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Research Article

Comparison of Colour and Brightness Values of Different Varnishes Applied to Woods Used in Manufacturing Wooden Yachts

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Abstract

This study investigated the colour performance of various varnishes used in wooden yachts under rapid ageing, focusing on brightness and salt fog effects. Limba (*Combretaceae terminalia superba*) and chestnut (*Castanea sativa* Mill.) and sapele (*Entandrophragma cylindricum*) test wooden were created for the samples. Yacht, polyurethane and epoxy varnish were used as varnish types in the experiments. As a result of the rapid test, the most significant color change among the tree species was found in sapele, while the least color change was found in limba. Among the varnishes, the highest colour change was observed in epoxy varnish. The highest brightness value was observed in the limba tree and the lowest in the sapele tree. The highest gloss value among the varnishes was obtained in the epoxy varnish, while the yacht varnish resulted in the lowest gloss value. The highest colour change among the tree species under the salty water effect was observed in the sapele wood and the lowest colour change occurred in the limba wood. The highest colour change was observed in the epoxy varnish and the difference between polyurethane and yacht varnish was not statistically significant. It has been observed that selecting the appropriate varnish according to the tree species used in yacht construction has an enhancing effect on the protective layer performance on the wood surface.

Keywords: Accelerated ageing, gloss test, saltwater fog test, polyurethane varnish, epoxy varnish

1. Introduction

The yacht and small boat sector is a high-value sector, generating significant foreign currency for the national economy, attracting foreign investment, facilitating technology transfer and characterized by high design and R&D activities. Traditional wooden yachts have been preferred in yacht manufacturing from the past to the present. Wood material is widely used in this sector for several reasons, including its economic benefits, ease of processing, aesthetic appeal and its ability to maintain a protective layer. Timber obtained from tropical and exotic trees, such as Limba, Sapele and Teak, grown in Africa, stands out as a premium wooden material in yacht building shipyards. While the yachts are being designed, it is desirable to preserve the natural appearance of the wood in skeletal elements such as parapets, tubers, rails and handrails, applied to the parts called the sides above the water. The same considerations apply to the deck, bridge, living quarters and furniture used in these areas and varnish applications are made for this purpose. Many studies have been conducted on the performance of varnishes in relation to the tree species used in applications. According to Tutgun (2014), it was aimed to determine the effect of wood material surface roughness on the adhesion strength of the varnish layer and the highest adhesion resistance at the tree species level was in Cherry (2.52 N mm^{-2}), the lowest in Yellow Pine (2.32 N mm^{-2}); At the varnish type level, the highest polyurethane varnish (3.15 N mm^{-2}) was obtained and the lowest was obtained in water-based varnish. According to the regression analysis, a strong relationship (r=0.69) was found between roughness and adhesion resistance in water-based varnish, with a similar result (r=0.67) observed in acrylic varnish. In contrast, this relationship is weak (r=0.33) in polyurethane varnish. According to Kocapınar (2014), the varnishing properties of wood from commercially essential tree species in our country were investigated. For this purpose, four different tree species: leafy tree species Eastern Beech (*Fagus orientalis* Lipsky.) and Bearded Alder (*Alnus glutinosa subsp*. barbata (C. A. Mey.) Yalt.) and coniferous Eastern Spruce [*Picea orientalis* L. (Link.)] and the Eastern Black Sea Fir (*Abies nordmanniana* subsp. *nordmanniana*) and cellulosic varnish were used. It was determined that the sanding process influences the roughness values and the best surface roughness is achieved with sanding number 180. It was determined that the radial and tangential cross-sections, roughness and adhesion strengths differ according to the tree species. Mercan (2012) investigated the adhesion resistance of various varnishes applied to some natural wood species in our country. As a result, polyurethane varnish had the highest film thickness, followed by acrylic and cellulosic varnishes, with slightly lower values. According the varnish types, the adhesion strengths were 3.22 N mm^{-2} for polyurethane varnish, 1.96 N mm^{-2} for acrylic varnish and 0.80 N mm^{-2} for cellulosic varnish. Eastern beech showed higher values of adhesion resistance for wood species. Tekin (2009) investigated the wear resistance of various varnish layers used in wood materials and found that it differed according to the kind of wood, varnish type and layer thickness. The wood and varnish types were effective in the first degree and the layer thickness was the second most effective in terms of abrasion resistance. It has been stated that the application of black walnut coated with three layers of acid hardener varnish will provide an advantage in wooden parquets and floor coverings, where abrasion resistance is essential. According to Bayram (2004), the effect of moisture amount, wood type and varnish type on the adhesion resistance of varnishes applied to wood material surfaces with different moisture contents was found to be significant and the highest adhesion strength was obtained in polyurethane varnish applied to oak at 8% humidity. According to Yakın (2001), the hardness, gloss and surface adhesion strength of water-based varnishes were lower than those of solvent-based (VOC) varnishes and application differentiation did not affect the physical properties of the varnished. The highest hardness was obtained for the acrylic emulsion (A1) varnish on beech

wood. The highest values were observed for pine in the gloss measurements parallel to the fibres and for oak in the measurements perpendicular to the fibres. According to Budakçı (1997), increasing the protective layer thickness had no significant effect on hardness in third-layer applications: however, it did cause an increase in gloss. In polymer-based varnishes, an increase in the layer strength increases the adhesion strength to the surface. According to Bulut (1996), the most used wood materials in the woodworking industry are oak, pine and beech. The most widely used varnish types are acid-hardened, one-component, two-component polyurethane, cellulosic and synthetic varnishes. After coating all the surfaces of the wooden samples with varnish, they were immersed in cold water at 20 °C for 2, 24, 48, 72 and 144 hours to determine their weight, thickness and width changes. Oak and two-component polyurethane varnish demonstrated the best resistance to water permeability. Wooden materials are preferred in shipyards that produce yachts with specific properties. However, some deterioration is observed in wood, as its structure is exposed to various effects over time. For this reason, wood must be protected to increase its resistance to the effects of fungi, insects, marine organisms, seawater, sunlight and other climatic conditions. Natural and artificial preservatives, such as varnishes, impregnation, paints and surface coating materials, including fiber and epoxy, are some of the protection methods. To eliminate these problems, the expensive yachts, for which substantial budgets are allocated every year, are towed to the boatyard's dry dock areas for maintenance and repair. The wood used in the construction of traditional wooden yachts should be long-lasting and have a good artistic, aesthetic and natural appearance. Considering these priorities, varnishing has emerged as a key method for producing a protective coating due to of its transparency. Aesthetic and natural appearance have an essential place in sailing boats such as gullet's, ketch and trandil, which are produced in our country, especially in the Aegean Region. In this study, the colour change of protective layers formed with multiple types of varnish on different types of wood used in wooden yacht production after rapid ageing and the determination of colour information under the effect of detail and salt water fog were investigated. The purpose of this study was to determine the type of varnish that provides the best protective layer performance based on the wood species used in the wooden yacht manufacturing industry in our country.

2. Material and Methods

2.1. Material

In this study, limba (*Combretaceae terminalia superba*), chestnut (*Castanea sativa* Mill.) and Sapelli (*Entandrophragma cylindricum*) woods, which are commonly used in shipyards and workshops to build wooden yachts, were selected as experimental materials for preparing the experimental samples. Experimental samples were randomly selected from Izmir Karabağlar as 1st class. One of the most preferred varnish types in the manufacture of wooden yachts in experiments was yacht varnish, followed by polyurethane varnish and epoxy varnish. Viscosity cups: Flow cups used to measure viscosity, or consistency, are the most widely used today, standardized by the German Standards Institute (DIN). Viscosity measurements were made following the manufacturer's recommendations and a DIN 4 viscosity cup was used for this purpose. Application viscosities were determined as 18 sec/DIN Cup 4/20±2.While preparing the varnishes for application conditions, the mixing ratios were made in accordance with the recommendations of the manufacturers and in a way that would not negatively affect the layer performance in the Table 1.

Table 1. Varnish application conditions

Varnishes	Varnish/Hardener (g)	Temperature (°C)	Viscosity (with DIN-4) (seconds)
Yacht varnish	65/35	20	18
Polyurethane varnish	75/25	20	18
Epoxy varnish	60/40	20	18

During the use of varnishes, attention was paid to the warnings of the manufacturer. The test samples were varied according to the principles specified in the ASTM D 3023 standard (ASTM, 2011).

2.2. Experiment design used in the study

In this study, a protective layer was created with three different varnish types (yacht varnish, polyurethane varnish and epoxy varnish) on three tree species (limba, chestnut and sapelli) and three different performance values of these protective layers (color change after rapid aging, gloss measurement and gloss change after salt fog) were investigated. A total of 135 specimens and five replicates for each sample were prepared and tested. The experimental design is presented in Table 2.

Table 2. Trial design used in the study

		Tier performance testing		
Species	Varnish type	Color change in the effect of rapid aging	Gloss measurement	Brightness change in the effect of salt fog
Limba	Polyurethane	5	5	5
	Yacht	5	5	5
	Epoxy	5	5	5
Chestnut	Polyurethane	5	5	5
	Yacht	5	5	5
	Epoxy	5	5	5
Sapele	Polyurethane	5	5	5
	Yacht	5	5	5
	Epoxy	5	5	5

2.3. Preparation of experimental samples

Experimental samples were prepared from first-class wood material with smooth fibers, no knots, no cracks, no color and density difference, annual rings perpendicular to the surfaces and sapwood parts according to TS 2470 (1976) principles. The experimental samples were kept in an air-conditioned cabinet at 20 ± 2 °C and 65 ± 5 % relative humidity until they reached a constant weight and the equilibrium humidity was ensured to be 12 % (air dry) on average. The dimensions of the experimental samples are listed in Table 3.

Table 3. Dimensions of the test samples

Tests	Relevant standard	Size (mm)	Number of specimens
Color change after rapid aging	ASTM D 4587-11 (ASTM, 2019)	150 x 75 x 5	45
Gloss measurement	EN-13722 (EN, 2004)	150 x 75 x 5	45
Brightness change after salt fog	ASTM B 117 and ASTM D 1654 (ASTM, 2018)	150 x 100 x 10	45

Wood panels: As this was repeated five times on three different wood materials and three different varnishes, 45 pieces were prepared for each test. For all tests, 135 pieces were cut into the desired dimensions. Examples of rapid aging and gloss measurement tests and measurements of the test samples are shown in Figure 1.

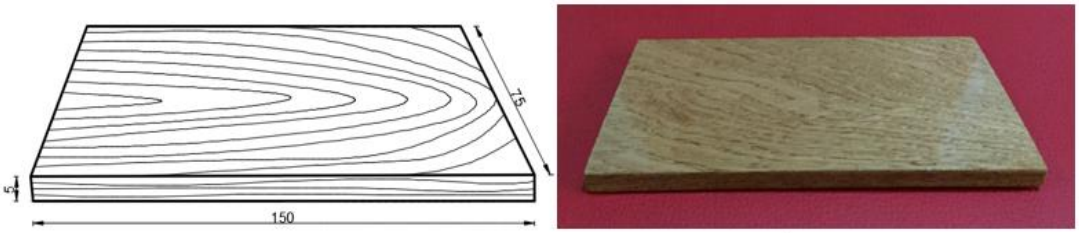


Figure 1. Specimens' specifications: a) size and b) Rapid ageing and gloss measurement test samples specimens

The measurements of the test samples prepared for the saltwater fog test and the determination of the brightness changes in the test samples after this test and the real images of the test samples are shown in Figure 2.

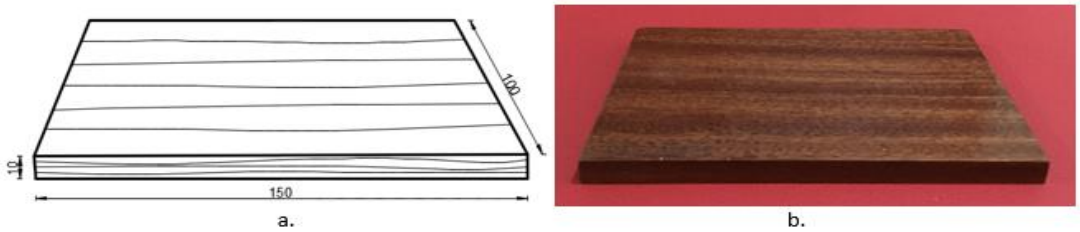


Figure 2. Specimens' specifications: a) size and b) Experimental samples of brine fog test gloss measurement.

The test samples, which were cut into the dimensions specified for the tests, were kept in an environment of 20 ± 2 °C and 65 ± 5 % relative humidity until they reached a humidity level of approximately 12 %. Humidity controls of the test samples were made according to TS 2471 (1976) and their densities were determined according to TS 2472 (1976). To prepare the test samples for surface treatment, their surfaces were first sanded with 80 grit sandpaper and then with 100 grit sandpaper. The sanded surfaces were cleaned with a soft bristle brush and compressed air before varnishing and were prepared for varnishing.

The prepared test samples were varnished with yacht varnish, polyurethane varnish and epoxy varnish as surface finishes. Three coats (2 coats of 100 g m^{-2} Filler and 100 g m^{-2} Topcoat) were applied to each test sample. The varnishes were applied using a spray gun according to the manufacturer's recommendations, using the appropriate air pressure and a spray gun tip opening, at a height of 20 cm from the test sample surface and at a uniform speed, perpendicular and parallel to the surface. In the varnishing process, the same amount of varnish was applied to both faces and edges of the samples and the samples were left to dry for 3 weeks under laboratory conditions to ensure complete drying, especially in the polyurethane varnish, before the trials.

2.4. Conducting the experiments

2.4.1. Rapid aging test

"Accelerated Weathering Tester (QUV/SPRAY)" device was used for rapid aging experiments in Figure 3. The operating conditions of the accelerated aging device consist of two phases. The first is the condensation phase. This phase simulates outdoor conditions by varying the temperature, coldness and humidity levels of the environment at specific intervals, spraying hot steam onto the sample pieces to cause them to expand. The second phase is the UV phase. Fast aging process: This process was applied for 4 h in the condensation period and 8 h in the UV period. Color measurements were performed according to the ASTM D 4587-11 (ASTM, 2019) standard for 50 h and 100 h periods.



Figure 3. Accelerated aging test device (QUV/SPRAY)

2.4.2. Luminance measurement test

The gloss measurement test was performed on a total of 45 test samples, consisting of 5 each of limba, chestnut and sapele woods, each with varnish applied, measuring (150x75x5) mm. Luminosity measurements were performed using the light-reflecting abilities of the varnished samples. The gloss measurements of the test samples were taken from five different points using a gloss measuring device BYK Gardner with a 60 degrees measurement angle. The arithmetic mean of the measurements was calculated using the brightness values.

2.4.3. Salt water fog test

The test samples, which were painted with a mixture of natural paint and liquid glass, were sprayed with solutions containing 5 % NaCl at regular intervals on the painted objects, which were kept in the test chamber atmosphere at a constant temperature of 35 °C according to the ASTM B 117 (ASTM, 2018) and ASTM D 1654 (ASTM, 2016) standards. The general appearance of the test panels, which were kept for 144 h in the salt-water mist environment created in the test chamber, was examined in terms of defects such as colour change, bubbling and rust progression under the film. The test period was applied at 24 hours intervals.

3. Results and Discussion

3.1. Color change findings after rapid aging

The results of multiple variance analyses performed to determine the changes in the color measurement values of the test samples after 50 h and 100 h of rapid aging by wood type, varnish type and the binary interaction of these factors are given in Table 4. According to the results of the variance analysis, as a result of the rapid aging (50 h and 100 h) test of wood type and varnish type, the effects on color change were found to be statistically significant for 0.05 error probability. The bilateral interactions were also significant. When the calculated F values are examined, it is understood that the most effective factor on the color change data obtained after 50 and 100 h of rapid aging test is the tree type, followed by the varnish type. The comparison of the average tree species for the LSD value (0.1283 and 0.1639) is given in Table 5.

Table 4. Analysis of multiple variances on rapid aging test color change

Experiment	Variance sources	Degrees of freedom	Sum of squares	Mean squares	F value	Probability of error p < 0.05
50 hours rapid aging	Tree type	2nd	3.510	1.755	59.2373	0.0000*
	Varnish type	2nd	2.065	1.033	34.8548	0.0000*
	Wood type x Varnish type	4	0.846	0.212	7.1401	0.0002
	Error	36	1.067	0.030	-	-
	Total	44	7.489	-	-	-
100 hours fast aging	Tree type	2nd	5.374	2.687	54.9061	0.0000
	Varnish type	2nd	4.156	2.078	42.4626	0.0000
	Wood type x Varnish type	4	0.866	0.217	4.4244	0.0052
	Error	36	1.762	0.049	-	-
	Total	44	12.159	-	-	-

Table 5. Comparison results by tree type

Tree type	Color change after 50 hours		Color change after 100 hours	
	$\overline{X}$	HG	$\overline{X}$	HG
Limba	0.4633	C	0.6053	C
Chestnut	0.8633	B	1.0540	B
Sapele	1.1440	A	1.4510	A
	LSD ± 0.1283		LSD ± 0.1639	

While the greatest color change occurred in the experimental samples prepared from sapele, the colour change rates in the experimental samples prepared from limba had the lowest values. An increase in the rapid aging time increased the color change values of the test samples. A comparison of the averages of the effects of the varnish type on the color change values after the rapid aging test for the LSD values of 0.1283 and 0.1639 is given in Table 6.

Table 6. Quick comparison results by varnish type

Varnish Type	Color change after 50 hours		Color change after 100 hours	
	$\overline{X}$	HG	$\overline{X}$	HG
Polyurethane	0.6880	B	0.8260	B
Yacht varnish	0.6567	B	0.8180	B
Epoxy	1.1260	A	1.467	A
	LSD ± 0.1283		LSD ± 0.1639	

The differences between the color change values of the test samples varnished with polyurethane varnish and yacht varnish were found to be statistically insignificant. The highest color change values were obtained for the experimental samples prepared with epoxy varnish. A comparison of the mean of the effects of the wood type–varnish-type binary interaction on the colour change values after the rapid aging test for the LSD values of 0.2222 and 0.2839 is given in Table 7.

Table 7. Comparison results according to the binary interaction of wood type and varnish type.

Tree type	Varnish Type	Color Change After 50 Hours		Color Change After 100 Hours	
		$\overline{X}$	HG	$\overline{X}$	HG
Limba	Polyurethane	0.1900	D	0.2240	D
	Yacht varnish	0.2360	D	0.3180	D
	Epoxy	0.9640	B	1.2740	B
Chestnut	Polyurethane	0.6700	C	0.8360	C
	yacht varnish	0.7060	C	0.8620	C
	Epoxy	1.2140	A	1.4640	AB
Sapele	Polyurethane	1.2040	A	1.4180	AB
	yacht varnish	1.0280	AB	1.2740	B
	Epoxy	1.2000	A	1.6620	A
		LSD ± 0.2222		LSD ± 0.2839	

Table 7 shows, after 50 h of rapid aging, the color change value in Chestnut test samples varnished with epoxy varnish gave the highest value with 1.2140, while the color change value in Limba test samples varnished with polyurethane varnish was the lowest with 0.1900. The differences between the color change values of the Limba test samples, which were varnished with polyurethane varnish or yacht varnish, were found to be statistically insignificant. Varnished with epoxy varnish. After 100 h of rapid aging, the color change value in Sapelli test samples varnished with epoxy varnish gave the highest value with 1.6620, while the color change value in Limba test samples varnished with polyurethane varnish was the lowest with 0.2240. The differences between the color change values of the Limba test samples varnished with polyurethane varnish or yacht varnish were also found to be statistically insignificant here.

3.2. Brightness test findings

The results of the multiple variance analysis performed to determine the effects of wood type, varnish type and the dual interaction of these factors on the gloss values of the experimental samples are presented in Table 8.

Table 8. Wood type-varnish type gloss values multi variance analysis

Experiment	Variance Sources	Degrees of Freedom	Sum of Squares	Mean Squares	F Value	Probability of Error $p < 0.05$
Brightness Test	Tree type	2nd	466.220	233.110	18.3662	0.0000*
	Varnish	2nd	3073.814	1536.907	121.0894	0.0000*
	Wood Type x Varnish Type	4	89.858	22.465	1.7699	0.1563
	Error	36	456.924	12.692		
	Total	44	4086.816			

According to the results of the variance analysis, the effects of tree type and varnish type main factors on gloss values were found to be statistically different with 0.05 error margin. The effect of the wood type varnish type binary interaction on the gloss values was not statistically significant. When the F values were examined, the most effective factor on the gloss values was the varnish type, followed by the wood type. A comparison of the averages of the effects of the tree species on the brightness values for the LSD value of 2.638 is given in Table 9.

Table 9. Comparison results of average brightness values by tree species

Tree type	Brightness value	
	$\overline{X}$	HG
Limba	88.93	A
Chestnut	86.69	A
Sapele	81.27	B
LSD ± 2. 638		

While the experimental samples prepared from Limba showed the highest gloss values numerically, the gloss values of the test samples prepared from Sapele were the lowest. The differences between the brightness values of the experimental samples prepared from lime and chestnut were scientifically insignificant. Limba trees were affected 9 % more than Sapele trees and 3 % more than chestnut trees. Chestnut trees were affected by 6 % more than sapele trees. A comparison of the averages of the effects of the varnish type on the gloss values for an LSD value of 2.638 is given in Table 10.

Table 10. Comparison results of average gloss values according to varnish type.

Varnish Type	Luminosity value (GU)	
	$\overline{X}$	HG
Polyurethane	81.61	B
Yacht varnish	78.14	C
Epoxy	97.15	A
LSD ± 2.638		

Accordingly, although the test samples varnished with epoxy varnish had the highest gloss values, the lowest gloss values were obtained for the samples varnished with yacht varnish.

3.2.1. Findings of brightness change after salt fog test

Table 11 shows the results of the multiple variance analysis performed to determine the effects of wood type, varnish type and the binary interaction of these factors on the gloss change values of the experimental samples after the salt-fog test.

Table 11. Analysis of multiple variances for salt mist test of wood type and varnish type

Experiment	Variance Sources	Degrees of Freedom	Sum of Squares	Center Squares.	F value	Probability of Error p < 0.05
Salt fog	Tree type	2nd	706.466	353.233	8.4479	0.0010
	Varnish Type	2nd	265.727	132.864	3.1775	0.0536
	Tree Type x Varnish Type	4	620.022	155.006	3.7071	0.0126
	Error	36	1505.278	41.813	-	-
	Total	44	3097.493		-	-

According to the results of the variance analysis, the effects of wood type and wood type varnish type interaction on the gloss change rate as a result of the salt water fog test were found to be statistically significant for the 0.05 error probability. The effects of the varnish-type main factor on the gloss change rate after salt fog were not significant, with a margin of error of 0.05. When the calculated F values are examined, it is understood that the most effective factor on the brightness change rates obtained after the saltwater mist

experiment is the tree species and then the binary interaction. A comparison of the mean effects of the tree species on the brightness change rates after the saltwater mist test for the LSD value of 4.789 is given in Table 12.

Table 12. Salt fog test comparison results by tree type

Tree type	Brightness change rate (%)	
	$\overline{X}$	HG
Limba	36.39	B
Chestnut	45.57	A
Sapele	43.70	A
LSD ± 4.789		

The experimental samples prepared from limba had the lowest brightness change ratio values, while the brightness change ratio values of the experimental samples prepared from chestnut were found to be the highest. A comparison of the wood type-varnish-type binary interaction for the gloss change after the salt–water mist test for the LSD value of 8.294 is given in Table 13.

Table 13. Wood type x varnish type binary interaction salt water mist test comparison results

Tree type	Varnish Type	Brightness Change Rate (%)	
		$\overline{X}$	HG
Limba	Polyurethane	45.33	AB
	Yacht varnish	31.22	C
	Epoxy	32.62	C
Chestnut	Polyurethane	42.95	AB
	Yacht varnish	46.01	AB
	Epoxy	47.76	A
Sapele	Polyurethane	47.48	A
	Yacht varnish	45.21	AB
	Epoxy	38.42	BC
LSD ± 8.294			

According to the results of the pairwise comparison, the lowest gloss change rate was found in the experimental samples prepared from Limba varnished with yacht varnish or epoxy varnish after the effect of saltwater mist and the highest gloss change rates were observed with epoxy varnish.

4. Conclusion

Wooden materials are often preferred in shipyard yachts due to their advantageous features. However, some deterioration is seen in the structure of wood materials due to the influence of various biotic and abiotic factors. For this reason, it is necessary to increase the strength of the wood because of the effects of fungi, insects, sea creatures, sea water, sunlight and other climatic conditions. Natural and artificial protectors such as varnish, impregnation, paint and surface coating materials such as fibre and epoxy are some of the methods of protecting wood materials. Especially, it is demanded that the wood used in the construction of traditional wooden yacht is long-lasting and the aesthetic and natural appearance is also good. When these priorities are considered transparent, varnishing stands out in forming protective layer. Based on the test results, the layer performance values of the test samples were calculated at the end of each cycle and it was determined that the accelerated aging process had statistically significant effects on layer performance. The most influential factor on the colour change data obtained was the wood type, followed by the varnish type. However, considering that all

varnishes exhibited the lowest colour change on Limba wood and the highest on Sapele wood, it was determined that varnishes exhibited less colour change on light-coloured woods than on darker woods. The most influential factor on the colour change data obtained was the wood type, followed by the varnish type. The highest gloss values for all varnishes were observed on Limba, chestnut and Sapele woods, respectively. This can be interpreted as indicating that light-coloured woods are more effective in gloss values than darker woods. In the yacht building industry, epoxy varnish is recommended for surfaces requiring a glossy finish on light-coloured woods like Limba. In general, where minimal colour change is desired, yacht varnish and especially polyurethane varnish, is recommended over epoxy varnish and light-coloured woods are recommended as wood materials. It appears that the most influential factor on the gloss change rates obtained after the saltwater fog test is the wood type, followed by the binary interaction. It has been observed that selecting the appropriate varnish for the wood species used in yacht construction enhances the protective layer performance on the wood surface. Epoxy varnish is the most affected by saltwater fog testing among all wood types. Polyurethane varnish is the least affected by saltwater fog testing on Limba and Chestnut wood, while yacht varnish is the least affected by saltwater fog testing on sapele wood. In the yacht building industry, it is recommended that polyurethane varnish and yacht varnish be used on areas exposed to waves and seawater, while epoxy varnish should be avoided in these areas.

Declaration of Author Contributions

Mehmet Colak: Conceptualization, methodology, investigation, formal analysis, doing experiments, testing, writing, original draft preparation; Murat Altiparmak: Conceptualization, methodology, investigation, formal analysis, doing experiments, testing, writing, original draft preparation, supervision, review and editing.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

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