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Studying the Effect of the Age in *Eucalyptus camaldulensis* Species on Wood Chemical Compounds Used in Pulping Process

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Abstract: In this research, the effect of the age in young *eucalyptus* trees (in ages of 6, 8 and 10 years) on chemical compounds, for use in pulp and paper industry was studied. Chemical compounds for each age, have been repeated three times and the amount of hemicelluloses, cellulose, lignin, extractives and ash for 6 years old have been obtained relatively 27, 38, 18, 2 and 0.76, for 8 years old have been obtained 21, 42, 22, 4 and 0.65 and for 10 years old have been obtained 16, 46, 24, 5, 0.43, respectively. These compounds in several ages have been compared with each other and the results show those 10 years old tree woods because of higher amount of cellulose and lower amount of ash can be more suitable choice for pulp industry.

Key words: Ash · *Eucalyptus camaldulensis* · Extractives · Cellulose · Hemicelluloses · Lignin

INTRODUCTION

Cell variations and chemical variations arising from tree growth, has important effects on properties and behavior of wood in pulp production process. Depend on used wood species (soft wood or hard wood or even something between soft wood and hard wood depend on growth condition and species anatomic) and also kind of pulping process (including chemical or semi chemical and alkali or acidic) removing extractive organic materials from pulp is difficult [1-2]. Studying properties of eucalyptus trees show that by increasing tree age, wood density, percentage of extractive, percentage of cellulose and yield of chemical pulping increases and percentage of lignin decreases [3]. Each of those noted changes are almost stable in a specific age and after that age, changes are meaningful. Density changes from 3 years old yield of pulp, cellulose percentage and lignin percentage from 5 years old and percentage of extractives from 8 years old is meaningful [4]. Comparing between young wood and mature wood shows that fiber length, fiber density, cell walls thickness, cellulose amount and pulp yield in young wood are less and amount of lignin, extractives and hemicelluloses are more than mature wood [5]. Studying the effect of age and growth factors of young *eucalyptus glublus* trees on chemical compounds changes shows that by increasing the age from 2 to 6, lignin percentage has developed a little, extractives and cellulose percentage also has reduction but the amount of other carbohydrates (hemicelluloses), has reduction [6]. Because *eucalyptus camaldulensis* species is fast growing and usual harvesting is under 10 years old, the main goal in this research is studying the effect of tree age on amount of lignin, cellulose, hemicelluloses, extractives and ash and determining the most suitable harvesting age (among young eucalyptus trees) in regard of wood chemical compounds, for using in pulp industry.

MATERIALS AND METHODS

Wooden samples prepared from plantation forests in Sistan and Bloochastan in Iran and after determining the exact age, for the next examinations, disks of 30 to 40 centimeters sectioned. The lignin, ash and Ethanol/acetone extractable of *eucalyptus camledulnnesis* fiber were determined by TAPPI T222 om-97, T267 om-85,

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T207 om-97, respectively [7-9]. Holocellulose (sum of the cellulose and hemicelluloses) was determined following the procedure of Wise and Karl [10].

Statistical Methods: For obtained data from chemical analysis, factorial statistical design has been used and each sample in any age has been tested three times. Then for analysis of tree age effect on chemical compounds the one way variance analysis test has been used and in the end for comparing the average of several samples with each other the Duncan statistical test has been used.

DISCUSSION AND CONCLUSION

Chemical compounds percentage of each eucalyptus trees (6, 8, 10 years old) separately in three times repeating had been measured and the effect of tree age on the amount of extractives, lignin, cellulose, hemicelluloses and ash in rate of 1 percent has been meaningful (Table 1).

Results of statistical analysis and comparing the averages in Duncan method show that by increasing tree age, the amount of cellulose, extractives and lignin increase but the amount of hemicelluloses and ash decrease (Table 2). By increasing tree age, volume of hearth wood increase, percentage of parenchyma death cells increase, these cells at death time ooze organic materials (extractives), the amount of these materials will increase in wood [1-2]. In pulping processes like acid sulfite and Kraft, removing more organic materials is difficult and those in pulping process get polymerization and this causes color changing and bitumen will be produced in pulp [11].

In Table 2, increasing tree age leads to increasing the amount of wood lignin. Usually by increasing the age in mature wood, lignin percentage decrease but in this research by increasing age from 6 to 10 years the amount of lignin has increased. This increasing can have several reasons like genetic properties of wood species in comparison with young wood and mature wood and Depend of wood species, until a specific age; a large volume of wood is young wood that in comparison with mature wood shows different properties. Lignin percentage in cell walls of young wood is more than mature wood that naturally by increasing the age and increasing mature wood volume, lignin percentage decrease [5, 12-13]. By increasing tree age, cell walls of wooden fibers get thicker and percentage of cellulose increase and higher percentage of cellulose will have a good effect on produced pulp [1-2]. Young wood in comparison with mature wood has larger amount of hemicelluloses [1]. In hardwoods by increasing the age, percentage of hemicelluloses decrease and percentage of cellulose increase [13]. In younger woods, according to existing more active cells from the point of living, absorbing mineral materials (remaining ash in wood) will be more that by increasing absorption age, these materials little by little will be less [2]. However making decision about the best year of young eucalyptus trees harvesting, after examination the morphology of fibers and cooking results will be more perfect but in this study from the point of chemical compounds, the best year of harvesting is introducing and the last conclusion will be in later researches. After the last examination, results of chemical compounds analysis, eucalyptus trees in 10 years old age because of having better properties that is because of the point of higher cellulose (that has a great effect on produced pulp) lower percentage of ash and a little difference in amount of lignin with lower ages, is offered as more a appropriate wood for using in pulping industry.

Table 1: Data of one way variance analysis for the effect of tree age on wood chemical compounds

Factor	Average squares	F
Hemicelluloses	20.327	37.932
Cellulose	12.721	30.428
Lignin	7.458	22.521
Extractives	6.548	66.272
Ash	0.432	74.232

Table 2: Chemical compounds of *eucalyptus camaldulensis* wood by Duncan test

Chemical compounds	Tree age	Average	Groups
Hemicelluloses	6	27.00	A
	8	21.00	B
	10	16.00	C
Cellulose	6	38.00	C
	8	42.00	B
	10	46.00	A
Lignin	6	18.00	B
	8	22.00	A
	10	24.00	A
Extractives	6	2.00	B
	8	4.00	A
	10	5.00	A
Ash	6	0.76	A
	8	0.65	A
	10	0.43	B

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