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Research Article

EFFECT OF DIFFERENT RATIO PERACETIC ACID BLEACHING ON COLOUR CHANGING OF SPRUCE WOOD AND BEECH WOOD

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ABSTRACT

Final quality of finishing depends on various elements including application method of coating, characteristics of substrate such as porosity, chemical structure, and interaction between coating and the substrate. The purpose of this work is to determine some surface properties of peracetic acid bleached specimens of wood species with cellulosic varnish as a function of peracetic acid ratio. For this purpose, beech which hardwoods species and spruce which softwoods species were used and also cellulosic varnish were used and peracetic acid with there diferent raito (undiluted, 1/3 diluted and 1/6 diluted) was used. The color change of the samples was determined. As a result, the highest colour changing was determined of bleached beech wood with peracetic acid diluted 1/3.
Keywords: Spruce, colour changing, bleaching, peracetic acid (undiluted, 1/3 diluted and 1/6 diluted).

1. INTRODUCTION

The colour of furniture is as important as its shape, dimension, form, and balance. In interior decoration, carpets, curtains, etc. should be in harmony with wall, ceiling, and base coverings. The natural colour of wood materials, in many cases, cannot meet these requirements. Therefore, to provide colour compatibility, wood may be subjected to a bleaching process prior to surface finishing. Bleaching is a process in which some specific chemical solutions are applied to turn the colour of wood lighter. In the furniture industry, this process is carried out on some tree woods (mahogany, oak, etc.) together with surface treatments. Bleaching and impregnation affect the wood structure and specifications such as hardness, colour, and brightness to some extent. The hardness of the varnish layer is the most important parameter for the protection of wood against external factors [1].

Each type of wood species has its own variation of colour, texture and grain pattern. Some cuts of solid wood and flitches of veneer may be light error darker than others. To obtain a uniform colour for use in furniture, the choice is generally limited to a colour equal to or darker than the natural colour of the wood. The only way to avoid this darkening is to bleach the wood or

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use a bleaching toner on the wood before finishing [2]. There are two reasons for the discoloration of wood. The first is damage, drying of branches, disease etc. in alive trees [3]. The second is oxidation, iron s tains, fungi discoloration and chemical stains occurring on wood cut from trees. This kind of discoloration degrades the quality of wood material [4]. Bleaching is there moving of colour pigments in the structure of wood using various bleaching chemicals and bleaching systems [5]. While there are many materials available, that we most common chemicals used as wood bleaching agents are sodium hydroxide and hydrogenperoxide [1].

Physical characteristics in particular appearance of the finished product is affected by not only the type of finish but also interaction between finish and the substrate. It is well known fact that species, wood density and roughness of the substrate are considered major parameters to have an effective finishing process. Wood being non-homogenous material also creates certain challenges for an ideal finished member. Sapwood and heartwood ratio within its anatomical structure would also be important element affecting interaction between the finishing material and the substrate. In certain species having extractives and other chemicals in the heartwood would create some barrier having good adherence of finish to the surface of wood substrate. Various studies investigated adhesion strength of different wood species coated using different types of finishing materials [6, 7, 8, 9].

The main objective of the present research was to evaluate bleaching effect on the varnish properties of spruce wood and beech. Five different bleach chemicals which sodium hydroxide-hydrogen peroxide, oxalic acid, peracetic acid, peracedic acid diluted 1/3, ,peracedic acid diluted 1/6 and spruce wood (*Picea orientali*s L. (Link.)) were used. In this study, effect of heartwood, sapwood ratio and flat, edge grained cross section of colour changing on spruce wood and beech were determined it.

2. MATERIALS AND METHODS

2.1. Wood Species

The wood species, namely spruce (Picea orientalis L. Link) and beech (Fagus orientalis L) were used fort the experiments. A total of 300 defect free heartwood (flat and edge grained) and sapwood samples (flat and edge grained)with dimensions of 400 mm by 100 mm by 200 mm were prepared and conditioned in a climate room having a relative humidity of 65 % and a temperature of 20 °C until they reach to equilibrium moisture content of 12%. Conditioned specimens were sanded with 80-grit and 180-grit sand paper using a commercial sanding machine (Feed speed: 12 m/min, sanding pressure: 0.5 MPa).

2.2. Bleaching Chemicals

All specimens bleached with five different chemicals, namely, sodium hydroxide-hydrogen peroxide, oxalic acid, peracetic acid, peracedic acid diluted 1/3, peracedic acid diluted 1/6.

2.3. Varhish Applying

In the next step both heartwood and sapwood specimens were coated with cellulosic based varnish using a pressurized spray gun at a spread rate of 120 g/m^2 and cured in the convection drying chamber.

2.4. Colour measurement

The CIELAB system is derived from CIE (International Commission on Illumination) Standard Colour Table by transforming the original X, Y and Z colorimetric coordinates (colour

values) into three new reference values of L*, a* and b*. The objective of this transformation is a colour-space to aid in the numerical classification of colour differences. Each colour in the CIELAB colour-space (Fig. 1) has a unique location defined by its Cartesian coordinates with respect to the axes L*, a* and b*where L* is the degree of lightness, ranging from white (100) to black (0) along a grey scale, a* is the degree of redness and greenness, and b* is the degree of yellowness and blueness.

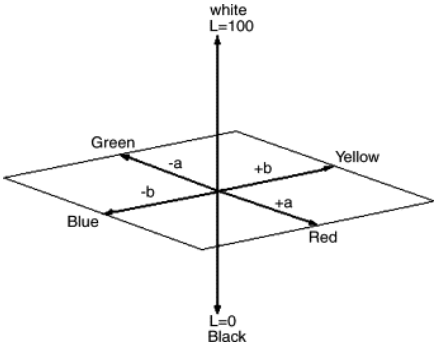

Figure 1. The CIE L*a*b* colour space

Colour measurements were conducted according to ISO 7724-2 standard [10]. L*, a*and b* colour coordinates for each sample group were determined before and after high temperature drying, exposure to laboratory indoor conditions and preservative treatments. These colour space values were used to calculate the total colour change

(ΔE*) as a function of treatments applied to veneers according to the following equations:

$$\Delta L^*=Lt^*-Li^* \text{ , } \Delta a^*=at^*-ai^*, \ \Delta b^*=bt^*-bi^*$$

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

All groups were given characteristics of used bleaching chemicals in Table 1.

Table 1. Characteristics of used bleaching chemicals

Number	Used bleaching Chemicals
1	Control Groups
2	sodium hydroxide-hydrogen peroxide
3	oxalic acid
4	peracetic acid
5	peracedic acid diluted 1/3
6	peracedic acid diluted 1/6

3. RESULTS AND DISCUSSION

It was given values of finishing colour change in spruce and beech wood in Table 1 and 3.

According to Table 1, The highest color change was observed for edge grain sapwood (8.12) of spruce which was bleached with sodium hydroxide-hydrogen peroxide, it was followed by bleaching process, peracedic acid diluted 1/3, peracetic acid, and oxalic acid , respectively.

When the flat-grained sapwood of spruce was evaluated, the highest color change was obtained by the bleaching process with the peracedic acid diluted 1/6 (6.77), followed by the bleaching process with peracetic acid, peracedic acid diluted 1/3 and sodium hydroxide-hydrogen peroxide, respectively. The lowest color change was obtained by bleaching process with oxalic acid (2.82).

Table 1. Finishing color changes in spruce wood

		SAPWOOD				HEARTWOOD			
		Edge grain	Edge grain*	Flat grain	Flat grain*	Edge grain	Edge grain*	Flat grain	Flat grain*
2	*L*	77.05	82.12	79.98	78.79	79.58	77.52	75.89	80.11
	a	6.88	1.85	5.88	2.92	5.69	3.23	6.82	2.45
	b	18.76	22.63	21.31	23.77	21.18	20.96	21.65	20.46
	ΔE		**8.12**		**4.03**		**3.22**		**6.19**
3	*L*	78.73	78.50	80.76	79.51	83.74	81.35	81.36	78.98
	a	6.50	7.42	4.95	6.65	4.06	6.31	5.07	6.89
	b	19.97	20.60	17.92	19.79	20.92	21.86	19.75	20.23
	Δ*E*		**1.14**		**2.82**		**3.41**		**3.03**
4	*L*	76.68	80.28	75.29	80.31	77.86	80.65	70.56	78.57
	a	6.93	5.20	7.14	4.93	6.21	4.67	6.18	5.11
	b	19.48	22.21	19.00	21.06	20.26	21.59	19.66	21.35
	Δ*E*		**4.84**		**5.86**		**3.45**		**8.26**
5	*L*	78.03	82.29	77.94	81.62	73.65	79.57	75.69	80.96
	a	5.91	4.28	6.25	4.30	7.55	4.98	6.63	4.62
	b	17.96	22.13	18.63	21.25	22.21	23.62	20.99	21.59
	Δ*E*		**6.18**		**4.92**		**6.61**		**5.67**
6	*L*	76.11	81.77	77.70	83.69	80.15	83.28	80.70	83.98
	a	6.91	4.20	5.82	3.34	5.85	3.94	5.64	3.73
	b	18.90	22.17	18.23	20.18	20.90	21.34	21.44	21.41
	Δ*E*		**7.08**		**6.77**		**3.69**		**3.80**

Table 2. The color change (ΔE) values in the resulting spruce wood of the bleaching process

	SAPWOOD		HEARTWOOD		
	Edge grain	Flat grain	Edge grain	Flat grain	
2	8.12	4.03	3.22	6.19	**5.39**
3	1.14	2.82	3.41	3.03	**2.60**
4	4.84	5.86	3.45	8.26	**5.60**
5	6.18	4.92	6.61	5.67	**5.84**
6	7.08	6.77	3.69	3.80	**5.33**
	5.47	**4.88**	**4.08**	**5.39**	

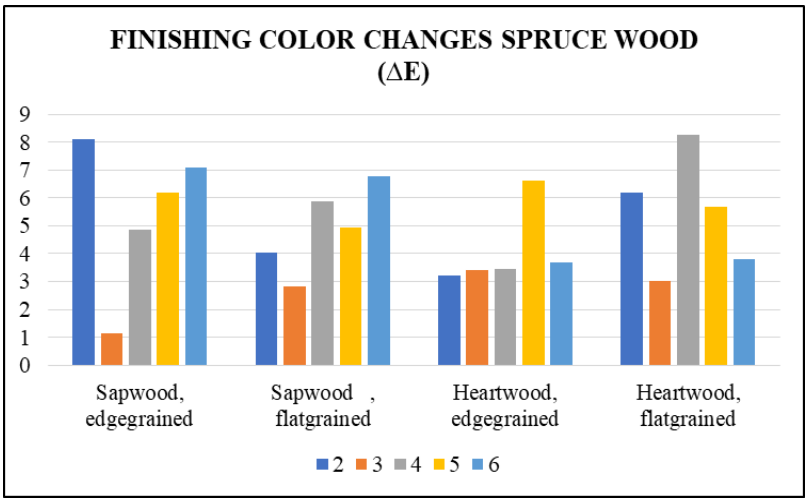

Figure 2. Color change in spruce wood (ΔE)

In the radial section for heartwood of spruce, the highest color change was obtained by bleaching process peracedic acid diluted 1/3 (6.61), followed by the bleaching process peracedic acid diluted 1/6, peracetic acid, oxalic acid. in the order hands the lowest color change was obtained for sodium hydroxide-hydrogen peroxide bleaching process (3.22).

For flat grained heartwood of spruce, the highest color chainge was determined bleaching process with the peracetic acid (8,26). It was followed the bleaching process was sodium hydroxide-hydrogen peroxide, peracedic acid diluted 1/3, peracedic acid diluted 1/6, respectively. The oxalic acid (3,03) bleaching process was e obtained the lowest degree. It has also been reported in previous studies that oxalic acid alone does not have much bleaching effect. Peracetic acid has an intensive use as a bleach. In this study, the desired values of color change as a result of bleaching with peracetic acid were obtained. The use of sodium hydroxide-hydrogen peroxide was seen effectively in the bleaching of solid wood materials. The spruce wood also gave good results.

According to Table 3, when edge grained sapwood of beech wood was evaluated, the highest color change was observed by sodium hydroxide-hydrogen peroxide bleaching process(23,25), It was followed by peracedic acid diluted 1/6, peracedic acid diluted 1/3, peracedic acid, respectively and the lowest color change was obtained for bleaching process with ocalic acid (19,02).

The highest color change of the flatgrained sapwood was obtained sodium hydroxide-hydrogen peroxide bleaching process (19.02), it was followed by bleaching process of peracedic acid diluted 1/6, peracedic acid diluted 1/3, and peracedic acid respectively.

In the radial section of heartwood for beech wood, the highest color change was obtained by bleaching methods of sodium hydroxide-hydrogen peroxide (23,49), followed by peracedic acid diluted 1/6, peracedic acid diluted 1/3, peracedic acid, respectively, while the lowest color change was obtained by oxalic acid bleaching (1.82).

The highest color change was observed for the flat grained beech heartwood samples bleached with sodium hydroxide-hydrogen peroxide, while oxalic acid treatment (1.92) was the least effective in terms of color change.

Table 3. Finishing color changes in beech wood

		SAPWOOD				HEARTWOOD			
		Edge grain	Edge grain*	Flat grain	Flat grain*	Edge grain	Edge grain*	Flat grain	Flat grain*
2	*L*	70,78	88,59	70,82	84,68	71,43	88,49	63,89	78,36
	a	10,16	0,09	10,63	1,67	10,69	0,66	11,84	3,50
	b	25,59	14,54	24,32	14,86	26,25	13,60	24,80	18,91
	ΔE		**23,25**		**19,02**		**23,49**		**17,71**
3	*L*	71,24	69,22	72,82	71,24	69,07	68,59	69,76	69,26
	a	11,09	13,44	10,13	11,86	11,67	13,06	11,27	12,31
	b	26,87	27,35	23,71	23,73	27,12	26,05	26,36	24,83
	Δ*E*		**3,14**		**2,34**		**1,82**		**1,92**
4	*L*	71,79	76,99	73,74	77,02	72,54	77,40	69,62	76,34
	a	10,59	7,71	9,03	6,97	10,15	7,35	11,53	8,05
	b	25,60	25,37	22,60	23,12	25,47	23,81	26,39	24,69
	Δ*E*		**5,95**		**3,91**		**5,85**		**7,76**
5	*L*	71,23	80,28	71,52	77,28	68,65	76,40	67,01	74,68
	a	10,73	6,51	9,77	6,83	11,60	7,79	11,86	8,44
	b	25,46	25,17	23,37	23,30	27,39	26,14	26,40	26,48
	Δ*E*		**9,99**		**6,47**		**8,73**		**8,4**
6	*L*	72,08	81,50	75,53	82,21	68,39	77,09	67,95	78,09
	a	9,94	5,87	7,76	4,93	11,55	7,21	11,16	7,08
	b	24,30	24,29	20,47	22,01	27,05	25,41	24,79	25,15
	Δ*E*		**10,26**		**7,42**		**9,86**		**10,94**

Table 4. The color change (ΔE) values in the resulting beech wood of the bleaching process

	SAPWOOD	SAPWOOD	HEARTWOOD	HEARTWOOD	
	Edge grain	Flat grain	Edge grain	Flat grain	
2	23,25	19,02	23,49	17,71	**20,87**
3	3,14	2,34	1,82	1,92	**2,31**
4	5,95	3,91	5,85	7,76	**5,87**
5	9,99	6,47	8,73	8,4	**8,40**
6	10,26	7,42	9,86	10,94	**9,62**
	10,52	**7,83**	**9,95**	**9,35**	

1-sodium hydroxide-hydrogen peroxide,2-oxalic acid, 3-peracetic acid,
4-peracedic acid diluted 1/3, 5-peracedic acid diluted 1/6

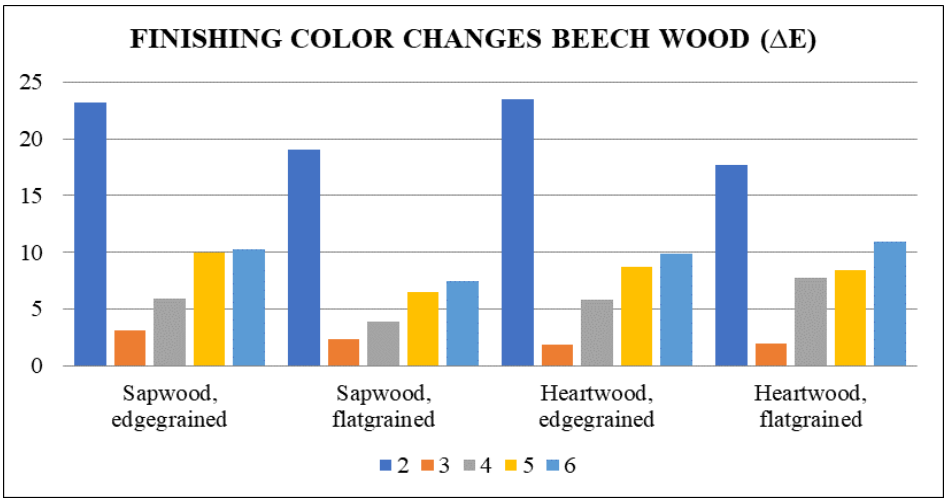

Figure 3. Color change in beech wood (ΔE)

Peracetic acid is extensively used as a bleaching agent. As a result of bleaching with peracetic acid, the desired values were obtained in the color change. In previous studies it was reported that oxalic acid was not very effective in bleaching and color change [1]. However, mixture of sodium hydroxide and hydrogen peroxide gave good results.

4. CONCLUSION

The effect of bleaching chemicals on the color change of spruce wood and beech wood were evaluated. Bleaching chemicals increased on surface activation. The highest color change was obtained for beech wood. The lowest color change was obtained for spruce wood. The least result in color change was obtained with oxalic acid bleaching method.

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