ONLINE ISSN 2069-7430
ISSN-L 1841-4737
PRO LIGNO
www.proligno.ro
Vol. 15 N° 4 2019
pp. 284-287

EVALUATION OF COLOUR CHANGING OF SATURATED WOODS SURFACE WITH NANOSILVER

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Abstract:

Wood is considered as one of the most applicable natural substance for inner and outer decoration. For this purpose, maintenance of beautiful and natural appearance and also stability of surface colour of wood is very important. Therefore, given the increase in population and the growing need for wood, it is necessary that wood sources to provide for increase in resistance using preservation techniques, such as nano silver. The usage of nano silver may change the wood surface colour to some extent, thus the evaluation of colour changing by this substance is necessary. In this study, cottonwood wood samples of 50×50×2mm were prepared and impregnated with nano silver with three levels of concentration: 4000, 400, 200 ppm by the way of corrected full cell. The surface colour of samples were measured after balancing humidity with the same level by the Elrepho 2000 apparatus. Treatment using nano silver with 4000 ppm concentration caused the most change in surface colour while concentration of 200 ppm caused to least amount of colour change in the surface of wood layers.

Key word: *Nano silver; corrected full cell; CIE L*a*b* colorimetry; Elrepho2000.*

INTRODUCTION

The beautiful natural appearance of wood and its easy processing for use in interior and exterior decoration, it is very functional and valuable. However, due to the low level of wood reserves and the increasing demand for wood, it is necessary to use the various methods to preserve and increase the durability of this important material, while respecting the principles of forestry and the development of wood resources. (Naji et al. 2005). One of these methods is the use of a nano silver protector, which provides antimicrobial properties, and are used as disinfectants, in refrigerators, washing machines, medical applications and antibiotics as well as for the conservation of wood and wooden layers can be used (Green and Arango 2005, Moya et al. 2014, Can et al. 2018, Nosal and Reinprecht 2018).

Colour is a basic visual characteristic for wood and wood products. Some treatments, such as drying, steaming, protective treatment and some phenomena such as activation and weathering, can change the colour of the wood. Colorimetry is one of the quality control tests that should be done because the colour deviation is easily detected by consumers. Of course, because of the change in colour variation, human sight is not always fixed, and electronic colour recognition tools can be used. The colour of the wood is an important factor when determining the price of wood and can be accompanied by different genetic factors, environmental conditions or treatment conditions such as light, temperature, humidity, acidity and alkaline environment during steaming or drying. The purpose of this research is to impregnate wood with a nano silver protector in order to protect the wood layers, as well as to check the level of colour change due to the use of this protective agent. Aydin and Colakoglu (2005), studied on the effect of thermal treatment and protective treatment on the roughness and colour of the surface of the wooden layers and found that both treatments increased the roughness and the colour change of the surface of the wood. Green and Arango (2007), investigated the effect of silver on termite damage in a non-selective laboratory test, and found that silver alone could not prevent termite damage, but could be an important additive to paint and protect wood. Ellis (2007a) investigated the effect of silver in protecting wood from the ship instead of using the chromated

copper arsenate (CCA - Pressure), and it became clear that commercial silver with a base of oxides produced a protective effect. Ellis et al. (2007b) examined the effect of silver in various environments and on living organisms.

MATERIALS AND METHODS

Methodology included the following steps:

Sample preparation

A total of 9 wooden piles with 50×50×2mm diameter were cut from the cottonwood. Wood samples were placed in a humidifying room at 70°C and a moisture content of 2% for 2 days. Then they were prepared to measure the surface colour.

Colour Measurement

There are several methods to measure colour. The colour of the surface of the wood can be measured using visual devices such as the Elrepho 2000 device (Fig. 1). Optical measurement methods can also be used to determine the uniformity of colour, which represents L*, a*, and b*. L* is the brightness that ranges from white (100) to black (0) throughout the gray scale. a* is red and green, and b* is yellowish and blue (Schanda 2007). In this study, the Elrepho 2000 device was used to measure the colour. The colour coordinates of one specimen were determined for each sample after being subjected to a moisture equilibrium of 20% and a temperature of 70°C, and once again, when the samples were saturated with a cell-saturated nanosilver, they were again subjected to a moisture equilibrium, Colour coordinates to calculate the overall colour change (ΔE*) as the function of the applied treatments (Nemeth and Faix 1988, Mononen et al. 2005, Hrcka 2008, Meints et al. 2017). The following formulas were used to calculate the overall colour variations in wooden samples.

$$\Delta L^* = L^*_{exposed} - L^*_{initial} \quad (1)$$

$$\Delta a^* = a^*_{exposed} - a^*_{initial} \quad (2)$$

$$\Delta b^* = b^*_{exposed} - b^*_{initial} \quad (3)$$

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (4)$$

Saturation

At this stage, the samples of the wood were saturated with filler cells, modified with a nano silver protector. Initial vacuum was taken 7 times for 30 minutes. After 500 mL of the material was added to the specimens, pressure was applied 10 times for 2 hours. Finally, the secondary vacuum was applied 7 times for 15 minutes. Three different concentrations of 200, 400 and 4000 ppm were used to saturate. In each of the concentrations, three wooden samples were saturated.

In this research, the results were analyzed by one-way ANOVA and Fisher test using mini-tab software.

RESULTS AND DISCUTION

After the wooden samples were saturated with the nano silver protector, the colour change of the wood at concentrations of 200, 400 and 4000 ppm was carefully investigated. Measures taken in L*, a* and b* indices can be seen before and after saturation in Table 1. Also, calculations of ΔL*, Δa*, Δb* and ΔE* are shown in Table 2 and the colour change is based on the column graph in Figure 2.

ONLINE ISSN 2069-7430
ISSN-L 1841-4737
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www.proligno.ro
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Fig. 1.
Elrepho 2000.

Table 1

Measure L*, a* and b* before and after saturation

Nano silver concentration ppm	Brfore saturation			after saturation		
	L*	a*	b*	L*	a*	b*
200	87.05	2.75	16.69	70.79	10.49	23.52
400	80.63	2.87	17.6	61.96	7.99	18.01
4000	28.91	2.56	16.60	40.83	9	14.78

Table 2

Measures the colour change before and after saturation

Nano silver concentration ppm	ΔL*	Δa*	Δb*	ΔE*
200	16.25	7.75	6.82	19.47
400	24.66	5.13	1.03	25.42
4000	45.91	6.43	3.19	46.72

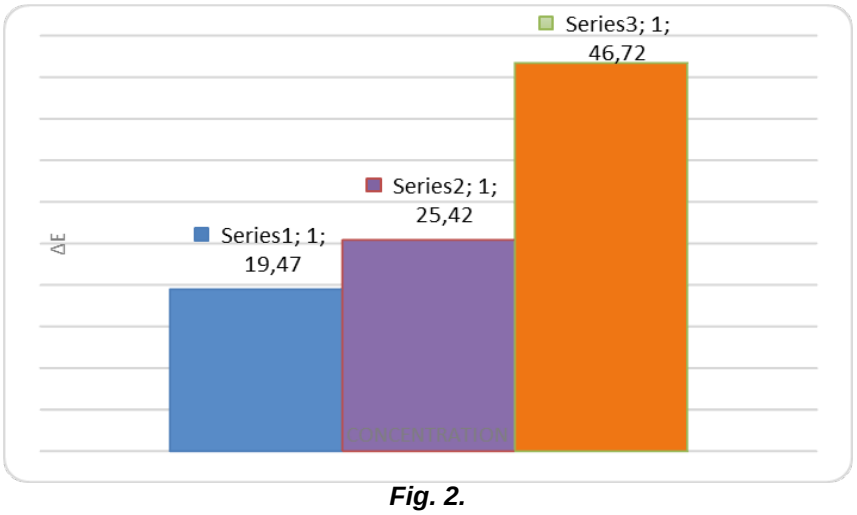

Fig. 2.
Measures the colour change before and after saturation.

In general, data showed that the use of a nano silver protector for wooden samples could cause discoloration in various concentrations. This colour change is different at different concentrations, which means that the higher the nano-silver concentration, the greater the colour change. As shown in Table 2, the colour change between concentrations of 200 and 4000 ppm has a significant effect. In Table 3, information is shown using the Fisher test.

Table 3

ΔL* comparison using Fisher test

Nano silver concentration ppm	200	400
400	ns	s
4000	s	

ns - the difference is not significant;
s - the difference is significant.

CONCLUSION

The type of nano silver material can be effective in changing the colour of the surface of the wood. According to research by Ellis et al., the use of nanosilver with another material such as nano-zinc, as a solution to wood-decay organisms, especially termites and bacteria, has antimicrobial properties. Therefore, it can be stated that in this study, the use of nano silver alone caused a difference in the results and caused significant changes in the surface of the wood.

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