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Study of some technological properties of wood branches for grown trees species at Dibis forest.

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ABSTRACT
This study was conducted on the branches of trees growing in the Dibs Forest/north of Kirkuk city. (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba, Populus nigra, Platanus Oreintalis*, *Platanus Orientalis, Salix alba* and *Dalbergia Sissoo*) where the study samples were taken from the lower branches of the trees, and samples were taken from the main trunk of the trees for comparison purposes. The technological characteristics studied included the morphological description of the branches and anatomical characteristics (length and diameter of fibers, diameter of Lumen, thickness of cell wall, Rankel ratios, Slendeness and flexibility coefficient) and chemical characteristics (percentage of soluble extracts, lignin, ash and Holocellulose) in addition to measuring density as a physical characteristic. It was not possible to measure the mechanical characteristics of the empties due to the significant twisting and lack of straightness.
Data varied within the studied species. Anatomical characteristics in branch wood showed a decrease in values, while the percentage of Holocellulose and density values increased in tree branches. Branch wood can be used in the manufacture of cellulose pulp and medium-quality paper, as well as in the production of composite panels.
Keywords: *wood branch; pulp & paper manufacturem, Dibis forest*.

INTRODUCTION

Iraq is a significant market for wood and its products, driven by the need for construction and reconstruction following the war. The demand for wood and its products is very high due to the rapid growth of the construction industry and daily consumption. Forests in Iraq suffer from a clear deficit in meeting the population's need for wood, as large areas of forests have been destroyed, burned, and cut by the population and unregulated grazing, leading to the loss of natural and artificial trees in afforestation sites [1]. The shortage of wood resources has negatively impacted many industries that rely on wood as a raw material, including the pulp and composite panels industries. Recent publications have discussed the use of branch wood in the manufacture of paper, wood panels and composite panels [2;3].

In hardwood and deciduous wood species, branches constitute a significant percentage, estimated to be between 20% and 50% of their above-ground biomass [4]. As a wood material, branches contain (25-30)% of the total wood material in trees [2]. The process of removing branches from trees is an intervention that provides wood resources as outputs for the harvesting process, such as pruning or thinning. In Europe, about 13 million tons of biomass from dry pruning are produced annually in olive groves and other woody tree orchards [5].

Branches may be harvested from operations in areas where it is difficult to transport large trunks, such as remote areas or rare tree populations and reserves where logging is prohibited or where the number of trees is small and limited [6]. In general, during harvesting activities within forests, approximately 35-50% of the tree biomass is left in the forest in the form of trunks, branches, and crowns. The remains of logging, especially branch wood, constitute a significant portion of the wood volume [7]. Currently, the biomass resulting from pruning or removal in forests is not utilised effectively due to a lack of technical information about this material and is often treated as waste [8].

Woody branches can be defined as formed from the middle layer, which is partly seen from the main stem. The general anatomical and structural characteristics of tension wood reported in the literature are: strong, increasing cellulose fibers and therefore less woody cell walls and a cellulose gel layer. The physical wall may be changed to varying degrees within and across deciduous species. Despite this adaptability at all levels, the tree is in a constant trade-off between water and nutrient transport and security, storage, and mechanical support functions at the wood cell level. It thus contains deciduous versions of leaves that have subsequently evolved with tissue distinction in most western regions where they contain specific types of water and fiber performance for mechanical strength to withstand static and dynamic loads. In existence, woody branches are diversely exposed to the effect of fatigue, which consists of tensile and compressive stresses[4].

It was noted through the results of the studies on the characteristics of branchs and timbers, that there are differences in the anatomical characteristic, chemical components, physical properties, and mechanical profits between the wood, leaves, and stems in the studied species[9].

Dibis Forest was established in 1967 on several types of Hard wood trees such as Eucalyptus, Poplar, Platanus, Sisso and other types of trees with the aim of supplying paper mills with raw materials as well as other industries.

Dibis Forest was established in 1964 on several types of trees such as Eucalyptus, Populus, Platanus, Salix, Dalbergia and other types of trees with the aim of supplying paper mills with raw materials as well as other industries. Due to the deterioration of the situation and the prevention of tree removal from it and the accumulation of the outputs of the operations carried out on the branches in the forest floor, this study was conducted targeting the following:

1. Study of some technological characteristics of the branch wood of *Eucalyptus camaldulensis, Populus euphratica*, *Populus alba, Populus nigra, Platanus Oreintalis*, *Platanus Orientalis, Salix alba* and *Dalbergia Sissoo trees* planted in the Dibis Forest.

Materials and methods.

2. Technological characteristic (density, Cell Dimensions and chemical content).
3. Comparison of the results obtained from the branches with the main trunk characteristics of the tree species.
4. Statement of the suitability of branch wood as a raw material for various wood industries,

Material and methods

2.1 Study Site

This study was conducted in the molasses forests, which are currently estimated to cover an area of 700 hectares, and are located within the geographical coordinates of longitude 44^{O} east and latitude 35 12 20 ^{O}north 52 39 [9]. Three trees of *Eucalyptus camaldulensis, Populus euphratica*, *Populus alba, Populus nigra, Platanus Oreintalis*, *Platanus Orientalis, Salix alba* and *Dalbergia Sissoo* were selected, taking into account that they are free from insect and fungal infections, The study samples were taken from the lower branches of the trees and 30 cm away from the point of branch separation from the main trunk to avoid or reduce the effect of tension and pressure wood in that area.

2.2 Preparation of study samples

The wooden branches were cut using hand saws and 5 cm thick discs were taken from each branch, taking into account that the branches were opposite and represented all directions of the tree. For comparison purposes, wooden cubes with dimensions of (3*3*3) cm were taken from the exact directions and at a height of 1.33 cm (DBH) from the main trunk. The samples were transferred to the Forest Science Laboratory at the College of Agriculture / University of Kirkuk and left to dry in the air for two weeks. Then, the study samples were taken from the branch discs after removing the bark. The bark thickness of the studied species was recorded and morphological observations were taken for the studied branches.

2.2.1 Anatomical Characteristics

The wood samples were divided into small pieces, the cells were separated according to the method used by [10,11,12], using a mixture of hydrogen peroxide and glacial acetic acid in equal volumes (1:1) and were placed in an electric oven at a temperature of 60$\pm$°C for 48h. . The samples were shaken well and then washed with cold water several times to make the samples ready for measurement. The separated cells were fixed on glass slides and the dimensions of the intact fibers were taken randomly using a microscope (fiber length, fiber diameter, fiber cavity diameter and fiber wall thickness). for cell clarification and measurement accuracy cells were stained using safranin stain. The Rankl ratio, slenderness ratio and elastic modulus were calculated from the measured data of the fibers.

2.2.2 chemical characteristic

The main chemical constituents of the wood were estimated based on the method used by [13] . The wood samples were ground and then sieved, where the samples passed through a 40 mesh sieve to settle on a 60 mesh sieve. The samples were .placed in an oven at a temperature until the weight was fixed

Extraction:

The percentage of extracts soluble in ethanol-benzene mixture and extracts soluble in hot water were estimated using the Soxhletextraction device. The dried samples were weighed before and after extraction , the percentage of solubles were calculated using the following equation:

Extraction% = (Sample weight before extract - Sample weight after extract / sample weight before extract) * 100

Lignin:

It was determined using concentrated sulfuric acid, where laboratory samples were digested in a solution at a concentration of 72% in a water bath for 2 hours with continuous stirring. Then the mixture was diluted to a concentration of 3% for 3 hours, the mixture was filtered and the difference in dry weights was calculated before and after extraction, The percentage of lignin was found. using the following equation:

Lignin% = (Sample weight before digestion - Sample weight after digestion/ sample weight before digestion) * 100

Ash:

Weigh 1 gram of dry sawdust and place it in an oven at 600°C for two hours. Then weigh the samples and find the ash percentage using the following equation:
Ash% = (Sample weight before heating -Sample weight after heating / sample weight before heating) * 100
Holocellulose :
:The percentage of holocellulose was calculated using the following equation
Holocellulose % = 100-(Extraction in both ethanol-Benzine & Hot Water +Lignin+ash) %.
2.2.3 Physical Characteristics
The physical properties of the wood (density) were estimated using the method described by [14,15].
Cubes were prepared with dimensions(1*1*1) cm were taken from each wooden disk from the top and bottom sides, and the samples were immersed in water for 72 hours (to ensure that the fiber saturation point was reached), then the wet weight of the samples was determined individually. The volume was measured using thewater displacement method The samples . were left to dry in the air for 72 hours, then dried in an oven at a temperature of (103) + 2° ,C until the weight was constant then the dry weight was determined immediately after that. Molten paraffin wax was used to create an insulating layer on the .samples while the dry volume was measured using the (water displacement method)
According to[14] -:the following equations were used to determine the physical properties ,
.density (g/cm3) = dry weight / dry volume
Results
3.1 Morphological description of tree trunks and branches
1. *Eucalyptus camaldulensis :* It is present in large numbers and its height in the study site reaches 25 meters or more for trees growing from seed origin and about 15 meters in trees growing from off shoot propagation, the branches appear at different angles relative to the main stem and start from a height of 2 meters in mature trees.
The average diameter of the branches reaches between (10 - 15) cm at the point where the branch meets the main trunk, the bark is smooth, white or cream with yellow, pink or brown spots with a thickness not exceeding 1 cm in the main trunk, The woody stems are easily broken by wind or the weight of the green crown.
which leaves large amounts of branch wood inside the forest floor.
2. *Populus euphratica* : It reaches a height of 15 m at the study site and its diameter exceeds 30 cm at DBH in the main trunk, which is usually curved and has few branches in the lower parts. The branches are characterized by their diameters exceeding 17 cm in some trees. The bark is thick, rough and brown in color and exceeds 1.5 cm in the main trunk. The branches are twisted and their branches increase at the upper ends.
3. *Populus alba* : A straight tree that reaches a height of 18 m in the forest floor, and its diameter at the base of the trunk is cm, with regular branches and small diameters that may reach 10 cm at older ages, the bark is smooth and greenish white 25 .to grayish white, and the branches have a small tail that reaches 10 cm at the point where the branch meets the main trunk
4. *Populus nigra* : Large trees, ranging in height from (20-24) m, and their trunk diameters reach 40 cm, straight, with few .branches from the main trunk, thick bark, and very twisted branches with diameters reaching 15 cm in the lower branches
5. *Platanus Oreintalis* : A large tree found in small numbers within limited areas within the forest, the height of the trees reaches 22 m and their diameters range between (30-40) cm, and their branches are few in the lower parts, but they are characterized by good diameters reaching 18 cm. The bark of the tree is sometimes peeling, sometimes not, and can become thick, rough, or smooth, with a tendency to turn white, reaching a thickness of 1 cm on the main trunk.
6. *Salix alba* : Trees up to 18 m tall, 30 cm or more in diameter, much branched, with branches up to 15 cm in diameter in the lower parts, bark grey-brown and deeply fissured in older trees.
7. *Dalbergia Sissoo* : It reaches a height of 20 meters and a diameter of between (18-23)cm. The trunks are often twisted and begin to branch at a height of 2 meters. The branches have small diameters and rarely reach 10 cm. The bark is brown and scaly.
Anatomical characteristic
Anatomical characteristics are one of the most important criteria that determine the suitability of wood as a raw material for pulp and paper industry, especially data related to fibres [16,17], It also affects its daily uses in the construction field. [18] indicates that the changes that occur in the anatomical parameters of wood directly affect its physical and mechanical properties. Anatomical variables are related to the mechanical properties of wood and affect their values. The thicker the cell wall, the higher the mechanical resistance of the wood. The higher the fiber diameter, cavity diameter, vessel diameter, beam height and beam width, the lower the mechanical resistance of the wood.
Table (1) Shows the results of the anatomical properties of the fibres in the branch woods and trunks.
3.2.1. Fiber length : The average fiber length of the branch wood of the species (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba, Populus nigra, Platanus Oreintalis*, *Platanus Orientalis, Salix alba* and *Dalbergia Sissoo*) were (0.78, 0.85, 0.62, 0.98, 0.58, 0.87 and 0.85)mm respectively, Throughout the convergence period they were close to each other, except for the branches of the *Platanus Oreintalis* trees which recorded shorter fiber lengths.
3.2.2. Fiber Diameter : The average fiber diameter of the branch wood of the species (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba, Populus nigra, Platanus Oreintalis*, *Platanus Orientalis, Salix alba* and *Dalbergia Sissoo*) were (

13.21, 19.52, 17.87, 21.02, 16.50, 23.61 and 14.80) µm respectively, from the data we find that the diameters of the fibers varied according to the species.

3.2.3.Fiber Lumen Diameter : The average fiber lumen diameter of the branch wood of the species (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba*, *Populus nigra*, *Platanus Oreintalis*, *Platanus Orientalis*, *Salix alba* and *Dalbergia Sissoo*) were (6.79, 12.42, 12.71, 13.26, 10.98, 17.83 and 8.78) µm respectively, The lowest valuesfor lumen diameter were obtained from eucalyptus and Dalbergia wood branches.

3.2.4. Fiber wall thickness: The average fiber lumen diameter of the branch wood of the species (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba*, *Populus nigra*, *Platanus Oreintalis*, *Platanus Orientalis*, *Salix alba* and *Dalbergia Sissoo*) were (3.21, 3.55, 2.58, 3.88, 2.76, 2.89 and 3.01) µm respectively, data varied for the thickness of the fiber wall, with the highest value recorded in *P. euphratica* branches wood and the lowest fiber wall thickness in *P. alba* wood.

General note : Through the recorded data of the dimensions of the branch wood fibers of the studied species and comparing them with the data of the dimensions of the fibers of the main stem wood, we find a different decrease in all the studied values of the branch wood. This path is consistent with the data of some trees in the study conducted by [6,19].

3.2.5. Runkel Ratio : It is an important measurement to find the most suitable wood material for making cellulosic pulp and then paper. In general, fibers with a high Runkel ratio are stiffer, less flexible and form larger paper with a smaller bonding area than fibers with a low Runkel ratio[12]. Having a Runkel ratio of less than 1 will be suitable for paper making. Figure (1) shows the Runkel values of the wood branches of the studied species. There is a variation in Runkel values between the studied species, with a range between (0.32-0.94), but all values are less than 1.

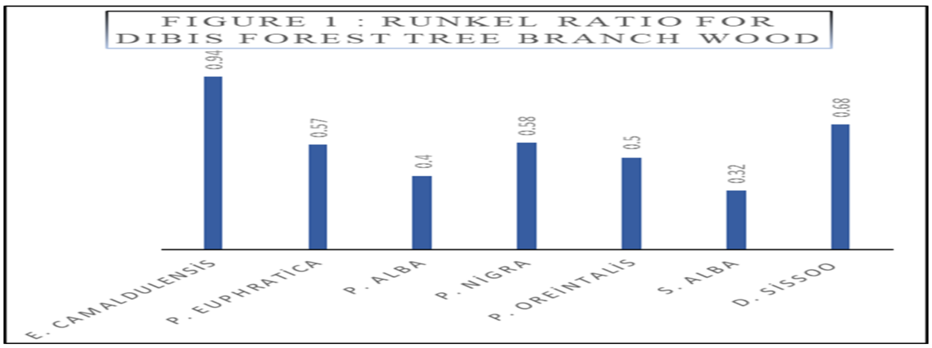
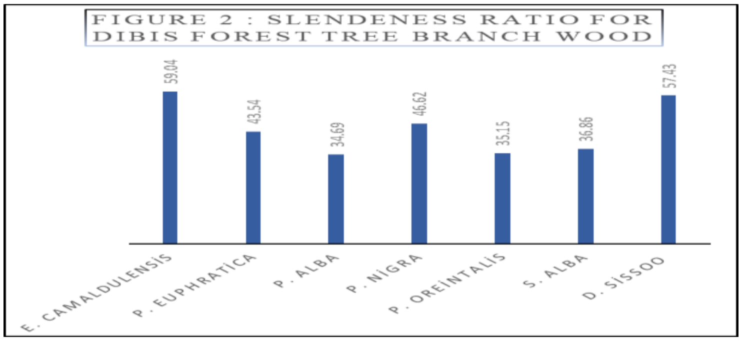


Table 1: Anatomical Characteristic of Dibis Forest Tree (Trunk & Branches)

Tree type	Tree part	Fiber Length (L) (mm)	Fiber Diameter (d) (µm)	Fiber Lumen Diameter (l) (µm)	Fiber Wall Thickness (w) (µm)	Runkel Ratio 2 w / l	Slendeness Ratio L / d	Flexibility coefficient (%) l / d*100
Eucalyptus camaldulensis	T	1.12	15.70	7.68	4.01	1.04	71.3	48.91
	B	0.78	13.21	6.79	3.21	0.94	59.04	51.40
Populus euphratica	T	1.35	25.87	15.75	5.06	0.64	52.18	60.88
	B	0.85	19.52	12.42	3.55	0.57	43.54	63.62
Populus alba	T	0.90	23.80	16.44	3.68	0.44	37.81	69.07
	B	0.62	17.87	12.71	2.58	0.40	34.69	71.12
Populus nigra	T	1.32	27.00	17.04	4.98	0.58	48.88	63.11
	B	0.98	21.02	13.26	3.88	0.58	46.62	63.08
Platanus Oreintalis	T	0.99	21.78	15.10	3.34	0.44	45.45	69.32
	B	0.58	16.50	10.98	2.76	0.50	35.15	66.54
Salix alba	T	1.20	28.5	19.10	4.70	0.49	42.10	67.70
	B	0.87	23.61	17.83	2.89	0.32	36.86	75.51
Dalbergia Sissoo	T	1.10	19.86	11.86	4.00	0.67	55.38	59.71
	B	0.85	14.80	8.78	3.01	0.68	57.43	59.12

3.2.6. Slendeness Ratio : Also called felting strength, it is inversely proportional to fiber diameter. If the fiber floss ratio is less than 70, it will not be valuable for producing high-quality paper. A low floss ratio means low tear resistance, partly because short, thick fibers do not create good surface contact and inter-fiber bonding [20] .From the data on the ratio Figure (2), we find that all Slendeness values did not exceed the appropriate limit for producing high-value papers, but they are suitable for producing lower-quality papers such as wrapping paper, newspapers and cardboard.



3.2.7. Flexibility Ratio : An important factor that determines the suitability of wood for papermaking. Its high value provides better-shaped paper with good bonding. The fibers have a relatively good length to diameter which results in good flexibility for bonding the fibers during papermaking. On the other hand, the strength properties of paper such as tensile strength, bursting strength and folding strength are mainly affected by the way the individual fibers are bonded together in the paper sheets. Figure (3) shows that branch woods have good values for making paper with good flexibility.

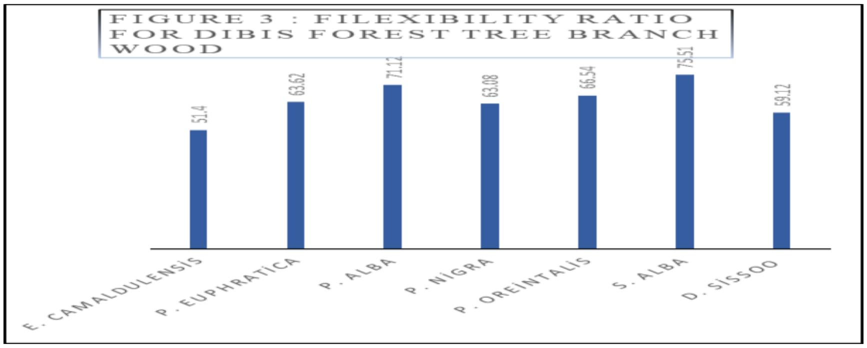


Table 2: Chemical Characteristic of Dibis Forest Tree (Trunk & Branches)

Tree type	Tree part	Extraction in Ethanol : benzine %	Extraction in Hot Water %	Lignin %	Ash %	Holo cellulose %
Eucalyptus	T	2.55	3.45	23.42	0.68	69.90
camaldulensis	B	2.13	2.85	19.24	0.32	75.46
Populus	T	3.41	2.50	20.31	0.65	73.13
euphratica	B	2.45	2.18	19.02	0.43	75.92
Populus alba	T	4.8	2.85	21.13	0.30	70.92
	B	3.85	2.41	18.67	0.20	74.87
Populus nigra	T	1.69	3.05	20.78	.068	73.80
	B	1.60	3.54	17.56	0.41	76.89
Platanus	T	2.54	2,77	20.85	0.86	72.98
Oreintalis	B	2.30	2.11	17.68	0.32	75.59
Salix alba	T	3.25	2.75	22.78	0.65	70.57
	B	2.56	2.34	19.35	0.40	75.35
Dalbergia	T	3.66	3.15	23.54	0.60	69.05
Sissoo	B	3.15	2.16	18.33	0.43	75.93

3.3 Chemical characteristic

The chemical composition of wood gives an idea of the feasibility of tree wood as a raw material for paper making. The fibrous constituent is the most important part of the plant. Since plant fibres consist of cell walls, the composition and amount of fibres is reflected in the properties of cell walls. Generally, lingnocellulose materials from wood and non-wood plant consist of cellulose, lignin, hemicelluloses, extractive and some inorganic matter. Information on the chemical composition is important in deciding the techno-commercial suitability, pulping method and paper strength of a particular wood material [20]. Table (2) shown the percentage of Extraction in Ethanol: benzine, Extraction in Hot Water, lignin, ash & Holocellulose for branch wood of the studied trees in addition to the wood of the main trunk for comparison purposes.

For (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba*, *Populus nigra*, *Platanus Oreintalis*, *Platanus Orientalis*, *Salix alba* and *Dalbergia Sissoo*), the total extracts of the branch wood amounted to (4.98, 4.63, 6.26, 5.14, 4.41, 4.9 & 5.31) % respectively, lignin percentage were (19.24, 19.02, 18.67, 17.56, 17.68, 19.35 and 18.33) % respectively, According to 22, the lignan ratios are within the lower limits of lignan rates in various forest trees, and their ratios are lower than the ratios of the main trunk wood. The reason may be due to the young age of the branch

compared to the main trunk, as the ratios of lignin and extracts increase with the passage of time. for [20] the ease of deignification of the material during the chemical pulping process can be estimated from lignin content However, they require high chemical consumption and/or reaction time during the pulping process in some factories.

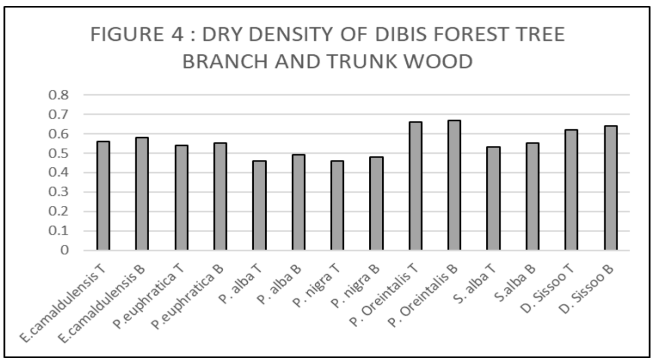
,The ash content of the wood showed lower percentages compared to the stem wood

,The percentages of holocellulose increased compared to the stem wood for all studied species and showed good values reaching (75.46, 75.92, 74.87, 76.89, 75.59, 75.35 and 75.93) % respectively.

3.4 Physical characteristic

Density g/cm^3: Figure (1) shows the results of the density values of the wood of the branches and trunks of the Dibis forest tree species, where the density values of the wood branches for (*Eucalyptus camaldulensis*, *Populus euphratica*, *Populus alba*, *Populus nigra*, *Platanus Oreintalis*, *Platanus Orientalis*, *Salix alba* and *Dalbergia Sissoo*) were (0.58, 0.55, 0.49, 0.48, 0.67, 0.55 and 0.64) g/cm^3 and trunk wood were (0.56, 0.54, 0.46, 0.46, 0.66, 0.53 and 0.62) g/cm^3 respectively.

It was noted from the results that the density of branch wood recorded higher values than the density of stem wood for all types of trees studied.



Conclusion

From the results obtained, we conclude the following:

1. The woody branches of the species in the Dibs Forest have branched and twisted stems, which make it difficult to use them in construction and carpentry work, and also complicate the study of their mechanical properties.
2. The values of the anatomical properties and the properties related to the paper industry of the wood of the branches suggest the possibility of using them to produce paper with average properties.
3. The proportions of the chemical components of the wood of the branches are good in terms of the content of Holocellulose and lignin, which suggests their use in the manufacture of paper and composite panels.
4. The branches can be used in the manufacture of composite panels & charcoal.

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دراسة بعض الصفات التكنولوجية الخشب أفرع بعض أنواع الأشجار النامية في غابة دبس.

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الخلاصة

أجريت هذه الدراسة على أفرع الأشجار النامية في غابة دبس / شمال مدينة كركوك وأختيرت أشجار (*Eucalyptus camaldulensis, Populus euphratica, Populus alba, Populus nigra, Platanus Oreintalis, , Salix alba Dalbergia Sissoo*) حيث أخذت عينات الدراسة من الأفرع السفلية للأشجار كما أخذت عينات من الساق الرئيسي للأشجار لأغراض المقارنة ، تضمنت الصفات التكنلوجية المدروسة الوصف المظهري للأفرع والصفات التشريحية (طول وقطر الألياف وقطر التجويف وسمك جدار الخلية ونسب رانكل والتلبد والمرونة) والصفات الكيميائية (نسبة المستخلصات الذائبة واللكنين والرماد والهولوسيليلوز) إضافة لقياس الكثافة كصفة فيزيائية، تعذر قياس الصفات الميكاميكية للأفرغ بسبب كثرة الإلتواء وعدم الإستقامة.

تباينت البيانات ضمن الانواع المدروسة، الصفات التشريحية في خشب الأفرع أظهرت إنخفاضاً في القيم ، نسبة الهولوسيليلوزوقيم الكثافة أظهرت زيادة في أفرع الأشجار، من الممكن إستخدام خشب الأفرع في صناعة الـعجينة الـسيليلوزية وورق ذات جودة متوسطة فضلاً عن إستخدامها في صناعة الألواح التركيبية.

الكلمات المفتاحية: فرع الخشب, تصنيع الورق ,غابات دبس.