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ВЛИЯНИЕ КОЛИЧЕСТВА СЛОЕВ НАНЕСЕННОГО ВОСКА НА НЕКОТОРЫЕ СВОЙСТВА ПОВЕРХНОСТИ МАХАГОНИ (*SWIETENIA MAHAGONI* (L.) JACQ.)

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Аннотация. В данном исследовании были изучены некоторые поверхностные свойства (параметры цвета, индекс белизны *WI** и глянец (параллельно и перпендикулярно к волокнам под углами 20, 60 и 85°)) воска, нанесенного на древесину махагони (*Swietenia mahagoni* (L.) Jacq.) с разным количеством слоев (1, 2 и 3). Была сформирована контрольная группа, и поверхности, обработанные воском, сравнивались с результатами. Согласно полученным результатам, количество слоев оказалось значимым во всех тестах в анализе дисперсии. В то время как образцы с тремя слоями нанесения дали самые высокие значения глянцевости, были замечены увеличения при осмотре. Значения *WI**, а также все параметры цвета уменьшались при нанесении слоев воска в обоих направлениях. Значения Δ*E** составили 7,41 для однослойного нанесения воска, 8,87 для двух слоев и 9,81 для трех слоев. Поскольку полученные значения общего цветового отличия были очень близкими друг к другу, было замечено, что однослойное нанесение воска будет достаточным.

Ключевые слова: махагони, индекс белизны, *Swietenia mahagoni* (L.) Jacq.; цвет, блеск, воск

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Scientific article

THE EFFECTS OF THE NUMBER OF COATS OF APPLIED WAX ON CERTAIN SURFACE PROPERTIES OF MAHOGANY (*SWIETENIA MAHAGONI* (L.) JACQ.) WOOD

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Abstract. In this research, some surface properties (color parameters, whiteness index: *WI**, and glossiness (parallel and perpendicular to the fibers at 20, 60, and 85 degrees)) were investigated on wax applications applied to mahogany (*Swietenia mahagoni* (L.) Jacq.) wood with different coat numbers (1, 2, and 3). A control group was formed, and the surfaces treated with wax were compared with the results. According to the determined results, the coat number was found to be significant in all tests in the analysis of variance. While the samples with three coats of application yielded the highest results in glossiness values, increases were observed upon examination. The *WI** values, as well as all color parameters, decreased with the application of wax layers in both directions. Δ*E** values of 7,41 were recorded for a single coat of wax application, 8,87 for two coats, and 9,81 for three coats. Since the total color difference values obtained were very close to each other, it was observed that a single coat wax application would be sufficient.

Keywords: Mahogany; whiteness index, *Swietenia mahagoni* (L.) Jacq., color, glossiness, wax

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Introduction

Waxes are also used as additives that affect the appearance, softness, and water repellency of different coating formulations (Bulian and Graystone, 2009). Plant waxes are derived from plant leaves, stems, or fruits, predominantly composed of alkyl esters. Their chain length and composition vary significantly based on the surface (Bower, 2005).

Natural waxes can serve as an interesting alternative to synthetic polymers while protecting wooden surfaces (Toward energy…, 2015). Waxes, whether animal or plant-derived, are esters formed from high molecular weight monohydroxy alcohols and high molecular weight carboxylic acids. They exhibit distinct chemical properties compared to solid and liquid oils, hydrocarbon or paraffin waxes, and synthetic polyether waxes like carbowax (Bodmier and Hermann, 1997).

Natural waxes contain various simple lipid components such as esters, ketones, fatty alcohols, mono-, di-, tri-acylglycerols, hydrocarbons, and sterol esters (Kolattukudy, 1976).

Waxes have a wide range of applications due to their specific properties. They are commonly used for texturing, oil gelling, and increasing viscosity (Badal and Delgoda, 2017).

Studies on various wax applications are observed in the literature. Peker et al., (The Effects…, 2024) investigated the effects of wax application (1, 2, and 3 coats) on some surface properties (color, WI*, and glossiness) of olive (*Olea europaea* L.) wood. Since the results for 2 and 3 coat applications were very similar based on the Δ*E** value, it was concluded that a 3rd coat application was unnecessary. Zhang et al. (Properties and durability…, 2022) the color properties of lodgepole pine (*Pinus contorta Douglas* ex Loudon.)

and eucalyptus (*Eucalyptus saligna*) wood species treated with high melting point polyethylene wax for outdoor use were investigated for their characteristics and durability.

Peker et al., (2024b) examined how applying varying numbers of wax coats (1, 2, and 3) affected certain surface characteristics (glossiness, color and *WI**) of plum (*Prunus domestica* L.) wood treated with wax. Their findings indicated that wax application led to alterations in the surface properties of the wood. Furthermore, they noted that due to the similarity in ΔE^* values between the 2 and 3 coat applications, applying a 3rd coat was deemed unnecessary.

Akçay (2020) studied the effects of beeswax applications on lime, beech, poplar, and Scots pine woods, while Liu et al., (Colour and surface…, 2022) examined the L^*, a^*, and b^* values after wax applications to walnut (*Juglans regia*) and sycamore maple (Acer pseudoplatanus) woods.

Dao et al. (The effect of… 2018) investigated the color properties of sweetgum wood treated with hot wax material (wax and insect wax). Zhang et al. (Chromatic variability…, 2020) investigated the color parameters of larch (*Larix gmelinii*) wood treated with oil-wax coating.

In their study, Yang et al. (Effects of vacuum…, 2021) determined the color properties of Pterocarpus macrocarpus Kurz wood that had been subjected to wax impregnation at 90°C under atmospheric pressure for 48 h.

After conducting research in the literature, it is observed that wax application with different numbers of coats has not been performed on mahogany wood. If information about this tree species is to be provided: *Swietenia mahogany* (L.), a perennial large tree belonging to the Meliaceae family, is primarily grown in tropical regions such as India, Malaysia, and South China, and is highly valued for its top-quality wood (The chemistry…, 2000).

The heartwood of this tree has a distinct appearance, with the outer wood exhibiting a gray coloration. Depending on the specific species, the inner wood can range from yellow to reddish-brown and tends to darken over time when exposed to air (Şanıvar and Zorlu, 1980).

Mahogany is renowned globally as one of the most prized woods (20 Genetic resources…, 2010) due to its unique combination of characteristics. It boasts a beautiful color and grain, is lightweight yet exceptionally strong and resistant to decay, and is remarkably easy to work with. Consequently, it finds widespread use in the production of high-end furniture, panels, musical instruments, and yachts (Grogan, 2011).

Furthermore, mahogany, along with some other species, is employed in the timber industry for crafting exquisite cabinets and furniture owing to the wood's color, structure, and durability (Gilman and Watson, 1994).

Providing information about this wood species, in mahogany wood, the screw-holding capacity is 38,36 N/mm^2 (Determination of screw…, 2018), the thermal conductivity value is 0,152 W/mK, and the density value is 0,732 g/cm^3, the air-dry specific gravity is approximately 0,50–0,60 g/cm^3 (Şanıvar and Zorlu, 1980).

In the furniture industry, mahogany is extensively utilized both as solid wood and veneer due to its superior qualities. Its importation into Turkey results in higher costs, making veneer the predominant choice. It also finds applications in luxury settings and is well-suited for turning and carving. Mahogany-faced plywood is manufactured for various purposes, while solid wood applications are less common. Its mechanical strength is superior (Dinçel et al., 1970).

In this study, the effects of the number of coats on certain surface properties (color, glossiness, and whiteness index: *WI**) of wax applied to mahogany (*Swietenia mahagoni* (L.) Jacq.) wood were investigated.

Materials and Methods

Wood Material

Mahogany (*Swietenia mahagoni* (L.) Jacq.) wood was chosen for this study. The test samples were prepared in dimensions of 100 mm × 100 mm × 15 mm. Subsequently, climate conditioning was applied to these samples at 20 ± 2 °C and 65 % relative humidity (ISO 554, 1976).

Application of Wax to Wooden Material Surfaces

In the study, a mixture of natural and synthetic waxes was applied to oil wooden material surfaces using a brush, in 1, 2, and 3 coats.

Determination of Whiteness Index (*WI) Characteristics**

In this study, the Whiteness Meter BDY-1 device was used to determine the whiteness index (*WI**) values (ASTM E313-15e1 2015) (Figure 1D).

Determination of Glossiness Characteristics

Gloss tests were conducted using the ETB-0833 model gloss meter device according to ISO 2813 (1994) standard at three different angles (20°, 60°, and 85°) in both perpendicular and parallel directions to the fibers (Figure 1E).

Color Measurements Determination of Colour Characteristics

Color changes in the samples were assessed utilizing a CS-10 device (CHN Spec, China), adhering to the ASTM D 2244-3 (2007) standard, which employs the CIE 10° standard observer and CIE D65 light source, with an 8/d (8°/diffuse illumination) setup (Fig. 1A). The analysis was conducted using the CIELAB color system. Total color variations were quantified using the formulas described in Ayata et al., (2021a;b).

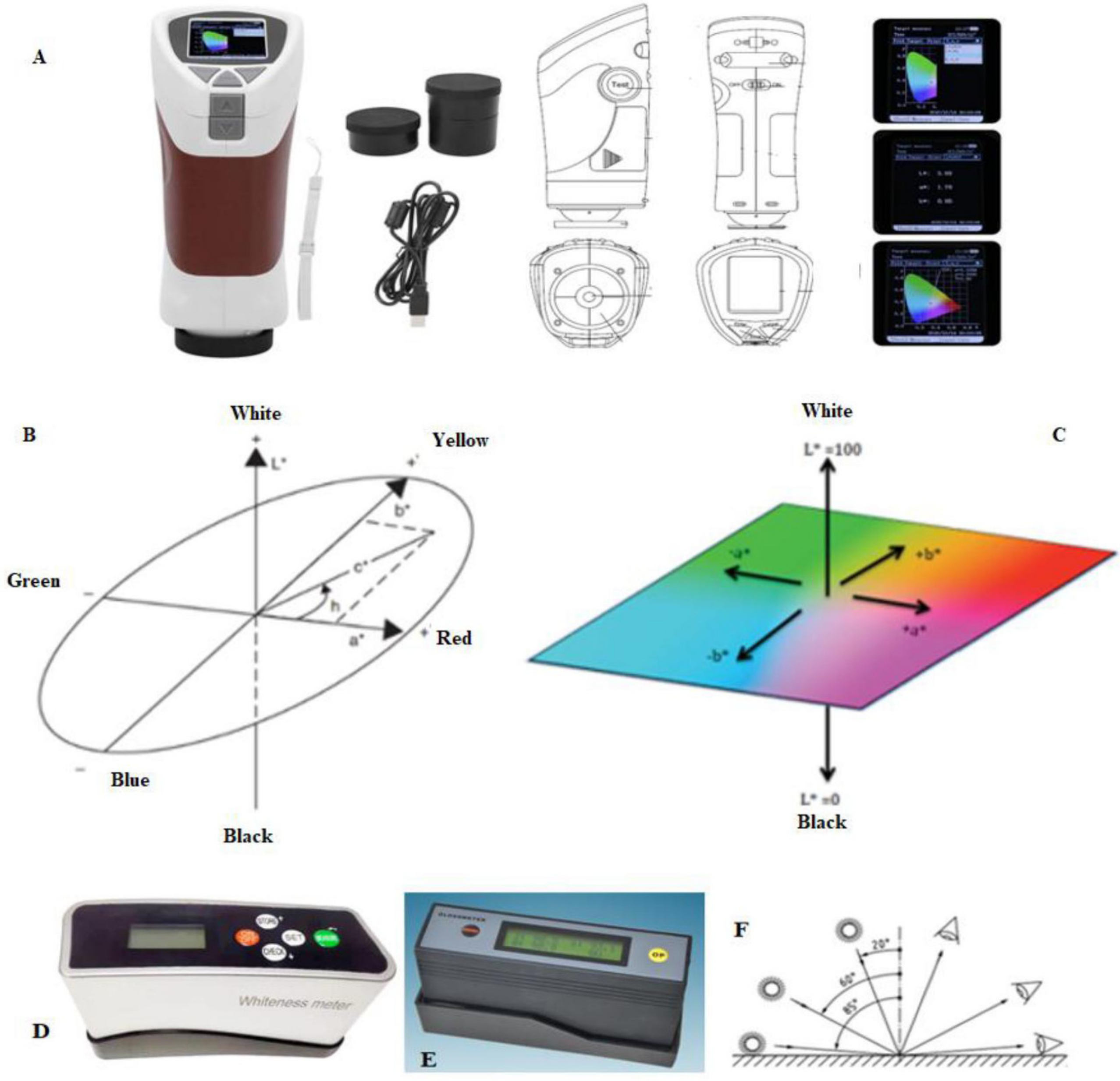

Fig. 1. Color measurement device (A), CIELAB color space and CIELCH color space (Gangakhedkar, 2010) (B), and RGB representation of CIE-Lab color space (Detecting objects…, 2012) (C), whiteness index measurement device (D), gloss measurement device (E), and measurement angles (ISO 2813, 2014) (F)

$$\Delta a^* = (a^*_{\text{wax applied}}) - (a^*_{\text{control}}) \quad (1)$$
$$\Delta L^* = (L^*_{\text{wax applied}}) - (L^*_{\text{control}}) \quad (2)$$
$$\Delta b^* = (b^*_{\text{wax applied}}) - (b^*_{\text{control}}) \quad (3)$$
$$\Delta E^* = ((\Delta L^*)^2 + (\Delta b^*)^2 + (\Delta a^*)^2)^{1/2} \quad (4)$$
$$C^* = ((a^*)^2 + (b^*)^2)^{1/2} \quad (5)$$
$$\Delta C^* = (C^*_{\text{wax applied}}) - (C^*_{\text{control}}) \quad (6)$$
$$h° = \arctan (b^*/a^*) \quad (7)$$
$$\Delta H^* = ((\Delta E^*)^2 - (\Delta L^*)^2 - (\Delta C^*)^2)^{1/2} \quad (8)$$

ΔL^*: Positive values of ΔL^* signify a lighter shade than the reference, while negative values indicate a darker shade. ΔH^*: Reflects changes in hue angle or shading. ΔC^*: Indicates alterations in chroma or saturation. Positive values of ΔC^* represent an increase in vibrancy and luminance compared to the reference, while negative values indicate a decrease in vividness and distinctiveness relative to the reference. Δa^*: Positive values of Δa^* indicate a shift towards a more pronounced red tone compared to the reference, whereas negative values suggest a shift towards a greener hue. Δb^*: Positive values of Δb^* represent an increase in yellowness compared to the reference, while negative values indicate an increase in blueness (Lange, 1999).

Moreover, the color change criteria outlined in Table 1 by Barański et al., (High temperature…, 2017) have been juxtaposed with the results presented in Table 8.

Table 1

Color change criteria by Barański *et al.* (2017)

Color change criteria	►	ΔE^* value
Invisible color change	►	$\Delta E^* < 0.2$
Slight change of color	►	$2 > \Delta E^* > 0.2$
Color change visible in high filter	►	$3 > \Delta E^* > 2$
Color change visible with average quality of filter	►	$6 > \Delta E^* > 3$
High color change	►	$12 > \Delta E^* > 6$
Different color	►	$\Delta E^* > 12$

Statistical Analysis

In this study, an SPSS software was employed to analyze a range of parameters, including minimum and maximum values, identification of groups with similar traits, standard deviations, percentage variations (%), multivariate coefficients of variation, and means.

Results and Discussion

The results of the analysis of variance are provided in Table 2. According to these results, it is observed that the number of wax layers applied significantly affects the values of color parameters (Table 2).

Measurement results for color parameters are provided in Table 4. While the highest result for L^* was determined in the control group (38,12), the lowest result was found in samples with 3 coats of wax applied (30,82). Decreases in L^* values were observed with an increase in the number of coats. This situation was determined to be 15,06 %, 18,21 %, and 19,15 % for 1, 2, and 3 coat applications, respectively. The highest result for the a^* parameter was obtained in the control experimental group (13,14), while the lowest result was determined in samples with 3 coats of wax applied (11,57). Decreases in a^* values were observed with an increase in the number of coats applied (0,46 %, 4,19 %, and 11,95 % for 1, 2, and 3 coat applications, respectively) (Table 3).

Decreases in b^* were observed with an increase in the number of coats applied (30,47 %, 35,81 %, and 41,41 % for 1, 2, and 3 coat applications, respectively), While the highest result for b* was determined in the control samples (15,36), the lowest result was found in samples with 3 coats of wax applied (9,00). The highest result for C^* was observed in the control group (20,22), while the lowest result was obtained in samples with 3 coats of wax applied (14,67). It was determined that decreases in C^* values were achieved with an increase in the number of coats applied, and the decreases were determined to be 16,52 %, 20,87 %, and 27,45 % for 1, 2, and 3 coat applications, respectively. The highest result for $h°$ was obtained in the control experimental group (49,49), while the lowest result was determined in samples with 2 coats of wax applied (38,07). Decreases in $h°$ were observed in 1, 2, and 3 coat applications by 20,75 %, 23,08 %, and 22,99 %, respectively (Table 3).

Peker et al., (The Effects…, 2024) reported that in wax application studies on olive (*Olea europaea* L.) wood surfaces with 1, 2, and 3 coats applied, it was observed that the values of C^*, a^*, and b^* increased as the number of coats increased, while L^* and $h°$ were reported. Akçay, (2020) reported that wax application to linden, beech, poplar, and Scots pine woods resulted

Table 2

Variance results of color parameters

Source	Test	Sum of Squares	df	Mean Square	F	Sig.
Number of coat	*L**	345,993	3	115,331	672,184	0,000*
	*a**	15,645	3	5,215	28,794	0,000*
	*b**	242,234	3	80,745	343,134	0,000*
	*C**	168,106	3	56,035	167,783	0,000*
	h°	918,828	3	306,276	320,689	0,000*

*: Significant

Table 3

Results of the color parameters

Test	Wax Application	N	Mean	Change Ratio (%)	*HG*	SD	Minimum	Maximum	COV
*L**	Control	10	38,12	–	A*	0,48	37,58	38,87	1,25
	1 coat	10	32,38	↓15,06	B	0,42	31,69	32,84	1,29
	2 coat	10	31,18	↓18,21	C	0,30	30,50	31,50	0,95
	3 coat	10	30,82	↓19,15	C**	0,44	30,24	31,46	1,44
*a**	Control	10	13,14	–	A*	0,46	12,28	13,68	3,50
	1 coat	10	13,08	↓0,46	A	0,34	12,63	13,57	2,60
	2 coat	10	12,59	↓4,19	B	0,39	12,03	13,15	3,09
	3 coat	10	11,57	↓11,95	C**	0,50	10,86	12,23	4,29
*b**	Control	10	15,36	–	A*	0,20	15,03	15,67	1,32
	1 coat	10	10,68	↓30,47	B	0,48	10,11	11,39	4,45
	2 coat	10	9,86	↓35,81	C	0,41	9,17	10,29	4,20
	3 coat	10	9,00	↓41,41	D**	0,71	8,04	9,86	7,87
*C**	Control	10	20,22	–	A*	0,40	19,64	20,72	1,98
	1 coat	10	16,88	↓16,52	B	0,55	16,21	17,72	3,28
	2 coat	10	16,00	↓20,87	C	0,51	15,13	16,70	3,17
	3 coat	10	14,67	↓27,45	D**	0,78	13,52	15,71	5,33
h°	Control	10	49,49	–	A*	0,86	48,51	51,36	1,74
	1 coat	10	39,22	↓20,75	B	0,63	38,48	40,00	1,60
	2 coat	10	38,07	↓23,08	C**	0,92	36,94	39,61	2,41
	3 coat	10	38,11	↓22,99	C	1,36	36,09	39,69	3,56

COV: Coefficient of Variation, *N*: Number of Measurements, *SD*: Standard Deviation, *HG*: Homogeneity Group,
* Highest value, ** Lowest value

in a decrease in *L** values and an increase in *a** and *b** values. Similarly, Liu *et al.* (Colour…, 2022) reported that wax application to walnut (*Juglans regia*) and sycamore maple (*Acer pseudoplatanus*) woods led to a decrease in *L** values and an increase in *a** and *b** values. Peker *et al.* (Effects of different…, 2024) reported that increasing the number of wax coats (1, 2, and 3) applied to wax-treated plum (*Prunus domestica* L.) wood led to a decrease in the *L** and *h*° values, while the *a**, *C**, and *b** values increased.

The analysis of variance results, as outlined in Table 4, indicates a significant impact of the number of wax layers applied on the glossiness values.

Table 4

Variance results of glossiness values

Source	Test	Sum of Squares	df	Mean Square	F	Sig.
Number of coat	⊥20° glossiness	0,432	3	0,144	216,000	0,000*
	⊥60° glossiness	113,837	3	37,946	1107,900	0,000*
	⊥85° glossiness	710,771	3	236,924	462,842	0,000*
	‖20° glossiness	0,917	3	0,306	268,317	0,000*
	‖60° glossiness	158,647	3	52,882	1034,091	0,000*
	‖85° glossiness	1243,797	3	414,599	2203,685	0,000*

*: Significant

Measurement results for glossiness values are presented in Table 6. Looking at the gloss values, increases were determined in measurements taken parallel (‖) and perpendicular (⊥) to the fibers at 60 and 85 degrees. Increases in these measurements were obtained with an increase in the number of coats, with the lowest values determined in the control samples and the highest measurements found in samples belonging to the group with 2 coats applied. At 20 degrees, gloss measurements perpendicular to the fibers in control, 1, and 2 coat applications resulted in the same outcomes. Additionally, at 20 degrees, gloss measurements parallel to the fibers in control and 1 coat applications also yielded the same results (Table 5).

In the wax application studies conducted by Peker *et al.*, (The Effects…, 2024) on olive (*Olea europaea* L.) wood surfaces with 1, 2, and 3 coats applied, it was reported that the gloss values increased following the increase in the number of coats applied. Peker *et al.* (Effects of different…, 2024) reported that after applying wax to plum (*Prunus domestica* L.) wood with different numbers of coats (1, 2, and 3), increases in gloss values were observed at both 60 and 85 degrees. Conversely, decreases were observed with one coat of wax at 20 degrees in both directions, while increases were noted with two and three coats of wax.

The analysis of variance, detailed in Table 6, highlights a notable influence of the number of wax layers applied on the whiteness index (*WI**) values.

Measurement results for whiteness index (*WI**) values are shown in Table 7.

Decreases were determined in *WI** values in both parallel (‖) and perpendicular (⊥) measurements with an increase in the number of coats applied. In addition, *WI** values ⊥ to the fibers were found to be higher than those ‖ to the fibers. *WI** values in both directions were higher in the control samples compared to wax-applied samples (⊥:5,45 and ‖:2,38). Decreases in *WI** values ⊥ to the fibers were determined to be 38,53 %, 51,56 %, and 56,70 % for 1, 2, and 3 coat applications, respectively, while decreases in WI* values ‖ to the fibers were determined to be 49,58 %, 57,98 %, and 68,49 % for 1, 2, and 3 coat applications, respectively (Table 7).

In the wax application studies conducted by Peker *et al*. (The Effects …, 2024) on olive (*Olea europaea* L.) wood surfaces with 1, 2, and 3 coats applied, it was observed that the *WI** (in both directions) values decreased following the increase in the number of coats applied. Peker *et al.* (Effects of different…, 2024) observed that increasing the number of wax coats (1, 2, and 3) applied to wax-treated plum (*Prunus domestica* L.) wood resulted in a decrease in the *WI** values (in both directions).

The results for total color differences (Δ*C**, Δ*L**, Δ*b**, Δ*a**, Δ*E**, and Δ*H**) are presented in Table 8. Following all wax applications, Δ*L** (darker than the reference), Δ*a** (greener than the reference), Δ*b** (bluer than the reference), and Δ*C** (duller, matte than the reference) values were determined to be negative. Δ*E** values were found to be 7,41 for 1 coat wax application, 8,87 for 2 coat wax application, and 9,81 for 3 coat wax application. Δ*H** and Δ*E** values increased with the number of coats.

Table 5

Results of the glossiness values

Test	Wax Application	*N*	Mean	Change Ratio (%)	*HG*	*SD*	Minimum	Maximum	*COV*
⊥20°	Control	10	0,10	–	B**	0,00	0,10	0,10	0,00
	1 coat	10	0,10	0,00	B**	0,00	0,10	0,10	0,00
	2 coat	10	0,10	0,00	B**	0,00	0,10	0,10	0,00
	3 coat	10	0,34	↑240,00	A*	0,05	0,30	0,40	15,19
⊥60°	Control	10	0,12	–	D**	0,04	0,10	0,20	35,14
	1 coat	10	0,44	↑266,67	C	0,10	0,30	0,50	21,96
	2 coat	10	2,31	↑1825,00	B	0,22	2,10	2,60	9,45
	3 coat	10	4,34	↑3516,67	A*	0,28	3,90	4,70	6,44
⊥85°	Control	10	0,10	–	C**	0,00	0,10	0,10	0,00
	1 coat	10	0,16	↑60,00	C	0,10	0,10	0,30	60,38
	2 coat	10	4,56	↑4460,00	B	0,46	4,20	5,10	10,19
	3 coat	10	10,40	↑10300,00	A*	1,35	9,30	12,80	12,98
‖20°	Control	10	0,10	–	C**	0,00	0,10	0,10	0,00
	1 coat	10	0,10	0,00	C**	0,00	0,10	0,10	0,00
	2 coat	10	0,20	↑100,00	B	0,00	0,20	0,20	0,00
	3 coat	10	0,47	↑370,00	A*	0,07	0,40	0,60	14,36
‖60°	Control	10	0,44	–	C**	0,08	0,30	0,50	19,17
	1 coat	10	0,56	↑27,27	C	0,05	0,50	0,60	9,22
	2 coat	10	3,41	↑675,00	B	0,14	3,30	3,60	4,02
	3 coat	10	5,16	↑1072,73	A*	0,42	4,60	5,80	8,13
‖85°	Control	10	0,13	–	D**	0,05	0,10	0,20	37,16
	1 coat	10	0,54	↑315,38	C	0,13	0,40	0,70	23,42
	2 coat	10	8,26	↑6253,85	B	0,26	8,00	8,70	3,14
	3 coat	10	13,46	↑10253,85	A*	0,82	12,60	14,90	6,07

COV: Coefficient of Variation, *N*: Number of Measurements, *SD*: Standard Deviation,
HG: Homogeneity Group, *: Highest value, **: Lowest value

Table 6

Variance results of whiteness index (WI*) values

Source	Test	Sum of Squares	df	Mean Square	F	Sig.
Number of coat	*WI** (⊥)	58,542	3	19,514	1858,476	0,000*
	*WI** (‖)	15,647	3	5,216	492,811	0,000*

* Significant

Table 7

Results of the whiteness index (WI*) values

Test	Wax Application	*N*	Mean	Change Ratio (%)	*HG*	*SD*	Minimum	Maximum	*COV*
*WI** ⊥	Control	10	5,45	–	A*	0,14	5,30	5,60	2,48
	1 coat	10	3,35	↓38,53	B	0,14	3,20	3,50	4,04
	2 coat	10	2,64	↓51,56	C	0,05	2,60	2,70	1,96
	3 coat	10	2,36	↓56,70	D**	0,05	2,30	2,40	2,19
*WI** ‖	Control	10	2,38	–	A*	0,20	2,00	2,60	8,36
	1 coat	10	1,20	↓49,58	B	0,00	1,20	1,20	0,00
	2 coat	10	1,00	↓57,98	C	0,00	1,00	1,00	0,00
	3 coat	10	0,75	↓68,49	D**	0,05	0,70	0,80	7,03

COV: Coefficient of Variation, *N*: Number of Measurements, *SD*: Standard Deviation,
HG: Homogeneity Group, *: Highest value, **: Lowest value

Table 8

Results of total color differences

Wax Application	Δ*L**	Δ*a**	Δ*b**	Δ*C**	Δ*H**	Δ*E**	Color Change Criterion (High temperature…, 2017)
1 coat	–5,74	–0,06	–4,68	–3,33	3,29	7,41	High color change (12 > Δ*E** > 6)
2 coat	–6,94	–0,55	–5,50	–4,22	3,57	8,87	
3 coat	–7,30	–1,56	–6,36	–5,55	3,47	9,81	

When the results obtained in this study are compared with the values given in Table 1 Barański *et al.* (High temperature…, 2017) for Δ*E** evaluation, it is observed that the "high color change (12 > Δ*E** > 6)" criterion is achieved for all applications (Table 8).

In the wax application studies conducted by Peker *et al.*, (The Effects…, 2024) on olive (*Olea europaea* L.) wood surfaces with 1, 2, and 3 coats applied, Δ*E** values were reported as 5.73 for 1 coat application, 11.39 for 2 coat application, and 12,00 for 3 coat application. Peker *et al.*, (Effects of different…, 2024) determined the Δ*E** values as 9,16 for 1 coat of wax, 11,36 for 2 coats of wax, and 11,14 for 3 coats of wax applied to wax-treated plum (*Prunus domestica* L.) wood.

Conclusions

The number of coats showed significance across all tests in the variance analysis.

For a single coat of wax application, Δ*E** values were recorded at 7,41, for two coats at 8,87, and for three coats at 9,81.

Application of wax layers led to a decrease in whiteness index values and all color parameters in both directions.

While three coats of application resulted in the highest glossiness values, increases were noted upon inspection.

Due to the close proximity of total color difference values, it was observed that a single coat of wax application would suffice.

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