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Suitability of *Eucalyptus camaldulensis* dehnh. growing in kurdistan region of iraq for sawn lumber industry

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Abstract

The absence of utilization-plan for the plantations of eucalypt in Kurdistan region created the necessity of exploring the wood and its validity for sawn lumber production. Twenty two trees of *Eucalyptus camaldulensis* Dehnh. were cut, bucked, and sawed for boards with different thicknesses. Boards were dried once in summer; second in winter under three methods of drying in each of the two seasons. Flat sawing (FS) and quarter sawing (QS) were tested. Board volumes were measured and classified into different categories according to board dimensions. Total income for the two methods of sawing and for the different seasons was estimated. Results indicated that merchantable quality sawn boards can be produced from the species by using certain drying techniques. FS and QS were suitable but boards produced were different in quality and quantity. Waste of sawing was higher in case of QS technique. Almost all of wide boards (>16 cm) belonged to (FS). Equal log volume (2.5 m^3) resulted in 1.81 m^3 and 1.35 m^3 of sawn boards by FS and QS respectively. Because of lessen wastes and better quality, FS offered 48% more income.

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Introduction

Eucalyptus is known as one of the fastest wood producing trees. Under favorable conditions, it has the ability to produce around 100 cubic meters per hectare annually. Some studies reported that there are about 18 Million hectare of Eucalypt in the world (Myburg *et. al.*, 2006), it was expected that the global total area of *Eucalyptus* in 2010 would increase up to 20 Million hectare (Iglesias *et. al.*, 2008). Genus *Eucalyptus* has more than 600 species and varieties. Those cultivated due to the commercial standards, do not exceed a dozen of its kinds, *E. camaldulensis* is one of them (Acosta *et. al.,* 2008). They are widely used for a variety of products like sawn timber, poles, fire wood, pulp, essential oils, furniture, honey, tannin, shade and shelter, soil reclamation, construction purposes, wind break, pest resistance, and natural landscaping (Eldridge *et. al.*,1993).

In Iraq, few species of the genus were introduced to the country as an exotic trees during the last century. Literature referred that more than twenty species of the genus were found in Iraq, where the main ones being *E. camaldulensis* and *E. microtheca*. Some other species as *E. largiflorens, E. sideroxylon,...etc.* were planted in an experimental attempts and could not be considered as established species (Rooitzsch and Reader,1969). Trees of the genus have been used in the country for pulp, chipboard, fire wood, shelter belts... etc. In the middle and southern part of the country, where a significant levels of high temperature are predominant in summer, the species could stand well and resist the sever drought conditions. Proper temperature and humidity rates as well as precipitation in some parts of Kurdistan offered better conditions for Eucalypt in summer. The situation is different in winter; it is not advisable to be planted at high elevations where long period of frost is expected during the season. Such sever conditions eucalypts cannot resist.

Wide areas among big project of forestation were planted in Iraq since the mid of last century, *Eucalyptus* was the predominant species. Some of plantations were established in Kurdistan region. Unstable political and economical circumstances before 2003 resulted in sever deterioration of the afforested areas. Currently, serious efforts are being exerted for establishing new forestation projects either by Eucalypt or by other species. Kurdistan region has no utilization activities, so absence of utilization plan for the plantations of eucalypt motivated to search in this field. Therefore, aim of the study was to explore utilizing possibilities of *E. camaldulensis* grown under Kurdistan region conditions for sawn lumber industry.

Materials and methods

Locality: The study was conducted in the Faculty of Agriculture and Forestry, University of Duhok, Sumeil, Kurdistan Region of Iraq. Trees of *Eucalyptus camaldulensis* were selected from a stand at Khabat district (Askikalak) in Erbil Governorate. Trees with proper height, diameter, straightness, having no infection were selected to be the material of the study. Ten trees for summer season and twelve for winter were marked and felled in June 2011 and in January 2012 respectively.

Logging: Felling was done by using chain saw, by which limbing has been carried out, too. Conditions of correct felling were maintained for insuring safe felling and no additional stresses to be occurred. They were felled on flat area, so no additional stresses were arise while cross cutting. Lengths of all logs were measured from opposite sides by measuring tape. Four diameter readings were taken by caliper at each of the two ends. The main stems were bucked up to merchantable diameter into number of logs varied from 3-6 depending on diameter.

Measurments: Volumes and related parameters of the two seasons are illustrated in Tables 1 and 2. Stem volume of the summer trees was not far from that of winter although the later contained 12 trees with larger mean diameter. The reason most probably was the shorter stem length, though; less number of logs was obtained. Comparable volume of saw-logs has achieved from each of the two seasons. In summer (4.97 m^3) of technical round wood could be prepared

for sawing from a total of (7.99 m³) stem volume, but a volume of logs equal to (5.50 m³) has obtained in winter from a total stem volume of (8.65 m³). Difference in small diameter mean had its effects on resulted log volumes (Technical round wood).

Sawing: Because of unavailability of a specialized sawmill, sawing was carried out at Aso saw mill in Erbil.

It has been supplied by normal carpentry saws, by which the process was performed. The logs were converted into boards with three thicknesses (2, 4, 6 cm) and using of two sawing techniques (flat and quarter) and three methods of drying (air, kiln, and solar drying), that was according to experimental plan being prepared and discussed in preceding papers as apart of Ph. D. study (Abd Ali and Taha, 2013 a,b).

Three stacks for each season (one stack for each drying method) were prepared. Green boards dimensions were: Length = 2m, Thickness = 20, 40, and 60 mm and Width = 32-202 mm). Boards were classified depending on grade and dimensions into specific products or uses. Indirect profits were not included in the study because of lack of basic data on such branch of utilization neither in Kurdistan nor in all of Iraq.

Iraqi markets do not deal with local woods (eucalypt is one of them) as sawn lumber. Method of marketing in the country is almost depending on piece, pole, or log. Therefore, market prices in Iraq are inapplicable for a study searching with scientific base of estimations. Hence, global mean prices of comparable *Eucalyptus* species sawn-boards were used instead. They were, of course, not exact but they could offer an accepted level of confidence. Total income was estimated for each of the two utilization seasons. Comparison between sawing methods in term of income was prepared.

Results and discussion

As the main object of the study was the explore of utilizing possibility of *E. camaldulensis* wood in saw lumber industry, measurements and calculations were carried out on the main stem only, other parts of trees were out of this study concern.

Table 1. Stem dimensions and log volumes of summer- felled trees.

Tree No.	Merchantable Length (m)	Small Diameter (cm)	Large Diameter (cm)	Mean Diameter (cm)	Stem Over bark Volume (m³)	Technical Round Wood (m³)
1	17.250	9.750	33.380	21.565	0.764	0.514
2	19.175	11.175	31.900	21.540	0.889	0.446
3	19.975	8.675	30.175	19.425	0.777	0.475
4	20.100	6.625	37.400	22.013	1.095	0.650
5	22.175	7.525	29.550	18.540	0.820	0.496
6	20.740	8.075	27.725	17.900	0.695	0.424
7	19.875	8.600	29.840	19.220	0.678	0.460
8	19.960	8.510	25.990	17.250	0.596	0.363
9	19.900	10.260	29.640	19.950	0.818	0.465
10	21.862	6.740	33.600	20.170	0.860	0.676
Mean	20.092	8.590	30.920	19.763	0.799	0.497
Total					7.990	4.970

When logs were subjected to sawing, diameter played an important role in output. Larger log diameters of winter produced (3.994 m³) of sawn boards (Tab. 3), while summer logs could not produce more than (3.167 m³) (Tab. 4). Since lumber dimensions are important criteria in determining board quality and prices, equal length dried boards were classified according to width and thickness into five classes for better volume and price estimate (Tabs. 3, 4, 6, 7). According to nature and properties of *E. camaldulensis* wood, some uses were suggested to each class. These uses or products have their global prices.

Almost all of summer wide boards (>16 cm) belonged to (FS) and only one was quarter-sawn board (Tabs. 6, 7). These results approved what many specialists (Washusen and Clark (2005), Jones *et al.*, (2010) Bootle, (1983) and Frey, (2007) mentioned that quarter sawing affords higher percentage of wastes. Wider free defects boards are classified as high grade timbers and having their high prices. These results were not expected since most of literatures (Booker, 1994), (Yasin and Raza, 1992) and (Nolan *et al*, 2003) recommended that quarter sawing for *E. camaldulensis* offers better quality timbers.

Table 2. Stem dimensions and log volumes of winter- felled trees.

Tree No.	Merchantable Length (m)	Small Diameter (cm)	Large Diameter (cm)	Mean Diameter (cm)	Stem Over bark Volume (m^3)	Technical round wood (m^3)
1	18.250	12.100	34.800	23.450	0.875	0.484
2	14.900	10.050	29.750	19.900	0.500	0.394
3	17.100	10.000	42.930	26.460	1.034	0.879
4	13.950	12.360	26.300	19.330	0.440	0.311
5	15.250	11.110	32.750	21.930	0.620	0.316
6	16.250	11.880	36.300	24.090	0.790	0.449
7	16.250	10.330	36.600	23.465	0.743	0.514
8	17.750	10.550	32.650	21.600	0.703	0.594
9	19.250	11.150	35.600	23.375	0.880	0.393
10	18.200	9.000	32.450	20.725	0.670	0.413
11	16.250	12.000	37.000	24.500	0.810	0.372
12	17.300	11.000	28.750	19.870	0.580	0.385
Mean	16.725	10.960	33.820	22.390	0.720	0.459
Total					8.645	5.504

Although, higher volume has attained in winter drying, closer width of boards has obtained. Class II (6-10) cm contained 390 boards i.e. 56% of the total boards number (Tab. 3). No wider boards (more than 16cm) could be produced from winter sawing. Summer log volume (4.97 m^3) was divided into two parts; 2.515 m^3 for flat and 2.455 m^3 for quarter sawing, i.e. quite similar volumes (Tab. 5). The first (FS) produced 1.8181m^3 of sawn boards (Tab. 6), while the second (QS) offered 1.3474 m^3 only (Tab. 7). The difference was about 1/2 m^3 of sawn boards in addition to enhancing quality in case of (FS) by attaining boards with greater width. Out of 45 summer wide boards, 44 of them belonged to (FS) and only one was quarter-sawn.

Table 3. Estimated prices and total income of sawn boards of *Eucalyptus camaldulensis* for winter drying.

Class Width(cm)	Boards Number	Volume (m^3)	%	Type of products	Unit price US / m^3	Mean Price (US $)	Income (US $)
I (4 - <6)	53	0.17728	4.4	Tiles & Flooring	150-320	235	41.6
II (6 - <10)	390	2.23322	55.9	Furniture Grade & Plywood	220-500	360	803.9
III (10 - <16)	145	1.58335	39.7	Furniture Grade & Plywood	220-500	360	570.0
IV (16 -<20)	-	-	-	-	-	-	-
V (20 +)	-	-	-	-	-	-	-
Total	588	3.9938	100				1415.5

These results approved what many specialists (Washusen and Clark (2005), Jones *et al.*, (2010). Bootle, (1983) and agreed what Frey, (2007)) mentioned that quarter sawing affords higher percentage of wastes. Wider free defects boards are classified as high grade timbers and having their high prices.

These results were not expected since most of literatures (Booker, 1994), (Yasin and Raza, 1992)

and (Nolan *et al,* 2003) recommended quarter sawing of *E. camaldulensis* for getting better quality timbers. Defect testing and quality assessment of same study did not appear significant inferiority to (FS) boards. (Abd Ali and Taha, 2013a,b). No definite explanation could interpret the results more than two suggestions, the first is the conditions under which trees grown, the second is the mild drying conditions followed during drying processes.

Table 4. Estimated prices and total income of sawn boards of *Eucalyptus camaldulensis* for summer drying.

Width class (cm)	No. of boards	Volume		Type of products	Unit price (US $ /m³)	Income of SB (US $)
		(m³)	%			
I (4-<6)	97	0.3652	11.54	Tiles & Flooring	150 – 320	85.82
II (6-<10)	184	1.0993	34.73	Furniture Grade	220-500	395.75
III (10-<16)	106	1.0266	32.4	Furniture Grade	220-500	369.56
IV (16-<20)	37	0.4857	15.34	Wood Door	350 – 980	323.01
V(20+)	12	0.1888	6.0	Wood Door	350 – 980	125.54
Total	436	3.1656	100			1299.68

Larger volume of sawn board does not necessarily mean more income. Total winter sawn board volumes (3.9938m³) could not ensure more than ($1415.5) income. That because none of this season boards could belong to the best two classes (IV and V). Calculation of per - unit income resulted in (354.39 $/m³) of sawn boards. Simultaneously, (3.1656 m³) of summer sawn boards could ensure a total income of US$ 1299.7.

Volume of (1.3474 m³) of quarter sawn boards ensured a total income of US ($448.7), i.e. 333 $/m³, whereas flat sawn board volume of (1.818 m³) could have ($850.9) as a total income, that means an income of 468 $/m³ has insured. Improving per - unit income was guaranteed through the application of flat sawing in about 50% of summer boards.

Summer sawing resulted in interesting results (Tab.6). Comparing with winter, less number of boards by about 26% has obtained. From other hand, high percentage of wider boards has accomplished. Classes (IV and V) contained 49 boards i.e. 1/5 of the total number. When summer boards divided into two categories depending on sawing method, the volume obtained could explain most of the above-mentioned results.

Table 6. Estimated prices and total income of flat sawn boards of *Eucalyptus camaldulensis* Den. for summer drying.

Width class (cm)	No. of FS boards	Volume		Type of products	Unit price (US $ /m³)	Income of SB (US $)
		(m³)	%			
I (4-<6)	14	0.0605	3.33	Tiles & Flooring	150 – 320	14.36
II (6-<10)	26	0.1615	8.8	Furniture & Plywood	220-500	58.70
III (10-<16)	92	0.9552	52.5	Furniture & Plywood	220-500	347.09
IV (16-<20)	36	0.4543	25.0	Wood Door	350 – 980	306.40
V (20 +)	12	0.1865	10.32	Wood Door	350 – 980	124.39
Total	180	1.8181	100			850.94

Wood product prices in global markets are not fixed, they are dependable upon time, place, and of course species and quality, therefore, the range of price is mostly used. In this study, the average of global market prices was calculated by taking the average of lower and higher limits. That means the estimations of class and total income could be more or less than the above mentioned calculations, but the important point is that the trend will be the same.

Table 7. Estimated prices and total income of quarter sawn boards of *Eucalyptus camaldulensis* Den. for summer drying.

Width class (cm)	No. of QS boards	Volume		Type of product	Unit price (US $ /m³)	Income of SB (US $)
		(m³)	%			
I (4 - 6)	85	0.3039	22.5	Tiles & Flooring	150 - 320	71.21
II (6 - 10)	161	0.9416	69.8	Furniture Grade & Plywood	220 - 500	338.02
III (10 -16)	9	0.0892	6.6	Furniture Grade & Plywood	220 - 500	31.02
IV (16 -2 0)	1	0.0127	1.0	Wood Door	350 - 980	8.49
V (20 +)	-	-	-	-	-	-
Total	256	1.3474	100			448.74

Conclusions and Recommendations

Based on the study results, the following points can be concluded:

Eucalyptus camaldulensis Den. growing in Kurdistan region is suitable to be used as timber wood.

Merchantable quality sawn boards can be produced from the species by using certain drying techniques.

Sawn boards with conventional merchantable thicknesses can be prepared with no difficulties.

Flat sawing together with quarter sawing can be used for eucalypt wood successfully.

Therefore, the following recommendations might be useful to authorities of forestry and wood industry in the country:

Adopting planting projects in appropriate locations to increase eucalypt harvest volume.

Establishing lumber industry including all production stages to support regional economy.

Erecting composite panel plant and /or pulping industry to enable the exploitation of forest and factory wastes, and ensuring high degree ofutilization.

Further studies are needed on wood properties, physical, mechanical and machinery for determining the type of products for which *Eucalyptus camaldulensis* is more suitable.

Feasibility study is needed taking into account economical, legal, technological, and other factors to analyze the potential ofestablishing any of the proposed projects successfully.

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