost white to black, spectrum of colours. The light species are bamboo (*Bambusa* Shreb), canadian maple (*Acer saccharum* Marsh), obeche (*Triplochiton scleroxylon* K. Schum.) or rubberwood (*Hevea brasiliensis* Wild. ex A. Juss.). Slightly darker species are e.g. tauari *(Couratarii* sp.*),* chlorophora (*Milicia excels* (Welw. C.C. Berg.)) or goiabao (*Pouteria Pachycarpa Pires*). Wood species such as sucupira (*Bowdichia* spp.), ipe (*Tabebuia* sp.) or wenge (*Millettia laurentii* Wild.) have characteristic dark hue. From more unusual species it is worth listing purpleheart (*Peltogyne* sp.) with almost violet hue or opepe (*Nauclea diderrichii* (Wild.&Th.Dur.) Merr.) with an orange, intensive shade. One of the methods, which limits intensity of a colour change is used properly to species coating and lacquers with blockers of UV light (Rowell 2005, Organista-Nowaczyk 2009). In the case of some species the reactions with covers take place which leads to colour changes before the species are exposed to irradiation (Jankowska and Szczęsna 2011). The one of the reasons for wood colour changes can be pH of used coating or lacquer. The change of two parameters (a* - change in red direction and b* in the yellow direction) of walnut wood *(Juglans nigra)*

colour due to treatment with acid, neutral and basic solutions was detected in the presented work.

MATERIAL AND METHODS

Preparation of samples

The investigated materials were exotic eastern black walnut wood (*Juglans nigra* L.). Samples with dimension of 60 x 30 x 4 mm (±1 mm) (long. x tang. x red.) were prepared from the same boards. They were polished with sandpaper (400 P) prior investigation, after cutting. Then, they were divided into eight groups. The first group was the control sample. The next groups were dipped in acid (pH = 2.0, 3.0, 4.0, 5.0), neutral (pH = 7.0), alkaline (pH = 8.0, 9.0, 10.0) buffers, produced by Honeywell Burdick & Jackson. The investigation was performed using three samples from each variant. Three circle measuring points were marked on each sample (diameter 10 mm). The buffer treatment lasted 1h and 24h and was performed under laboratory conditions (23 °C, 45% RH). After dipping, the samples were dried at 40 °C for 24h. The samples humidity during experiment was constant and amounted 5.8%±0.1.

Colour measurements

All the colour measurements were taken from the surface of the samples. The samples were measured before and after treatment in H_20, acid or alkaline buffers. The colour coordinates in the CIE $L^*a^*b^*$ system were recorded with a Datacolour 600 dual-beam d/8° spectrophotometer, using the D_{65} standard illuminant. The wavelength range of spectrophotometer was from 360 nm to 700 nm, reporting at 10 nm intervals. Reflectance of instrument was 0.15 (max), 0,008 (avg.).The sensor head diameter was 10 nm. The measurement of colour coordinate L^* was performed on three samples per each variant. Calibration of the instrument was performed before testing using the white tile, green tile and black trap standards provided with the spectrophotometer. Three points of fixed locations were measured on each sample.

Data listed in this work are the average of nine replicated measurements. The colour sphere is described as a tridimensional system of colour coordinates(axes L^*, a^* and b^*). Axis a^* depicts the share of green or red colour within the analysed colour; hues of green take on negative values and hues of red, positive values. Axis b^* depicts the share of blue or yellow colour within the analysed colour; hues of blue take on negative values and hues of yellow, positive values. Axis L^* describes colour brightness within the value from 0 to 100. $L^* = 100$ means that a given colour is close to white, and $L^* = 0$ that a colour is close to black. In this work color coordinates a* i b* were described.

RESULTS

Changes of colour parameter Δa* of the walnut wood samples treated with buffers during 1 and 24h are presented in figure 1. It was detected that in the case of the acid buffers wood became more red. The only one variant in which samples were treated with buffer pH=5 by 1h is exceptional. Higher values of Δa* were obtained after longer treatment which lasted 24h. However obtained changes were minor both and after 1 and 24h of treatment and amounted approximately to 1 point. The treatment with neutral buffer (B7) caused higher and opposite changes of parameter a*. After this treatment lasting 1 and 24h samples of walnut became less red. The obtained values exceeded 1.5 and a slightly higher change was detected in the case of the longer treatment. Significantly more visible changes of the parameter a* were found in the case of the samples treated with the alkaline buffers (B8, B9 i B10) both in

the case of a short (1h) as well as a long treatment (24h). Moreover, the alkaline buffers treatment caused that samples were less red than control samples. Similar investigations were performed for ipe wood and obtained results were opposite (Zborowska et al. 2014). After 1h of the submerge obtained changes were similar for all variants of buffers and they achieved values 2.3 – 2.5. The samples which were treated for 24h underwent higher changes. In this case the observed parameter Δa* was significantly dependent on the value of buffer pH.

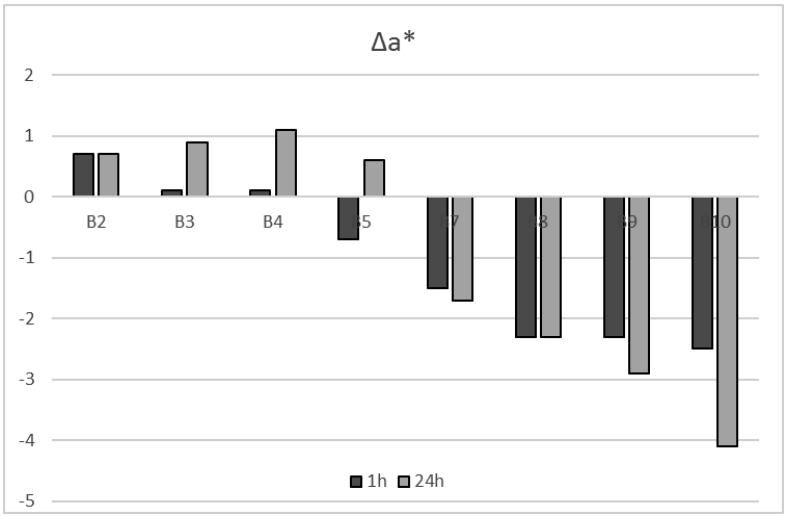

Figure 1. Changes of colour parameter Δa* of the walnut wood samples treated with buffers during 1 and 24h

Changes of the colour parameter Δb* of the walnut wood samples treated with the buffers during 1 and 24h are presented in figure 2. Both the acid as well as alkaline buffers caused yellowing of the walnut wood. Similar results for pine wood obtained Stachowiak - Wencek et al. (2014). Only in the case of short (1h) treatment with buffer B8 the wood samples became slightly less yellow. The significant differences were visible between the samples treated during 1h and 24h. The longer submerge (24h) caused substantially more visible changes. Δb* after the acid treatment achieved between 4.9 – 6.6 while after the alkaline treatment between 5.7 – 9.8. In the case of the short and long alkaline treatment the trend can be detected, the higher pH the higher value of Δb*.

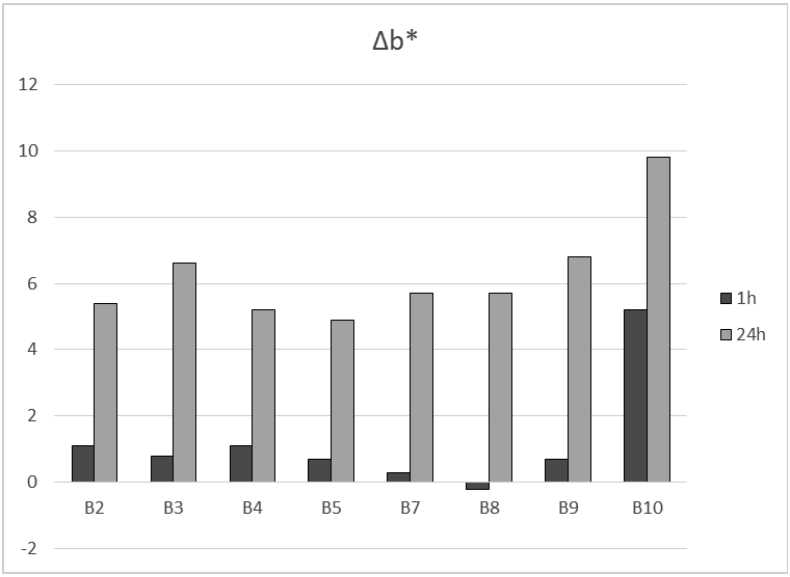

Figure 2. Changes of colour parameter Δb* of the walnut wood samples treated with buffers during 1 and 24h

SUMMARY

On the basis of the conducted research it may be stated that:

1. The treatment of the walnut samples with the acid and alkaline buffers caused opposite changes of colour coordinates Δa*. The samples after treatment with the acid buffer became more red, while the samples after the treatment with the alkaline buffer less red.
2. The treatment with the alkaline buffer caused more significant Δa* changes of the walnut samples in comparison to the treatment with the acid buffer.
3. The walnut samples after the treatment with the acid and alkaline buffers became yellower.
4. It was observed that the higher pH value the buffer has the higher changes of parameter Δb*.

Streszczenie: *Zmiana parametrów* Δa* i Δb* *drewna orzecha amerykańskiego po działaniu kwaśnych i zasadowych buforów.* Badaniom poddano drewno orzecha amerykańskiego (*Juglans nigra* L.). W celu zbadania wpływu pH buforów na parametry barwy Δa* i Δb* próbki drewna zanurzono w ośmiu buforach. Cztery bufory miały odczyn kwaśny (pH 2 - 5), jeden obojętny, a pozostałe trzy zasadowy (pH 8 - 10). Na podstawie uzyskanych rezultatów stwierdzono, że barwa drewna orzecha amerykańskiego poddanego działaniu buforów o odczynie kwaśnym zmienia się w kierunku czerwonego. Obserwowana zmiana jest jednak niska, na poziomie 1 punktu. Zdecydowanie większe zmiany parametry a* obserwowano po działaniu na drewno orzecha amerykańskiego buforami o odczynie zasadowym. Roztwory te powodowały, że badane drewno stawało się mniej czerwone, a obserwowane zmiany sięgały 4 punktów. Działanie na drewno badanego gatunku buforami o odczynie kwaśnym i zasadowym spowodowało, że jego barwa stała się bardziej żółta. Stwierdzono, że wydłużenie czasu działania buforów do 24h, zarówno kwaśnych jak i zasadowych spowodowało znaczną zmianę parametru b*.

REFERENCES

1. CHANG, S. T., AND CHENG, S. S. (2001): "Effects of environmental factors on the colour of sugi (*Cryptomeria japonica* D. Don) yellowish heartwood," *Holzforschung* 55(5), 459-463. DOI: 10.1515/HF.2001.076
2. IMAMURA H. (1989): Contribution of Extractives to Wood Characteristics. In: Natural Products of Woody Plants Rowe J.W. (ed) Springer Series in Wood Science; pp 843-860.
3. JANKOWSKA A., SZCZĘSNA M. (2011): The study of colour changes of chosen species of wood from southeast asia caused by transparent coatings and exposure to sunlight. Drewno: Pr. Nauk. Donies. Komunik. 54(185), 51-60.
4. KUBOVSKÝ I., KAČÍK F. (2014): Colour and chemical changes of the lime wood surface due to CO_2 laser thermal modification Applied Surface Science 321, 261-267.
5. NOWACZYK-ORGANISTA M. (2009)b: Protection of Birch and Walnut wood colour from the effect of exposure to light using ultra-fine zinc white. Drewno-Wood 52(181), 20-41.
6. MITSUI, K., TAKADA, H., SUGIYAMA, M., AND HASEGAWA, R. (2001): "Changes in the properties of light-irradiated wood with heat treatment. Part 1. Effect of treatment conditions on the change in colour,"*Holzforschung* 55(6), 601-605. DOI: 10.1515/HF.2001.098.
7. PERSZE L., TOLVAJ L. (2012): Photodegradation of wood at elevated temperature: Colour change. Journal of Photochemistry and Photodegradation B: Biology.108(2012):44-47.
8. ROWELL R., M. (2005): Chemical modification of wood. In Rowell R.,M. (ed.), Handbook of Wood Chemistry and Wood Composites, CRS Press, Boca Raton, Chap.14, pp. 381-420.
9. TOLVAJ, L., AND MITSUI, K. (2005). "Light source dependence of the photodegradation of wood," *Journal of Wood Science* 51(5), 468-473. DOI 10.1007/s10086-004-0693-4
10. TOLVAJ, L., NEMETH, R., PASZTORY, Z., BEJO, L., AND TAKATS, P. (2014). Colour stability of thermally modified wood during short-term photodegradation. *BioResources* 9(4), 6644-6651.

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