Электронный архив УГЛТУ

Леса России и хозяйство в них. 2025. № 1 (92). С. 182–190.
Forests of Russia and economy in them. 2025. № 1 (92). P. 182–190.

Научная статья
УДК 674.07
DOI : 10.51318/FRET.2025.92.1.020

ПРИМЕНЕНИЕ ГУММИАРАБИКА К ТЕРМИЧЕСКИ ОБРАБОТАННОЙ ДРЕВЕСИНЕ СКАЛЬНОГО ДУБА (*QUERCUS PETRAEA*)

Хусейн Пекер[1], Осман Чамлибел[2], Гёксел Улай[3], Умит Аята[4]

[1] Университет Артвин Чорух, Артвин, Турция
[2] Университет Кириккале; Кириккальский профессиональный колледж, Кириккале, Турция
[3] Университет Ван Юзюнкюзюль; Ванский профессиональный колледж, Ван, Турция
[4] Байбуртский университет, Байбурт, Турция
[1] peker100@artvin.edu.tr, http://orcid.org/0000-0002-7771-6993
[2] osmancamlibel@kku.edu.tr, https://orcid.org/0000-0002-8766-1316
[3] gokselulay@gmail.com, https://orcid.org/0000-0003-4080-8816
[4] umitayata@yandex.com, http://orcid.org/0000-0002-6787-7822

Аннотация. Гуммиарабик широко используется в различных областях, таких как стабилизатор пищи, производство красок и лаков, покрытие и сцепление древесных поверхностей, художественная реставрация, покрытие фармацевтических таблеток, связующее средство в косметике и укрепление бумаги. В данном исследовании были изучены изменения цветовых параметров и индекса белизны (WI^*) поверхностей, полученных после нанесения приготовленного раствора гуммиарабика на термически обработанные и необработанные поверхности древесины дуба скального (*Quercus petraea*). Поверхности, обработанные гуммиарабиком, были сравнены с необработанными поверхностями. Согласно результатам, анализы дисперсии для всех испытаний оказались значимыми. Значения ΔE^*, вычисленные с использованием формул, составили 8,82 для необработанных образцов с нанесенным гуммиарабиком и 15,23 для термически обработанных образцов с нанесенным гуммиарабиком. Были обнаружены уменьшения значений WI^*, $h°$ и L^* в обоих направлениях для обоих типов образцов с нанесением гуммиарабика, в то время как значения a^* увеличились. Кроме того, нанесение гуммиарабика на необработанные образцы привело к увеличению значений b^* и C^*, в то время как для термически обработанных образцов наблюдалось снижение этих параметров. Было установлено, что термическая обработка и применение гуммиарабика изменяют поверхностные свойства древесины.

Ключевые слова: скальный дуб, гуммиарабик, цвет, индекс белизны

Для цитирования: Применение гуммиарабика к термически обработанной древесине скального дуба (*Quercus petraea*) / Х. Пекер, О. Чамлибел, Г. Улай, У. Аята // Леса России и хозяйство в них. 2025. № 1 (92). С. 182–190.

© Пекер Х., Чамлибел О., Улай Г., Аята У., 2025

Электронный архив УГЛТУ

Original article

APPLICATION OF GUM ARABIC TO HEAT-TREATED SESSILE OAK (*QUERCUS PETRAEA*) WOOD

Hyuseyin Peker[1], Osman Chamlibel[2], Gyoksel Ulay[3], Umit Ayata[4]

[1] Artvin Choruh University, Artvin, Turkey
[2] Kyrykkale University; Kyrykkale Vocational School, Kyrykkale, Turkey
[3] Van Yuzuncu Yil University; Van Vocational School, Van, Turkey
[4] Bayburt University, Bayburt, Turkey
[1] peker100@artvin.edu.tr, http://orcid.org/0000-0002-7771-6993
[2] osmancamlibel@kku.edu.tr, https://orcid.org/0000-0002-8766-1316
[3] gokselulay@gmail.com, https://orcid.org/0000-0003-4080-8816
[4] umitayata@yandex.com, http://orcid.org/0000-0002-6787-7822

Abstract. Gum arabic is widely used in various fields such as food stabilizer, paint and varnish production, wood surface coating and adhesion, art restoration, pharmaceutical tablet coating, cosmetic binder, and paper strengthening. In this study, changes in color parameters and whiteness index (*WI**) properties of surfaces obtained after applying a prepared gum Arabic solution on thermally treated and untreated sessile oak (*Quercus petraea*) wood surfaces were investigated. Surfaces treated with gum Arabic were compared to untreated surfaces. According to the results, variance analyses for all tests were found to be significant. The Δ*E** values calculated using formulas were determined to be 8,82 for untreated + gum Arabic-applied samples and 15,23 for thermally treated + gum Arabic-applied samples. Decreases were observed in *WI**, *h*°, and *L** values in both directions for both thermally treated and untreated samples with gum Arabic application, while increases were found in *a** values. Additionally, the application of gum Arabic to untreated samples caused increases in *b** and *C** parameters, whereas decreases in these parameters were observed for thermally treated samples. It was found that the application of thermal treatment and gum Arabic altered the surface properties of the wood.

Keywords: sessile oak, gum arabic, color, whiteness index

For citation: Application of gum arabic to heat-treated sessile oak (*Quercus petraea*) wood / H. Peker, O. Chamlibel, G. Ulay, U. Ayata // Forests of Russia and economy in them. 2025. № 1 (92). P. 182–190.

Introduction

Wood has been one of the most accessible and renewable resources throughout human history. In modern times, wood consumption outpaces all other materials. The industry producing a variety of wooden products continues to expand. While green wood serves as a primary raw material for numerous products, its characteristics impose certain limitations on its use. For instance, wood shrinks and may crack during drying, is highly hygroscopic, and is susceptible to decay, fire, and other damages. Among various wood processing methods, two main approaches dominate the production of most wood-based products: the removal of liquids (e. g., dehydration, drying, extraction) and the addition of specific substances to wood in liquid or vapor form (Kozhin and Gorbachev, 2011).

Thermal treatment is a wood modification technique designed to improve properties such as dimensional stability, water resistance, and biological durability without relying on harmful chemicals. In recent years, the rising demand for non-toxic, high-performance wood products has increased the popularity of thermally treated wood. Today, thermally modified wood is widely used in applications such as solid flooring, exterior cladding, decking, sauna/wall

Электронный архив УГЛТУ

panels, windows/doors, and garden furniture. The process, also known as thermal modification, involves controlled pyrolysis at high temperatures (between 180 °C and 240 °C) in an oxygen-free environment using steam, nitrogen, or oil to prevent combustion (Homan and Jorissen, 2004; Jirouš-Rajković and Miklečić, 2019).

The formation of gums is commonly explained through three primary theories. The first suggests that gums form naturally through a process called "gummosis", where internal plant tissues deteriorate, leading to cavity formation and the exudation of transformed carbohydrates known as gums. The second theory posits that gums are produced in response to injuries in the bark or trunk. The third explanation links gum formation to fungal or bacterial attacks on the plant. Most gums exude from the trunk, while only a few are sourced from roots, leaves, or other parts of the plant. These gums decompose completely upon heating without melting and are found in a diverse group of plant families (Goswami and Naik, 2014).

Most commercial gum Arabic is obtained from Sudan, which supplies 80–90 % of the global market. This percentage may vary depending on availability. The gum Arabic sourced from Sudan is known to be produced from *Acacia senegal* var. *senegal*, whose physical, chemical, and functional properties are well understood. Recently, it has been demonstrated that some varieties of A. senegal also produce gum Arabic of comparable quality to that obtained from Sudan. Commercial gum Arabic from Kenya, on the other hand, is produced from A. senegal var. kerensis (Chikamai, Banks, 1993; Processing of gum Arabic…, 1996).

The physical properties of gum Arabic can vary based on factors such as the origin and age of the trees, the duration of exudation, and climatic conditions. Post-harvest processes, such as washing, drying, sun bleaching, and storage conditions, also influence the physical properties of gums (Characterization and properties…, 2007; Musa et al., 2018). It is evident that gums derived from different species (*A. senegal* and *A. seyal*) inherently exhibit distinct characteristics. Even within the same species, different varieties and individuals from various regions produce gums with differing properties. Recognizing these species, varietal, and environmental differences plays a crucial role in the production of gum Arabic for specific end-use applications (Chikamai, 1997; Yebeyen et al., 2009).

In the literature, no research has been found regarding whether solutions prepared with gum Arabic exhibit color-altering effects when applied to thermally treated wood surfaces.

In this study, changes in color parameters and whiteness index (*WI**) properties were investigated on the surfaces of thermally treated and untreated sessile oak (*Quercus petraea*) wood after the application of a gum Arabic solution.

Materials and Methods

Sessile oak (*Quercus petraea*) wood samples were prepared with dimensions of 100 mm × 100 mm × × 20 mm, and the samples were conditioned according to the ISO 554 (1976) standard. The thermal treatment of the wood materials was carried out at a temperature of 212 °C for 1 h by a specialized company. Both the wood materials and gum Arabic were procured from a commercial supplier.

In a glass container, 20 g of ground gum Arabic were combined with 100 ml of distilled water and boiled for 20 min. After boiling, the mixture was filtered using cheesecloth to obtain a pure solution. The sample surfaces were sanded using a vibrating sander with 80, 120, and 150 grit sandpapers. Subsequently, the prepared solution was applied as a single coat to the wood surfaces using a brush.

Whiteness index (*WI**) values were measured using a Whiteness Meter BDY-1 device (ASTM E313-15e1, 2015). Color changes were measured with a CS-10 device (CHN Spec, China) [CIE D65 light source, CIE 10° standard observer; illumination system: 8/d] (ASTM D2244-3, 2007). The chroma difference or saturation difference was denoted as ΔC^*, and the hue difference or shade difference was denoted as ΔH^* (Lange, 1999).

The total color differences were calculated using the following formulas.

$$C^* = \left[\left(a^*\right)^2 + \left(b^*\right)^2 \right]^{0.5}, \quad (1)$$

$$h^o = arctan \left(b^*/a^*\right), \quad (2)$$

Электронный архив УГЛТУ

$$\Delta C^* = (C^*_{sample\ with\ prepared\ solution} - C^*_{control}), \quad (3)$$

$$\Delta a^* = (a^*_{sample\ with\ prepared\ solution} - a^*_{control}), \quad (4)$$

$$\Delta L^* = (L^*_{sample\ with\ prepared\ solution} - L^*_{control}), \quad (5)$$

$$\Delta b^* = (b^*_{sample\ with\ prepared\ solution} - b^*_{control}), \quad (6)$$

$$\Delta H^* = \left[(\Delta E^*)^2 - (\Delta L^*)^2 - (\Delta C^*)^2 \right]^{0.5}, \quad (7)$$

$$\Delta E^* = \left[(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2 \right]^{0.5}. \quad (8)$$

Definitions of other parameters are provided in Table 1, and the color change range according to Jirouš and Ljuljka (1999) is presented in Table 2 (Lange, 1999).

Variance analyses, homogeneity groups, mean values, standard deviations, maximum and minimum values, and percentage (%) change rates were obtained using a statistical program. Ten measurements were taken per test.

Table 1

Descriptions for Δ*L**, Δ*a**, Δ*b**, and Δ*C** (Lange, 1999)

Parameter	In negative case	In positive case
Δ*L**	Darker than reference	Lighter than reference
Δ*b**	Bluer than reference	More yellow than reference
Δ*C**	Matte, more blurred than reference	Clearer, brighter than reference
Δ*a**	Greener than reference	Redder than reference

Table 2

Color change range according to Jirouš and Ljuljka (1999)

Δ*E** Range	Color Change Estimation	Δ*E** Range	Color Change Estimation
< 0,20	Unnoticeable	3,00–6,00	Very noticeable
0,20–0,50	Very slight	6,00–12,00	Intense
0,50–1,50	Light	> 12,00	Very intense
1,50–3,00	Noticeable	–	–

Results and Discussion

The results of the analysis of variance are shown in Table 3. For all tests, thermal treatment (A), Arabic gum application (B), and the interaction (AB) were found to be significant (Table 3).

The measurement results for the color parameters are presented in Table 4. The application of gum Arabic to control samples resulted in a 12,37 % decrease in *L** values, while a 29,64 % decrease was observed in thermally treated experimental samples. This indicates a darkening effect on the wood surfaces. The highest *L** values (60,31) were found in untreated and gum Arabic-free samples, whereas the lowest *L** values (30,26) were recorded in thermally treated samples with gum Arabic application (Table 4).

For the *a** parameter, gum Arabic application caused increases of 53,59 % in control samples and 12,22 % in thermally treated samples. This demonstrates the red-enhancing effect of gum Arabic on the wood surface. The lowest *a** values (6,12) were observed in untreated and gum Arabic-free samples, while the highest *a** values (11,94) were found in thermally treated samples with gum Arabic application (Table 4).

In terms of *b** values, gum Arabic application led to a 16,20 % increase in the control samples but a 44,20 % decrease in the thermally treated samples. The highest *b** values (24,24) were obtained from untreated samples with gum Arabic, while the lowest *b** values (10,39) were observed in thermally treated samples with gum Arabic application (Table 4).

Электронный архив УГЛТУ

Table 3

Results of variance analysis (*: Significant)

Test	Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F Value	α ≤ 0.05
*L**	Thermal Treatment (A)	3978,230	1	3978,230	21949,762	0,000*
	Varnish Application (B)	1021,211	1	1021,211	5634,502	0,000*
	Interaction (AB)	69,934	1	69,934	385,858	0,000*
	Error	6,525	36	0,181	–	–
	Total	91952,280	40	–	–	–
	Corrected Total	5075,900	39	–	–	–
*a**	Thermal Treatment (A)	124,538	1	124,538	1290,672	0,000*
	Varnish Application (B)	52,395	1	52,395	543,006	0,000*
	Interaction (AB)	9,702	1	9,702	100,551	0,000*
	Error	3,474	36	0,096	–	–
	Total	3817,230	40	–	–	–
	Corrected Total	190,110	39	–	–	–
*b**	Thermal Treatment (A)	647,140	1	647,140	2555,432	0,000*
	Varnish Application (B)	58,782	1	58,782	232,119	0,000*
	Interaction (AB)	337,038	1	337,038	1330,900	0,000*
	Error	9,117	36	0,253	–	–
	Total	14783,919	40	–	–	–
	Corrected Total	1052,077	39	–	–	–
*C**	Thermal Treatment (A)	274,105	1	274,105	903,315	0,000*
	Varnish Application (B)	4,577	1	4,577	15,082	0,000*
	Interaction (AB)	243,690	1	243,690	803,084	0,000*
	Error	10,924	36	0,303	–	–
	Total	18604,722	40	–	–	–
	Corrected Total	533,295	39	–	–	–
h°	Thermal Treatment (A)	4237,216	1	4237,216	9776,844	0,000*
	Varnish Application (B)	1452,387	1	1452,387	3351,199	0,000*
	Interaction (AB)	518,328	1	518,328	1195,977	0,000*
	Error	15,602	36	0,433	–	–
	Total	154706,288	40	–	–	–
	Corrected Total	6223,533	39	–	–	–
*WI** ⊥	Thermal Treatment (A)	993,012	1	993,012	4992,102	0,000*
	Varnish Application (B)	427,062	1	427,062	2146,941	0,000*
	Interaction (AB)	63,252	1	63,252	317,984	0,000*
	Error	7,161	36	0,199	–	–
	Total	5894,190	40	–	–	–
	Corrected Total	1490,488	39	–	–	–

Электронный архив УГЛТУ

The end of table 3

Test	Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F Value	α ≤ 0.05
*WI** ‖	Thermal Treatment (A)	437,053	1	437,053	14897,284	0,000*
	Varnish Application (B)	255,126	1	255,126	8696,160	0,000*
	Interaction (AB)	91,870	1	91,870	3131,444	0,000*
	Error	1,056	36	0,029	–	–
	Total	1579,164	40	–	–	–
	Corrected Total	785,105	39	–	–	–

For the *C** parameter, the highest values (26,00) were recorded in untreated samples with gum Arabic application, whereas the lowest values (15,33) were found in thermally treated samples with gum Arabic. Gum Arabic application resulted in a 19,60 % increase in *C** for control samples but a 26,17 % decrease for thermally treated samples (Table 4).

The h^o parameter values decreased by 6,60 % in control samples and by 31,94 % in thermally treated samples after gum Arabic application. The highest h^o values (73,65) were observed in untreated and gum Arabic-free samples, while the lowest h^o values (41,01) were noted in thermally treated samples with gum Arabic application (Table 4).

For samples treated with gum Arabic, the whiteness index (*WI**) significantly decreased, and parallel-to-grain measurements dropped to nearly zero. This clearly demonstrates the darkening effect of gum Arabic on the surface (Table 4).

Table 4

Measurement results for color parameters and whiteness index

Test	Treatment	Arabic gum application	Mean	Change (%)	Homogeneity group	Standard deviation	Minimum	Maximum	Coefficient of variation
*L**	Control	No	60,31	↓12,37	A*	0,30	59,84	60,85	0,49
		Yes	52,85		B	0,47	51,98	53,84	0,89
	212 °C for 1 h	No	43,01	↓29,64	C	0,37	42,18	43,52	0,86
		Yes	30,26		D**	0,52	29,76	31,56	1,73
*a**	Control	No	60,31	↑53,59	D**	0,17	5,88	6,39	2,80
		Yes	52,85		C	0,29	8,87	9,79	3,09
	212 °C for 1 h	No	43,01	↑12,22	B	0,41	9,87	11,24	3,82
		Yes	30,26		A*	0,33	11,48	12,44	2,75
*b**	Control	No	60,31	↑16,20	B	0,16	20,57	21,16	0,79
		Yes	52,85		A*	0,25	23,89	24,71	1,04
	212 °C for 1 h	No	43,01	↓44,20	C	0,76	17,12	19,58	4,07
		Yes	30,26		D**	0,59	9,59	11,74	5,68

Электронный архив УГЛТУ

The end of table 4

Test	Treatment	Arabic gum application	Mean	Change (%)	Homogeneity group	Standard deviation	Minimum	Maximum	Coefficient of variation
*C**	Control	No	60,31	↑19,60	B	0,19	21,39	22,08	0,86
		Yes	52,85		A*	0,33	25,48	26,58	1,27
	212 °C for 1 h	No	43,01	↓26,17	B	0,84	19,76	22,58	3,93
		Yes	30,26		C**	0,60	14,96	17,11	3,78
h°	Control	No	60,31	↓6,60	A*	0,39	72,95	74,17	0,53
		Yes	52,85		B	0,38	68,39	69,43	0,55
	212 °C for 1 h	No	43,01	↓31,94	C	0,44	59,54	60,97	0,73
		Yes	30,26		D**	1,11	39,88	43,35	2,72
*WI** ⊥	Control	No	60,31	↓45,25	A*	0,18	19,70	20,20	0,88
		Yes	52,85		B	0,63	9,80	11,50	5,73
	212 °C for 1 h	No	43,01	↓53,46	C	0,29	7,20	7,90	3,90
		Yes	30,26		D**	0,53	2,90	4,00	15,24
*WI** ‖	Control	No	60,31	↓68,47	A*	0,15	11,61	12,00	1,24
		Yes	52,85		B	0,29	3,30	4,00	7,89
	212 °C for 1 h	No	43,01	↓93,52	C	0,08	2,10	2,30	3,90
		Yes	30,26		D**	0,05	0,10	0,20	36,89

Number of Measurements: 10. * Highest result. ** Lowest result.

The results of total color differences are presented in Table 5. The Δ*E** values were 8.82 for untreated samples with gum Arabic and 15.23 for thermally treated samples with gum Arabic. Additionally, the effect of thermal treatment alone was calculated as 18.02. In all three cases in Table 5, Δ*L** was negative (darker than the reference), and Δ*b** was positive (more yellow than the reference). Comparing these results with the color change criteria provided in Table 2 [Jirouš and Ljuljka (1999)], untreated samples with gum Arabic fell under the “intense” category (6.00–12.00), while thermally treated samples with gum Arabic and the effect of thermal treatment were categorized as “very intense” (> 12.00). The Δ*b** and Δ*C** values for untreated samples with gum Arabic were positive (indicating a yellower and more vivid appearance compared to the reference). In contrast, these values for thermally treated samples with gum Arabic and the effect of thermal treatment were negative (indicating a bluer and duller appearance compared to the reference) (Table 5).

Table 5

Results of total color differences

Treatment	Arabic Gum Application	Δ*L**	Δ*a**	Δ*b**	Δ*C**	Δ*H**	Δ*E**	Color Change (Jirouš and Ljuljka, 1999)
No	Yes	–7,46	3,27	3,38	4,26	2,00	8,82	Intense (6,00–12,00)
Yes	Yes	–12,75	1,30	–8,23	–5,61	6,16	15,23	Very intense (> 12,00)
Effect of Heat Treatment		–17,30	4,51	–2,24	–0,30	5,03	18,02	Very intense (> 12,00)

Электронный архив УГЛТУ

Conclusions

Gum arabic caused darkening of the wood and significant changes in color parameters in both thermally untreated and thermally treated samples. When used in combination with thermal treatment, gum arabic further enhanced color changes and caused a notable decrease in parameters such as the whiteness index. These results indicate that gum arabic can be an effective material for altering the aesthetic appearance of the surface and transforming the wood into darker tones. The preparation and application of gum arabic at different concentrations could be evaluated to observe how it influences the intensity of color changes on the surface.

References

ASTM D 2244-3, Standard practice for calculation or color tolerances and color, differences from instrumentally measured color coordinates. ASTM International, West Conshohocken, PA, 2007. URL: www.astm.org (accessed 10.01.2025).

ASTM E313-15e1 Standard practice for calculating yellowness and whiteness indices from instrumentally measured color coordinates. ASTM International, West Conshohocken, PA., 2015. URL: https://www.researchgate.net/ (accessed 10.01.2025).

Characterization and properties of *Acacia senegal* (L.) Wild. Var. senegal with enhanced properties (Acacia (sen) SUPER GUM™) : part 1-controlled maturation of Acacia senegal var. senegal to increase viscoelasticity, produce a hydrogel form and convert a poor into a good emulsifier / *S. Al-Assaf*, *G. O. Phillips*, *H. Aoki*, *Y. Sasaki* // Food Hydrocoll. 2007. № 21. P. 319–328. DOI: 10.1016/j.foodhyd.2006.04.011

Chikamai B. N. Production, markets and quality control of gum arabic in Africa: Findings and recommendations from an FAO project, 1997. URL: https://www.researchgate.net/ (accessed 10.01.2025).

Chikamai B. N., *Banks W. B.* Gum arabic from *Acacia senegal* (L) Willd. in Kenya // Food Hydrocolloids. 1993. № 7 (6). P. 521–534. DOI: 10.1016/S0268-005X(09)80246-4

Goswami S., *Naik S.* Natural gums and its pharmaceutical application // Journal of Scientific and Innovative Research. 2014. № 3 (1). P. 112–121.

Homan W. J., *Jorissen A. J.* Wood modification developments // Heron. 2004. № 49 (4). P. 361–385.

ISO 554. Standard atmospheres for conditioning and/or testing, International Standardization Organization. Geneva, Switzerland, 1976. URL: https://www.iso.org (accessed 10.01.2025).

Jirouš R. V., *Ljuljka B.* Boja drva i njezine promjene prilikom izlaganja atmosferskim utjecajima // Drvna Industrija. 1999. № 50 (1). P. 31–39.

Jirouš-Rajković V., *Miklečić J.* Heat-Treated Wood as a Substrate for Coatings, Weathering of Heat-Treated Wood, and Coating Performance on Heat-Treated Wood // Advances in Materials Science and Engineering. № 1. 2019. URL: https://www.researchgate.net/ (accessed 10.01.2025). DOI: 10.1155/2019/8621486

Kozhin V. P., *Gorbachev N. M.* Hydrothermal treatment and modification of wood: drying, impregnation : collective monograph // Wood : types, properties, and uses, Chapter 1. 2011. P. 1–48. ISBN: 978-1-61668-837-0.

Lange D. R. Fundamentals of Colourimetry – Application Report № 10e. New York, NY, USA, 1999. URL: https://www.researchgate.net/ (accessed 10.01.2025).

Musa H. H., *Ahmed A. A.*, *Musa T. H.* Hemistry, biological, and pharmacological properties of gum Arabic // Bioactive Molecules in Food. 2018. P. 1–18.

Processing of gum arabic and some new opportunities / *B. N. Chikamai*, *W. B. Banks*, *D. M. W. Anderson*, *W. Weiping* // Food Hydrocolloids. 1996. № 10 (3). P. 309–316. DOI: 10.1016/S0268-005X(96)80006-3

Yebeyen D., *Lemenih M.*, *Feleke S.* Characteristics and quality of gum arabic from naturally grown *Acacia senegal* (Linne) Willd. trees in the Central Rift Valley of Ethiopia // Food Hydrocolloids. 2009. № 23 (1). P. 175–180. DOI: 10.1016/j.foodhyd.2007.12.008

Электронный архив УГЛТУ

Информация об авторах

*Х. Пекер − председатель межвузовского совета, профессор,
кандидат технических наук (деревообработка);
О. Чамлибел − доктор Ph.D (деревообработка);
Г. Улай − заведующий кафедрой материалов и технологии их обработки, доктор Ph.D (деревообработка);
У. Аята − руководитель межвузовского совета, доцент, доктор Ph.D (обработка древесины).*

Information about the authors

*H. Peker − President of the Interuniversity Board, Prof., Dr. Ph.D (Woodworking), Graduate School;
O. Chamlibel − Head of Furniture and Decoration Program, Ph.D (Wood processing),
Kırıkkale Vocational College, Associate Professor;
G. Ulay − Head of Material and Material Processing Technology, Ph.D (Wood processing),
Van Vocational College, Associate Professor;
U. Ayata − Head of Inter-University Council, Associate Prof, Dr. Ph.D (Wood processing),
Graduate School.*

*Статья поступила в редакцию 20.12.2024; принята к публикации 10.01.2025.
The article was submitted 20.12.2024; accepted for publication 10.01.2025.*