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EFFECT OF TREE SPECIES ON SOME PHYSICAL PROPERTIES OF MDF [1,2]

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Abstract

In this study, effect of tree species on some physical properties of Medium Density Fiberboards (MDF), such as air dry density, thickness swelling (2 and 24 hours), and water absorption (2 and 24 hours), manufactured from furnishes of oak (Quercus robur), beech (Fagus orientalis), pine (Pinus nigra), and a mixture of these species (a mixture of 40 percent oak, 40 percent beech, and 20 percent pine furnish) was investigated. All physical properties were tested according to ISO standards. Analysis of variance (at a 95 percent confidence level) and multiple-range test (Duncan) were used to evaluate the effect of tree species on physical properties of MDF. From the tests performed, it was concluded that physical properties of the panels made from pine furnish are better than those of panels made from oak, beech, and mixed furnish.

Keywords: Medium Density Fiberboard (MDF), physical properties, tree species, thickness swelling, water absorption.

1. INTRODUCTION

Medium Density Fiberboard is defined, according to EMB (Euro MDF Board) as a panel material, generally having a thickness of > 1.0 mm manufactured from lignocellulosic fibers by the "dry process", i.e. having a fiber moisture content of less than 20 % at the forming stage. The bond is derived from a synthetic adhesive cured under heat and pressure. The panels can be given additional properties, e.g. flame retardance, moisture resistance, resistance to biological attack. Other additives may be included. MDF has densities between 650 kg/m^3 and 800 kg/m^3 (ANONYMOUS 1997).

In recent years, great changes have taken place in the MDF industry. Production of MDF products has increased dramatically and new plants are planned worldwide. MDF is used extensively in factory-assembled and ready-to-assemble furniture, as well as cabinets, underlayment, drawer fronts, molding, and counter tops. MDF is also replacing thin plywood and wet-process hardboard in the production of molded and flush door-skins (KRZYSIK et. al., 1999).

Of all the variables present in the composition board process, species is one of the most significant. It interacts with virtually every other variable of the process. It determine how low in

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specific gravity the final board can be. To a great extent it governs the type of particles that can be generated economically. Some species must have the moisture content more precisely controlled; otherwise the final board will blow or delaminate.

Low density wood species could be used solely as the surface furnish to improve the dimensional stability of high density surface regions, therefore improving the stability of the whole panel (XU/WINISTORFER/MOSCHLER 1996).

Wood species has long been recognized as a major variable in the manufacture of MDF. The most significant species attribute that influences the manufacturing process is density, even though other characteristics such as microscopic structure, bending strength etc. could affect the process of fiber generation and therefore fiber size variation (XU/SUCHLAND 1998).

If a single species is used, the production process can be adjusted to have maximum uniformity in panel properties. However, a mixture of species is an important factor influencing both physical and mechanical properties of the final product. In general, low quality oak, beech, and pine are used as raw materials, either as a single species or as a mixture for MDF manufacture in Turkey (AKBULUT/HIZIROĞLU/AYRILMIŞ 2000). Softwoods fibers have very homogenous structure relating to fiber yield. Whereas, hardwoods fibers have different fiber types such as Libriform wood fiber, fiber-tracheid, parenchyma cell etc.

HIZIROGLU and KAMDEM (1995) investigated physical and mechanical properties of hardboard made of chemi-thermo-mechanical pulp fibers from black locust (Robinia pseudoacacia) furnish. The hardboard made from black locust exhibited low thickness swelling.

After air dry density was determined of the specimens, water absorption (WA) and the thickness swell (TS), measured by the water soak method (24-hr exposure is the most practise), are usually taken as the primary measures of the water resistance ability of wood composite panel materials (XU/WINISTORFER/MOSCHLER 1996).

Objective of the Study

No study has been done concerning the effects of tree species on physical properties of MDF in our country under laboratory conditions so far. Very good quality MDF could be manufactured if such studies were done.

2. MATERIALS AND METHODS

Raw Material

Stem and branch woods used in the manufacturing experimental panels which were taken from Trakya (Quercus robur L.), Yalova (Fagus orientalis Lipsky), and Geyve-Adapazarı (Pinus nigra pallasiana) regions. They were 8-15 cm in diameter and average 1 m in lenght.

Panel Manufacture

Medium Density Fiberboard panels (3660 by 2230 by 18 mm) were manufactured at Kastamonu Integrated Wood Company located in Gebze, Turkey. Panels made from oak, beech, pine, and a mixture of these species were used in the experiments. A total of 12 panels, 3 for each type of furnish, were tested. The chips having an average dimension of 20 by 25 by 5 mm were produced from roundwood. Raw material was converted into fiber furnish in an Asplund defibrator using a steam pressure of 7.5 bar at a temperature of 178°C for 5 minutes. The following were added to the fiber furnish: 1 percent wax, 0.8 percent NH4CL as hardener, and 11 percent urea-formaldehyde resin. Mats with an average moisture content of 10.5 percent were pressed at temperature of 206°C for 4 minutes at a pressure of 3.5-4 N/mm. The panels were sanded with a sequence of 150, 180, and 200 grit size following the cooling process.

Testing

Specimens taken from experimental panels based on EN 326-1. Each panel was divided into panel piece of bigger than 800 mm by 1600 mm. After that, test specimens were cut from this piece of panel according to the above standard.

Preliminary experiments were first made on 20 samples in order to determine minimum sample numbers for each test. Thus, it was calculated minimum sample numbers varying from 10 to 25, according to test type. 50 samples from each panel type were used to determine density (air dry), water absorption (2 and 24 hours), and thickness swelling (2 and 24 hours).

Dimension of the specimens, number of the samples and standard numbers of the experimental specimens used in the tests were as follows;

Tests	Dimension of specimen (mm)	Number of specimen	Standard Number
Specific gravity (air dry)	100 x 100	50	ISO 769 (1972)
Thickness swelling (2 and 24 hours)	100 x 100	50	ISO 819 (1975)
Water absorption (2 and 24 hours)	100 x 100	50	ISO 819 (1975)

Prior to physical property testing, the specimens were conditioned at 20±2°C, and 65±5 percent relative humidity in a climate chamber. Measuring and weighing of test specimens were done according to EN 325. For this purpose, thickness of specimens were measured with a dijital micrometer (sensitive to 0.01 mm) and lenghts were measured with a dijital compass (sensitive to 0.01 mm) as seen in figure 1.

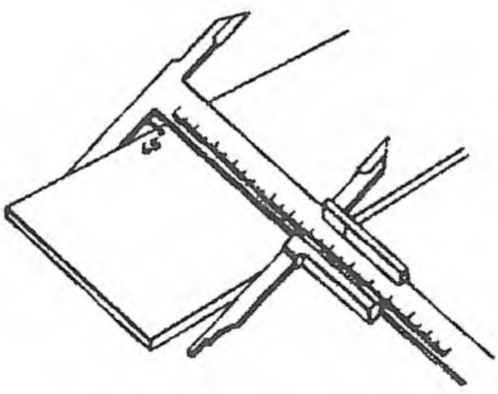

Figure 1: Measurement of a test specimen with compass (from EN 325)
Şekil 1: Kumpasla deney numunesinin ölçülmesi (EN 325'den)

3. RESULTS

3.1 Air Dry Density

Number of sample, arithmetical mean, maximum value, minimum value, standard deviation, variance, and coefficient of variation in connection with panel types manufactured from beech, oak, pine, and a mixture of these species are given in Table 1.

Table 1: Air Dry Density Values
Tablo 1: Hava Kurusu Yoğunluk Değerleri

Statistical values İstatistik değerler	Beech Kayın	Oak Meşe	Pine Çam	Mixture species (%40 B+%40 O+%20 P) Ağaç türlerinin karışımı
Number of the specimen Örnek sayısı	50	50	50	50
Arithmetical mean (g/cm^3) Aritmetik ortalama	0.758	0.763	0.763	0.766
Maximum value (g/cm^3) Maksimum değer	0.768	0.774	0.774	0.773
Minimum value (g/cm^3) Minumum değer	0.745	0.749	0.749	0.756
Standard deviation (g/cm^3) Standart sapma	0.005	0.005	0.005	0.004
Variance Varyans	0.000026	0.000032	0.000026	0.000016
Coefficient of variation (%) Standart sapma	0.683	0.750	0.675	0.536

The results of analysis of variance for this experiment indicate that panel types showed a difference at the confidence level of 95 % and then Duncan test were applied to the data in order to reveal the differences in the panel group or groups (Table 2 and 3).

Table 2: Results of Variance Analysis
Tablo 2: Varyans Analizi Sonuçları

Source of Variation Varyasyon Kaynağı	Degrees of freedom Serbestlik Derecesi	Sum of squares Tüm varyans	Mean square Ortalama kareler	F ratio 95 % F oranı % 95	Significant Level Önem Seviyesi
Groups Gruplar Arası	3	0.001775	0.0006	23.004 > 2.680	S^*
Error Gruplar İçi	196	0.005041	0.0000257		
Total Toplam	199	0.006816	0.0006257		

As shown in Table 3, in a given panel type except for oak/pine, a significant difference (at a 95 percent confidence level) was found between the other panel types based on the arithmetical mean values and the Rp values in air dry density.

Table 3: Results of Duncan Test
Tablo 3: Duncan Testi Sonuçları

Duncan Test	X_2	X_3	X_4
X_1 (R_D)	0.0023 (0.0021)	0.003 (0.0022)	0.0076 (0.0023)
X_2 (R_D)	–	0.00071 0.0021	0.0053 (0.0022)
X_3 (R_D)	–	–	0.0046 (0.0021)

X_1: Mixed Species X_3: Pine
X_2: Oak X_4: Beech

3.2 Thickness Swelling (2 and 24 hours)

3.2.1 Thickness Swelling (2 hours)

Number of sample, arithmetical mean, maximum value, minimum value, standard deviation, variance, and coefficient of variation in connection with panel types manufactured from beech, oak, pine, and a mixture of these species are given in Table 4.

Table 4: Thickness Swelling Values (2 Hours)
Tablo 4: Kalınlığına Şişme Değerleri (2 Saat)

Statistical values İstatistik değerler	Beech Kayın	Oak Meşe	Pine Çam	Mixture species (%40 B+%40 O+%20 P) Ağaç türlerinin karışımı
Number of the specimen Örnek sayısı	50	50	50	50
Arithmetical mean (%) Aritmetik ortalama	1.878	2.079	1.060	1.450
Maximum value (%) Maksimum değer	2.190	2.480	1.420	1.870
Minimum value (%) Minumum değer	1.640	1.720	0.500	1.130
Standard deviation (%) Standart sapma	0.132	0.168	0.17	0.168
Variance Varyans	0.017	0.028	0.029	0.028
Coefficient of variation (%) Varyasyon katsayısı	7.041	8.117	15.986	11.627

The results of analysis of variance for this experiment indicate that panel types showed a difference at the confidence level of 95 % and then Duncan test were applied to the data in order to reveal the differences in the panel group or groups (Table 5 and 6).

Table 5: Results of Variance Analysis
Tablo 5: Varyans Analizi Sonuçları

Source of Variation Varyasyon Kaynağı	Degrees of freedom Serbestlik derecesi	Sum of squares Tüm varyans	Mean square Ortalama kareler	F ratio 95 % F oranı % 95	Significant Level Önem Seviyesi
Groups Gruplar Arası	3	30.5590875	10.1863625	394.041 > 2.680	S*
Error Gruplar İçi	196	5.0668	0.02585102		
Total Toplam	199	35.6258875	0.179		

Table 6: Results of Duncan Test
Tablo 6: Duncan Testi Sonuçları

Duncan Test	X_2	X_3	X_4
X_1 (R_p)	0.201 (0.064)	0.629 (0.067)	1.01 (0.069)
X_2 (R_p)	–	0.428 (0.064)	0.809 (0.067)
X_3 (R_p)	–	–	0.381 (0.064)

X_1: Oak X_3: Mixed Species
X_2: Pine X_4: Pine

As shown in Table 6, a significant difference (at a 95 percent confidence level) was found between the panel types manufactured from beech, pine, oak, and mixed species based on the arithmetical mean values and the Rp values in thickness swelling (2 hours).

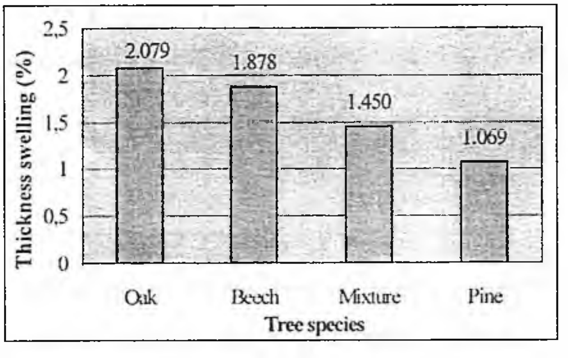

Figure 2: The arithmetical mean values of thickness swelling (2 hours)
Şekil 2: Kalınlığına şişme (2 saat) aritmetik ortalama değerleri

3.2.2 Thickness Swelling (24 hours)

Number of sample, arithmetical mean, maximum value, minimum value, standard deviation, variance, and coefficient of variation in connection with panel types manufactured from beech, oak, pine, and a mixture of these species are given in Table 7.

Table 7: Thickness Swelling Values (24 Hours)
Tablo 7: Kalınlığına Şişme Değerleri (24 Saat)

Statistical values İstatistik değerler	Beech Kayın	Oak Meşe	Pine Çam	Mixture species (%40 B+%40 O+%20 P) Ağaç türlerinin karışımı
Number of the specimen Örnek sayısı	50	50	50	50
Arithmetical mean (%) Aritmetik ortalama	7.402	8.100	6.236	6.713
Maximum value (%) Maksimum değer	7.862	8.470	6.796	7.659
Minimum value (%) Minumum değer	6.822	7.667	5.847	6.388
Standard deviation (%) Standart sapma	0.276	0.156	0.233	0.207
Variance Varyans	0.076	0.024	0.054	0.042
Coefficient of variation (%) Varyasyon katsayısı	3.738	1.928	3.745	3.084

The results of analysis of variance for this experiment indicate that panel types showed a difference at the confidence level of 95 % and then Duncan test were applied to the data in order to reveal the differences in the panel group or groups (Table 8 and 9).

Table 8: Results of Variance Analysis
Tablo 8: Varyans Analizi Sonuçları

Source of Variation Varyasyon Kaynağı	Degrees of freedom Serbestlik derecesi	Sum of squares Tüm varyans	Mean square Ortalama kareler	F ratio 95 % F oranı % 95	Significant Level Önem Seviyesi
Groups Gruplar Arası	3	99.39560755	33.1318692	668.380 > 2.680	S*
Error Gruplar İçi	196	9.7158	0.04957041		
Total Toplam	199	109.1114076	0.548		

Table 9: Results of Duncan Test
Tablo 9: Duncan Testi Sonuçları

Duncan Test	X_2	X_3	X_4
X_1 (R_D)	0.698 (0.089)	1.387 (0.093)	1.864 (0.096)
X_2 (R_D)	–	0.689 (0.089)	1.166 (0.093)
X_3 (R_D)	–	–	0.477 (0.089)

X_1: Oak X_3: Mixed Species
X_2: Beech X_4: Pine

As shown in Table 9, a significant difference (at a 95 percent confidence level) was found between the panel types manufactured from beech, pine, oak, and mixed species based on the arithmetical mean values and the Rp values in thickness swelling (24 hours).

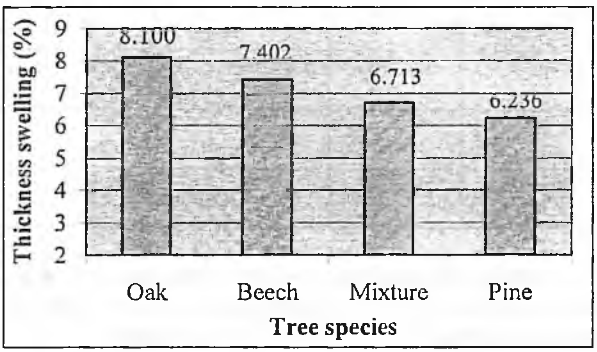

Figure 3: The arithmetical mean values of thickness swelling (24 hours)
Şekil 3: Kalınlığına şişme (24 saat) aritmetik ortalama değerleri

3.3 Water Absorption (2 and 24 hours)

3.3.1 Water Absorption (2 hours)

Number of sample, arithmetical mean, maximum value, minimum value, standard deviation, variance, and coefficient of variation in connection with panel types manufactured from beech, oak, pine, and a mixture of these species are given in Table 10.

Table 10: Water Absorption Values (2 Hours)
Tablo 10: Su Alma Değerleri (2 Saat)

Statistical values İstatistik değerler	Beech Kayın	Oak Meşe	Pine Çam	Mixture species (%40 B+%40 O+%20 P) Ağaç türlerinin karışımı
Number of the specimen Örnek sayısı	50	50	50	50
Arithmetical mean (%) Aritmetik ortalama	4.295	4.506	3.206	3.861
Maximum value (%) Maksimum değer	4.640	4.870	3.730	4.120
Minimum value (%) Minumum değer	4.000	3.960	2.420	3.380
Standard deviation (%) Standart sapma	0.185	0.225	0.298	0.143
Variance Varyans	0.034	0.050	0.089	0.020
Coefficient of variation (%) Varyasyon katsayısı	4.324	4.998	9.322	3.725

The results of analysis of variance for this experiment indicate that panel types showed a difference at the confidence level of 95 % and then Duncan test were applied to the data in order to reveal the differences in the panel group or groups (Table 11 and 12).

Table 11: Results of Variance Analysis
Tablo 11: Varyans Analizi Sonuçları

Source of Variation Varyasyon Kaynağı	Degrees of freedom Serbestlik derecesi	Sum of squares Tüm varyans	Mean square Ortalama kareler	F ratio 95 % F oranı %95	Significant Level Önem Seviyesi
Groups Gruplar Arası	3	49.616832	16.538944	339.260 > 2.680	S*
Error Gruplar İçi	196	9.555	0.04875		
Total Toplam	199	59.171832			

Table 12: Results of Duncan Test
Tablo 12: Duncan Testi Sonuçları

Duncan Test	X_2	X_3	X_4
X_1 (R_p)	0.211 (0.087)	0.645 (0.092)	1.3 (0.095)
X_2 (R_p)	–	0.434 (0.087)	1.089 (0.092)
X_3 (R_p)	–	–	0.655 (0.087)

X_1: Oak X_3: Mixed species
X_2: Beech X_4: Pine

As shown in Table 12, a significant difference (at a 95 percent confidence level) was found between the panel types manufactured from beech, pine, oak, and mixed species based on the arithmetical mean values and the Rp values in water absorption (2 hours).

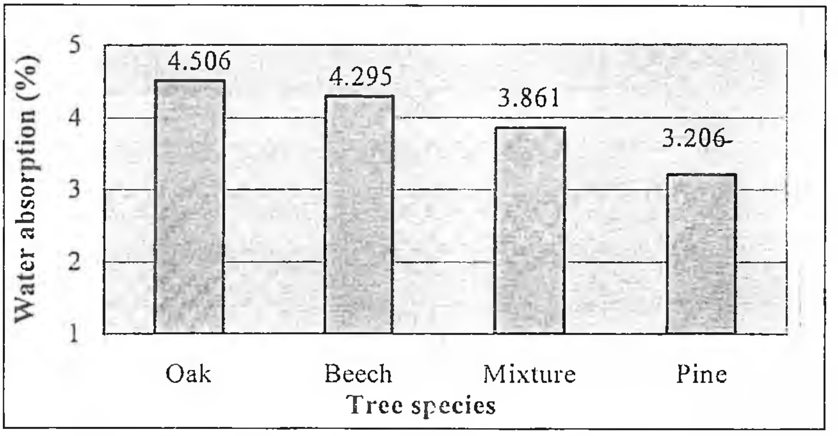

Figure 4: The arithmetical mean values of water absorption (2 hours)
Şekil 4: Su alma (2 saat) aritmetik ortalama değerleri

3.3.2 Water Absorption (24 hours)

Number of sample, arithmetical mean, maximum value, minimum value, standard deviation, variance, and coefficient of variation in connection with panel types manufactured from beech, oak, pine, and a mixture of these species are given in Table 13.

Table 13: Water Absorption Values (24 Hours)
Tablo 13: Su Alma Değerleri (24 Saat)

Statistical values İstatistik değerler	Beech Kayın	Oak Meşe	Pine Çam	Mixture species (%40 B+%40 O+%20 P) Ağaç türlerinin karışımı
Number of the specimen Örnek sayısı	50	50	50	50
Arithmetical mean (%) Aritmetik ortalama	17.030	18.310	14.300	15.960
Maximum value (%) Maksimum değer	18.620	20.090	14.810	18.760
Minimum value (%) Minumum değer	16.090	16.900	13.720	14.620
Standard deviation (%) Standart sapma	0.757	0.814	0.299	0.823
Variance Varyans	0.573	0.663	0.089	0.678
Coefficient of variation (%) Varyasyon katsayısı	4.446	4.447	2.091	5.159

The results of analysis of variance for this experiment indicate (Table 14) that panel types showed a difference at the confidence level of 95 % and then Duncan test were applied to the data in order to reveal the differences in the panel group or groups (Table 15).

Table 14: Results of Variance Analysis
Tablo 14: Varyans Analizi Sonuçları

Source of Variation Varyasyon Kaynağı	Degrees of freedom Serbestlik derecesi	Sum of squares Tüm varyans	Mean square Ortalama kareler	F ratio 95 % F oranı % 95'	Significant Level Önem Seviyesi
Groups Gruplar Arası	3	431.983495	143.9944983	287.389 > 2.680	S*
Error Gruplar İçi	196	98.2046	0.501043878		
Total Toplam	199	530.188095	2.664		

Table 15: Results of Duncan Test
Tablo 15: Duncan Testi Sonuçları

Duncan Test	X_2	X_3	X_4
X_1 (R_D)	1.28 (0.28)	2.35 (0.295)	4.006 (0.305)
X_2 (R_D)	–	1.07 (0.28)	2.726 (0.295)
X_3 (R_D)	–	–	1.656 (0.28)

X1: Oak X3: Mixed species
X2: Beech X4: Pine

As shown in Table 15, a significant difference (at a 95 percent confidence level) was found between the panel types manufactured from beech, pine, oak, and mixed species based on the arithmetical mean values and the Rp values in water absorption (24 hours).

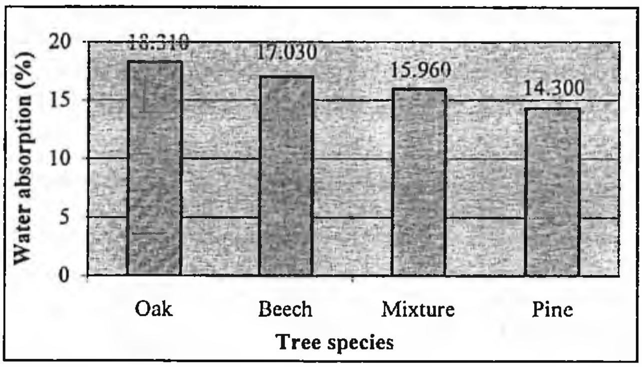

Figure 5: The arithmetical mean values of water absorption (24 hours)
Şekil 5: Su alma (24 saat) aritmetik ortalama değerleri

4. CONCLUSION

Based on these test results, it can be summarized that physical properties of the panels made from pine furnish are better than those of panels made from oak, beech, and mixed species furnish.

Some physical properties (arithmetical means) of the experimental panels are as follows:

Tests		Panel Type			
		Pine	Beech	Oak	Mixed species
Specific gravity	g/cm³	0.763	0.758	0.763	0.766
Thickness swelling					
2 hours	%	1.07	1.88	2.08	1.45
24 hours	%	6.23	7.40	8.10	6.71
Water absorption					
2 hours	%	3.21	4.30	4.51	3.86
24 hours	%	14.30	17.03	18.31	15.96

The Euro Standard (EN 622-5) specifies maximum 24-hour thickness swell values for 18 mm MDF panels as 12 %. This standard does not specify performance requirement for water absorption. Maximum water absorption property are specified by ANSI (American National Standard Organization) for other fiber-based products like basic hardboard MDF products as 40 percent. The thickness swell and water absorption values of all the MDF panels in the experiment were very below these maximum specified levels.

TS 3640 (was annuled in 2000) had specified maximum 24 hours thickness swell and water absorption values for MDF panels as 20 and 40 percent, respectively.

The reason for preferential use of the relatively light species is that they can be compressed into medium-density fiberboards with the assurance that sufficient interfiber contact area is developed during the pressing operation to achive good bonding. Heavier species simply can not be compressed into medium density fiberboards that are well bonded. A certain amount of pressure is necessary while consolidating the mat into the final board specific gravity to species specific gravity (MALONEY 1993).

Compression ratio has a strong effect on the physical and mechanical properties of MDF. Compression ratio is described as ratio of panel density to wood specific gravity. A ratio of (between 1.40 and 1.50)/1.0 provides a good guideline for determining if a species can be made into suitable medium density products have 750-800 kg/m^3 (the species is given an index number of 1.0). The lower density has been benefical in these cases in establishing the desired physical properties in relatively low-density board products.

Compression ratios for each panel type used in the experimental as follows;

		Pine	Beech	Oak
Wood specific gravity	g/cm³	0.520	0.640	0.650
Panel specific gravity	g/cm³	0.763	0.758	0.763
Compression ratio		**1.467**	**1.184**	**1.173**

Compression ratio of panels made from pine furnish is the highest in the experimental panels, as seen above. Because the mat prepared from pine furnish is lighter and softer than those of beech, and oak furnishes, it can be pressed easily in a hot press.

Fiber lenght has a strong influence on the physical and mechanical properties of MDF as well as compression ratio (SUCHLAND/WOODSON 1991). Since pine wood has longer fibers than oak and beech, it would have a larger number of bonding area and a longer lenght of overlap between two pine fibers than other species. Thus, bonding between pine fibers would be stronger and this may result in a higher physical and mechanical properties than other panel types. As oak fibers is the shortest in the experimental species, bonding strength between oak fibers would be weaker than other species.

At the same time, pH value of wood affects the curing rate of synthetic resins before hot press, which could result in curing of a resin before hot pressing known as precure in the mat. If pH value of wood is low (between 3-4), it could initiate the curing of synthetic resins in the bunker. Thus, precure could take place in the oak mat before coming to hot press. These panels manufactured in this manner have low physical and mechanical properties.

Moreover, extractives, extraneous matters, growth location, annual ring width, sapwood/heartwood proportions, latewood/earlywood proportions, etc. affect the physical and mechanical properties of MDF. Tree species having high extractive ratios such as, tanen, and coloring components are not prefered in the MDF manufacturing.

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MDF'NİN BAZI FİZİKSEL ÖZELLİKLERİ ÜZERİNE AĞAÇ TÜRÜNÜN ETKİSİ

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Özet

Bu çalışmada, MDF'nin mekanik özellikleri üzerine ağaç türünün etkisini incelemek amacıyla saplı meşe (Quercus robur L.), doğu kayını (Fagus orientalis Lipsky), karaçam (Pinus nigra var. pallasiana) ve bunların karışımlarından (% 40 saplı meşe + % 40 doğu kayını + % 20 karaçam) üretilen levhaların fiziksel özellikleri tespit edilmiştir. Deneyler 20 ± 2 °C sıcaklık ve 65 ± 5 bağıl nemde kondisyonlanmış örnekler üzerinde yapılmıştır. Deneme levhalarının fiziksel özelliklerinin tespitinde ISO standardı kullanılmıştır. Deneyler sonucunda elde edilen sonuçları istatistiksel olarak değerlendirmek amacıyla % 95 güven düzeyinde Basit Varyans Analizi ve Duncan testleri yapılmıştır. Çalışma sonucunda, Karaçam liflerinden yapılan MDF'lerin janka sertlik değerleri hariç, diğer bütün mekanik özelliklerinin Saplı Meşe, Doğu Kayını ve bu üç türün karışımlarından yapılan levhalardan daha üstün olduğu tespit edilmiştir.

Anahtar Kelimeler: Orta yoğunlukta liflevha (MDF), fiziksel özellikler, kalınlığına şişme, ağaç türü

1. GİRİŞ

MDF, orta sertlikte bir liflevha olup, termomekanik olarak odun veya diğer ligno-selülozik hammaddelerden elde edilen liflerin belirli bir rutubet derecesine kadar kurutulduktan sonra yaklaşık %9-11 oranında sıcakta sertleşen bir tutkal ile karıştırılarak sıcaklık ve basınç altında preslenmesiyle oluşan homojen yapıda levhadır. MDF'nin kalınlığı 1.80-60 mm, yoğunluğu ise genelde 0.55-0.80 g/cm_ arasında değişmekte olup, çoğunlukla 0.70-0.80 g/cm_ arasında üretilmektedir (AKBULUT 1999).

MDF'nin yaklaşık % 90 'nından fazlasını odun oluşturmaktadır. Bu yüzden ağaç türü, levha özellikleri üzerinde büyük etkiye sahiptir. Liflevha endüstrisinde uzun lifli ve nispeten hafif olmaları, pH değerlerinin levha üretimi için uygun bulunmaları ve kolay sıkıştırılabilmelerinden dolayı iğne yapraklı ağaçlar daha fazla tercih edilir.

Kuru yöntemle liflevha üretiminde yapraklı ağaçlar da büyük oranda değerlendirilmektedir. Yapraklı ağaçlar ekonomik olmaları ve fazla miktarlarda bulunmaları dolayısıyla levha üretiminde tercih edilmektedirler. Reçine ve tanen, boyar maddeler gibi ekstraktif madde oranı yüksek ağaç türleri liflevha üretiminde tercih edilmemektedir.

Farklı kullanım yerlerinde MDF'lerden istenen özellikler farklı olsa da, genellikle levhaların hafif ama yeterli derecede dirençli, düzgün yüzeyli ve stabil olması bütün kullanım yerlerinde arzu edilmektedir. MDF'nin bu özelliklerini, kullanılan hammaddeler ve üretim değişkenleri etkilemektedir. Diğer üretim değişkenleri aynı olduğu takdirde levha özelliklerini en fazla etkileyen hiç şüphesiz ağaç türüdür.

Çalışmanın Amacı

Ülkemizde henüz laboratuar şartlarında yerli ağaç türlerimizin MDF'nin fiziksel özellikleri üzerine etkisi incelenmemiş olduğundan bu konuda yeterli yerli literatür bulunmamaktadır. Bu araştırmanın amacı; MDF üretiminde en fazla kullanılan yerli iğne yapraklı ve yapraklı ağaç türlerinin MDF'nin teknolojik özellikleri üzerine etkisini inceleyerek, levhaların fiziksel özelliklerinin en yüksek olmasını sağlayan ağaç türlerini tespit etmek ve orman ürünleri sektörüne önemli bir katkı sağlamak hedeflenmiştir.

2. MATERYAL VE METOT

Denemelere tabi tutulan MDF'ler (3660 x 2230 x 18 mm) Kastamonu Entegre Ağaç Sanayii MDF fabrikasında üretilmiştir. Levhalar saplı meşe, doğu kayını, karaçam ve bunların karışımlarından üretilmiştir. Gövde ve dal odunları 20 x 25 x 5 mm boyutlarında yongalanarak Asplund defibratöründe 7.5 bar ve 178 °C'de 3-5 dakika doygun buhar altında liflendirilmiştir. Tam kuru lif ağırlığına oranla % 1 parafin, % 0.8 NH4CL ve % 11 üre-formaldehit liflere ilave edilmiştir. Ortalama % 10.5 rutubetteki levha taslağı sıcak preste 206 °C'de ve 3.5-4 N/mm_ basınç altında 4 dakika preslenmiştir. Levhaların her iki yüzeyi klimatize işlemini takiben zımpara makinesiyle sırasıyla 150, 180 ve 200 kumlu zımpara bantları ile zımparalanmıştır.

Numuneler üzerinde yapılan deneylerin adları, kullanılan numunelerin boyutları ve sayısı ile uygulanan standart numaraları aşağıda verilmiştir.

Deneyler	**Numune Boyutları (mm)**	**Örnek Sayısı (Adet)**	**Standard Birim**
Birim Hacim Ağırlığı(D_{12})	100 x 100	50	ISO 769 (1972)
Kalınlığına Şişme (2 ve 24 saat)	100 x 100	50	ISO 819 (1975)
Su Alma (2 ve 24 saat)	100 x 100	50	ISO 819 (1975)

Deneyler 20 ± 2 °C ve 65 ± 5 bağıl nemde kondisyonlanmış numuneler üzerinde yapılmıştır. Deneyler sonucunda elde edilen sonuçları istatistiksel anlamda değerlendirme amacıyla Basit Varyans Analizi ve Duncan testi yapılmıştır.

3. BULGULAR

Her bir levha grubuna ait deney sonuçlarının aritmetik ortalamaları aşağıda toplu halde verilmiştir.

Deneyler		**Levha Tipi**			
		Çam	**Kayın**	**Meşe**	**Türlerin Karışımı**
Birim Hacim Ağırlığı (D_{12})	g/cm³	0.763	0.758	0.763	0.766
Kalınlığına şişme					
2 saat	%	1.07	1.88	2.08	1.45
24 saat	%	6.23	7.40	8.10	6.71
Su alma					
2 saat	%	3.21	4.30	4.51	3.86
24 saat	%	14.304	17.03	18.31	15.96

Yukarıda görüldüğü üzere, Karaçam liflerinden yapılan MDF'lerin kalınlığına şişme ve su alma değerleri Saplı Meşe, Doğu Kayını ve bunların karışımlarından üretilen levhalardan daha üstün olduğu tespit edilmiştir.

Çam odunun denemelerde kullanılan diğer türlerden daha düşük yoğunluklu olması dolayısıyla sıcak preste diğer türlere oranla daha yüksek sıkıştırma oranı uygulanmaktadır. Bu şekilde elde edilen levha su içerisinde veya rutubetli bir ortamda suyun veya rutubetin levha içerisine nufüz etmesine, diğer levha gruplarından daha fazla direnç göstermektedir

Kalınlığına şişme üzerine etki eden bir diğer faktör ise lif uzunluğudur. İğne yapraklı ağaç lifleri, yapraklı ağaç liflerine göre daha uzun olduğundan taslak içerisinde lifler arasındaki temas uzunluğu artmakta ve bunun sonucu olarak iğne yapraklı türlerin yapışma dayanımı yapraklı türlere oranla fazla bulunmaktadır. Böylece lifler arasına suyun veya rutubetin girmesi kısa liflere oranla daha güç olmaktadır.

Doğu Kayını ve Saplı Meşe odunlarının lif uzunlukları arasındaki önemli fark olmamasına karşın Doğu Kayını odununun lif uzunluğu biraz daha fazladır. Doğu Kayını MDF'lerde lifler arasındaki temas uzunluğu Saplı Meşe MDF'lerden daha fazla olduğundan rutubetin veya suyun lifler arasına girmesi daha zordur. Ayrıca, Meşe odunu Kayın odununa göre daha asidik olmasından dolayı her iki ağaç türünden eşit üretim şartlarında iki taslak hazırlandığında Meşe odunundan hazırlanan levha taslağı sıcak prese gelmeden ön sertleşmeye uğrayabilmekte ve bunun sonucu olarak sıcak presten çıkan levhanın tutkal bağı zayıf olabilmektedir.

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