The Use of Sawn Timber for Barrel Production from Oak Wood (Quercus Petraea L.)

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Abstract

The number of firms involved in the production of barrels from white oak (quercus petraea L,) is small. The production of wood barrels is quite complex and with a low exploitation coefficient. We think it is in the interests of firms to know how much the coefficient of use of sawn material for these types of products is. For the study we have chosen the firm "BehaN" in Rahovec, which mainly deals with the production of oak wood barrels. The sawn material taken in the study was of a good quality. To do the tests we used weighing methods, as its volume was difficult to measure since it was half milled. Tests were conducted for the production of barrel details with a volume of 50, 30 and 20 litters, which are most widely used by the costumers. For the realization used by the firm were taken into account the dimensions and technology. From the measurement data it turned out that the weight of the sawn timber was about 250kg. The results of these weights were exchanged in volume and percentage and they are shown in final results.

Keywords: exploitation coefficient, plank, wood pieces, sawdust, barrel

Introduction

Barrels were first used for wine by the Romans. They were a big improvement over amphorae (Greek) and goat skins, can be built without metal using pegs and split willow hoops (Barrels & Ageing, 2014).

Traditionally, there are three species of wood used in barrel making: Q. petraea Liebl. and Q. robur L., the most common oak species in French forests, and the American oak Q. alba L. (Mariana Tavares, , Antonio M. Jordao and Jorge M. Ricardo-da-Silva, 2017).

In our country there are few companies that produce oak barrels (quercus petraea L.). But since it is a complicated work and with a small use of wood, we thought it was of interest to see how much it is used.

The production of barrels from wood is not only an interest in the preservation of wine, cognac and other alcoholic drinks, but it is also important for the fact that the physiological process that occurs due to the passage of oxygen into the air through the stave of barrel directly affects the formation and improves the quality of wine. Storing wine, cognac and other alcoholic drinks in barrels for a long time they become delicious, aromatic and clear. This is also the main reason why these products are stored in wooden barrels.

The study was done at "Beha-N" Company in Rahovec which deals with the production of wooden barrels. It produces barrels of various volumes where the most common are barrels 50, 30, 20 litters (figure 1).

Figure 1. Barrel

Aim of the Study

The purpose of this study is to see the percentage of sawdust used for the production of oak wood barrels (quercus petraea L.) and how much is the waste in wood pieces, shavings and sawdust.

Methodology

The sawn timber in this firm is dried naturally for the production of barrels. Sawn bands are dried in 12-16% moisture.

The amount of sawdust used is weighed on the scales in kg then the weight is exchanged to m^3. This is because the saw material used in this firm is half milled and it is difficult to draw the correct volume by other methods. In this way the pure stave, wood pieces, shavings and sawdust are measured. In this case specific weight calculation is also required.

Materials used

- Oak sawn timber with dimensions (31x120-160x1000mm.)
- Wood processing machines as well (saw blade, longitudinal saw, planer machines, milling machine, sanding machine etc.).
- Scale, meters, micrometer, etc.

Methodology used

Determination of sawn timber use was done by measurements in the field.

The following formulas are used for calculations:

The volume of sawn timber in [m^3] (Ajdinaj D. Marku P., 2014)

V = Psh.............(m)..............(1)
Yu

Where:

P“h - Weight of sawn timber in kg,

Yu - Specific wood weight in kg/m^3.

Net volume of stave [m^3]

V = P................ (m^3)............(2)

Yu

Where:

Pd - Weight of stave in kg,

Net yield stave in [%]

r = El x 100 =..........(%).....(**3**)

V]

Net volume of barrel heads [m^3]

V/ = Pf......... (m^3).........(4)

Yu

Where:

P

f - Net weight of barrel heads in kg,Net yield of barrel heads [%]

R f = V X100 = ...(%) . (5)

Wood pieces volume [m^3] (Sejdiu M, 2017)

p

V = p (m^3) .... (6)

Yu

Where:

pa -Wood pieces weight in kg.

Yield wood pieces [%]

R_a = Vr x 100 (%)................. (7)

Sawdust volume in [m^3] (Ajdinaj D. Marku P., 2014)

$V_g = {}^{p}$ .... (m^3) .... (8)

Yu

Where:

p

ʻ - Sawdust weight in kg.

Sawdust performance in [%]

r = Vl x100....(%).................. (9)

To calculate the specific weight, there were taken samples of 2x2x2cm and they were taken at the University of Applied Science Lab in Ferizaj. Samples were weighted on scale 0.1 gr. and measured with micrometer 0.01mm (figure 2).

Figure 2. The view of materials and tools during practical examinations.

Then the samples were dried to oven dry moisture (102±3°C). The measurements are given in chart 1.

Chart 1. Sample dimensions, volume, weight and moisture.

2E	Samples dimension in moisture 14%						Weight of oven dry samples in gr.	2E	Samples dimension in moisture 14%						Weight of oven dry samples in gr.
	Longitudinal mm.	Radial mm.	Tangential mm.	Volume in cm^3.	Weight of Samples gr.	Moisture %			Longitudinal mm.	Radial mm.	Tangential mm.	Volume in cm^3	Weight of Samples gr.	Moisture %	
1	19,83	18,65	18,65	6,90	5,60	14%	4,90	39	19,82	18,41	18,41	6,72	5,50	15%	4,80
2	19,85	18,49	18,56	6,81	5,40	15%	4,70	40	19,76	18,52	18,53	6,78	5,50	15%	4,80
3	19,91	18,48	18,69	6,88	5,20	13%	4,60	41	19,83	18,44	18,40	6,73	5,50	15%	4,80
4	19,91	18,49	18,61	6,85	5,60	14%	4,90	42	19,72	18,56	18,54	6,79	5,50	15%	4,80
5	19,84	18,58	18,59	6,85	5,50	15%	4,80	43	19,85	18,69	18,60	6,90	5,40	13%	4,80
6	19,72	18,63	19,10	7,02	5,50	15%	4,80	44	19,80	18,48	18,42	6,74	5,40	13%	4,80
7	19,86	18,58	18,59	6,86	5,50	15%	4,80	45	19,70	18,99	18,51	6,92	5,40	13%	4,80
8	19,73	18,57	18,51	6,78	5,40	15%	4,70	46	19,77	18,52	18,69	6,84	5,50	15%	4,80
9	19,80	18,66	19,10	7,06	5,50	15%	4,80	47	19,87	18,56	18,53	6,83	5,50	15%	4,80
10	19,88	18,41	18,40	6,73	5,40	15%	4,70	48	19,82	18,40	18,39	6,71	5,40	13%	4,80
11	19,90	18,52	18,72	6,90	5,40	15%	4,70	49	19,83	19,57	18,69	7,25	5,50	15%	4,80
12	19,87	18,38	18,57	6,78	5,50	15%	4,80	50	19,77	18,60	18,61	6,84	5,50	15%	4,80
13	19,92	18,53	18,61	6,87	5,50	15%	4,80	51	19,79	18,26	18,59	6,72	5,90	13%	5,20
14	19,38	18,56	18,61	6,69	5,40	15%	4,70	52	19,85	18,49	18,27	6,71	5,90	13%	5,20
15	19,88	18,62	18,67	6,91	5,50	15%	4,80	53	19,81	18,66	18,40	6,80	5,90	13%	5,20
16	19,82	18,58	18,52	6,82	5,50	15%	4,80	54	19,85	18,57	18,45	6,80	5,80	12%	5,20
17	19,80	18,62	18,67	6,88	5,50	12%	4,90	55	19,50	18,41	18,45	6,62	5,80	14%	5,10
18	19,81	18,48	18,51	6,78	5,40	15%	4,70	56	19,88	18,59	18,39	6,80	5,90	13%	5,20
19	19,79	18,66	17,65	6,52	5,50	15%	4,80	57	19,84	18,62	18,18	6,72	5,90	13%	5,20
20	19,85	18,58	18,64	6,87	5,40	13%	4,80	58	19,84	18,62	18,18	6,72	5,80	14%	5,10
21	19,77	18,53	18,64	6,83	5,50	15%	4,80	59	19,82	18,43	18,59	6,79	5,80	14%	5,10
22	19,78	18,55	18,68	6,85	5,40	15%	4,70	60	19,83	18,55	18,32	6,74	5,90	16%	5,10
23	19,81	18,56	18,84	6,93	5,40	13%	4,80	61	19,88	18,45	18,64	6,84	5,80	14%	5,10
24	19,81	18,67	18,68	6,91	5,50	12%	4,90	62	19,85	18,40	18,54	6,77	5,90	13%	5,20
25	19,81	18,64	18,73	6,92	5,40	13%	4,80	63	19,78	18,49	18,21	6,66	5,80	14%	5,10

25	19,81	18,64	18,73	6,92	5,40	13%	4,80	63	19,78	18,49	18,21	6,66	5,80	14%	5,10
26	19,93	18,50	18,63	6,87	5,30	13%	4,70	64	19,79	18,22	18,48	6,66	5,90	16%	5,10
27	19,72	18,63	18,58	6,83	5,40	13%	4,80	65	18,78	18,25	18,57	6,36	5,90	16%	5,10
28	19,76	18,62	18,63	6,85	5,50	15%	4,80	66	19,96	18,45	18,18	6,70	5,90	16%	5,10
29	19,83	18,64	18,58	6,87	5,60	14%	4,90	67	19,84	18,40	18,18	6,64	5,90	13%	5,20
30	19,72	18,60	18,66	6,84	5,70	19%	4,80	68	19,92	18,49	18,38	6,77	6,00	15%	5,20
31	19,64	18,55	18,69	6,81	5,30	13%	4,70	69	19,78	18,58	18,29	6,72	5,80	14%	5,10
32	19,85	18,64	18,73	6,93	5,40	13%	4,80	70	19,87	18,63	18,31	6,78	5,90	13%	5,20
33	19,88	18,56	18,52	6,83	5,50	12%	4,90	71	19,84	18,13	18,53	6,67	6,00	15%	5,20
34	19,78	18,56	18,61	6,83	5,50	15%	4,80	72	19,81	18,58	18,30	6,74	5,80	14%	5,10
35	19,80	18,65	18,71	6,91	5,50	15%	4,80	73	19,88	18,56	18,31	6,76	5,90	13%	5,20
36	19,85	18,40	18,51	6,76	5,50	12%	4,90	74	19,85	18,57	18,34	6,76	6,00	13%	5,30
37	19,85	19,28	18,67	7,15	5,60	14%	4,90	75	19,84	18,26	18,53	6,71	5,90	13%	5,20
38	19,68	18,53	18,67	6,81	5,50	15%	4,80								
Average				6,86	5,47	14%	4,79	Average				6,76	5,75	14%	5,04

According to the chart 1, the average moisture of wood was 13.94%, the average volume of samples in this moisture was 6.81 cm^3, the average weight of samples 5.61gr. and the average weight of samples in dry condition 4.92gr.

Specific wood weight calculation was with the formula (Fico S. Marku P. Shqau I., 1998):

$Yu = \frac{P}{V_u}$ ..... $S^{r/cm3}$ ...... (10)

Where:

Pu- Sample weight in gr.

Vu- Sample volume in m^3

According to these data we see that 1cm^3 in 13.94% moisture weights 0.824gr. or 1m^3 is equal to 824kg.

Results

Measurement of sawn timber - The sawn timber in this firm was chosen with small annual rings and large pith wood, as mark is inadequate.

The sawn timber taken in the study weighted 250kg, and then it was exchanged to m^3 by equation 1.

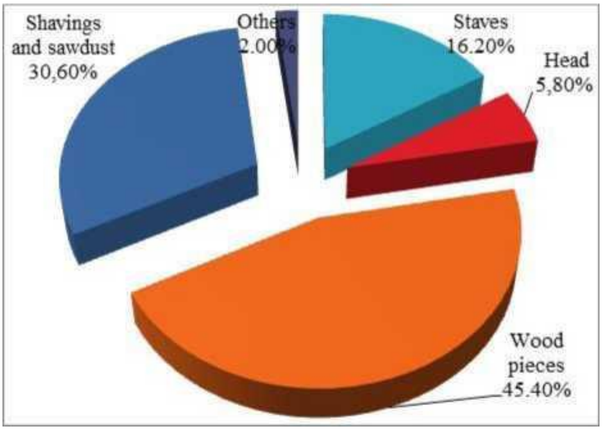
V = Ij!tL = 250 = 0.3033980 (m^3)

Then the final balance of the use of sawn timber for barrels was finalized. The results are presented in tabular form in chart 2.

Chart 2. Performance in volume and percentage

Sawn timber			Clean staves			Clean barrel			Wood pieces			Shavings and			Others		
Weight kg.	Volume m^3		Weight kg.	Volume m^3		Weight kg.	Volume m^3		Weight kg.	Volume m^3		Weight kg.	Volume m^3		Weight kg.	Volume m^3	

Graphically, the data of chart 2. for percentage are shown in graphic 1.



Graphic 2. Efficiency in percentage.

According to the chart it can be seen that the use of sawn timber is very low, about 22%. If we consider the losses of wood during sawing process to make planks and drying boards, then the yield is even lower. This is also, as we said above, for the production of barrels it is used the heartwood.

Conclusion and Recommendation

For the production of stave barrels it is used only the heartwood.

From the amount of dry sawn timber of 0.3303m3 used for the production of a barrel is:

Stave takes 16.2%, heads 5.8%.

Others, like wood pieces (45.4%), sawdust and shavings and others (32.6%), are considered losses.

Recommendations

Based on the findings of this study, several recommendations can be put forward to optimize the production process and improve resource utilization:

Implementation of Controlled Natural Drying Protocols

The establishment of standardized procedures for natural drying of planks is essential to minimize degradation and optimize moisture content. This should include careful monitoring of environmental conditions and the implementation of protective measures against adverse weather effects.

Enhancement of Cutting Process Precision

To maximize the quality of radial cuts, it is recommended to implement precision-guided cutting systems and regular calibration of cutting equipment. This would ensure consistency in plank orientation and optimize the extraction of radial sections from the raw material.

Development of Algorithmic Cutting Patterns

The creation and implementation of mathematically optimized cutting patterns should be prioritized for each barrel volume category. This approach would facilitate the systematic maximization of raw material utilization while maintaining the required quality standards for barrel production.

Secondary Product Development

Given the significant volume of wood pieces generated during production (45.4%), it is recommended to establish a secondary production line for value-added products. This would transform what is currently considered waste material into economically viable products, thereby improving overall resource efficiency.

Biomass Resource Recovery

The substantial volume of shavings and sawdust produced presents an opportunity for biomass energy recovery or densified fuel production. It is recommended to integrate a systematic approach to collecting and processing these materials for briquette or pellet production, contributing to both waste reduction and renewable energy generation.

These recommendations aim to enhance the sustainability of barrel production while maintaining product quality and improving economic efficiency. Further research into the implementation of these recommendations would be valuable for quantifying their potential impact on production efficiency and resource utilization.

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