Middle-East Journal of Scientific Research 8 (5): 967-970, 2011
ISSN 1990-9233

Chemical Composition Properties of Stem and Branch in *Alianthus altissima* Wood

[1]*Ahmad Samariha and* [2]*Majid Kiaei*

[1]Young Researchers Club, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Department of Wood and Paper Science and Technology,
Chalous Branch, Islamic Azad University, Mazandaran, Iran

Abstract: Wood chemical constituents such as cellulose, lignin, extractive alcohol-benzene and ash contents of *Ailanthus altissima* wood of trunks and branches were investigated. In trunk wood amount of cellulose, lignin, extractive alcohol-benzene and ash were 47.18, 25.19, 3.5 and 1.25% respectively, whereas for branch wood the corresponding values were 44.12, 23.86, 3.2 and 1.75% respectively. The amount of cellulose and lignin in the trunk wood and branch wood when compared with other types of wood suggest that relatively high pulp yield can be obtained from them. The result of chemical analysis of branch wood as presented in this report suggests that they can also be a potential source of pulp and paper industry.

Key words: *Ailanthus altissima* · Ash · Cellulose · Extractive alcohol-benzene · Lignin

INTRODUCTION

Ailanthus altissima (tree of heaven) is a non-indigenous invasive plant that was first introduced into the United States in 1784 by Philadelphia horticulturalist William Hamilton [1]. A non-indigenous plant has the connotation that its distribution has been altered by humans and the plant has been transported past geographical and environmental boundaries. An invasive plant can be defined as “an alien plant spreading naturally (without the direct assistance of people) in natural or semi natural habitats, to produce a significant change in terms of composition, structure or ecosystem processes” [2].

Ailanthus altissima can rapidly attain a height of 25-30 m [3] and the largest documented tree of heaven in virginia is 170 cm diameter at breast height [4]. The tree of heaven has odd-pinnately compound leaves, 20 to 60 cm long, with four to thirty-five leaflets per rachis [1]. The light brown stems are stout, pubescent when young and lack a terminal bud [5].

Wood chemical composition varies with geographical origin, genus and species. In general softwoods have higher lignin content (25-35%) and their hemicelluloses contain galactoglucomannan (15-23%) and arabinoglucuronoxylan (7-10%), while hardwoods have less lignin (18-30%) and their hemicelluloses contain acetylglucuronoxylan (15-30%) and glucomannan (2-5%). The chemical composition of different woods from different geographical origins has been collected over the years [6-7]. However, differences in analytical procedures and sample history in addition to the complexity of the chemical analysis involved require caution whenever comparisons are made. An important variation in composition is found in the heterogeneity of lignin which has a large impact in the pulping industry. Conifers have basically a G type lignin with a few H or S units and show less variation in lignin composition than hardwoods. Hardwoods have a more complex lignin composed of syringyl (S) and guaiacyl (G) units in varying ratios with a minor percentage of H units [8]. The S/G ratio can vary widely from as low as 0.51 for Acer macrophyllum [9] to 5.2 for *Eucalyptus maculata* [10]. Species of the same genus can also show a large variation in the S/G ratio: in eucalypts, a ratio of 5.2 was found for *E. maculata* and *E. diversicolor* [10] and 0.7 for *E. tereticornis* [11] and in Acers 0.4 for A. negundo [12] and 3.3 for A. rubrum [13].

Tree to tree variation is believed to contribute to lignin heterogeneity although there are few reported data. In eucalypts, the S/G ratio varied from 1.5 to 2.6 in E. globulus [14], from 0.68 to 2.22 in *E. tereticornis* and from 1.37 to 2.01 in *E. camaldulensis* [11], the latter two examples being associated with a wide geographical area of distribution from tropical to temperate zones.

Corresponding author: Ahmad Samariha, Young Researchers Club, Science and Research Branch, Islamic Azad University, Tehran, Iran.

Table 1: The Chemical Composition of *Ailanthus altissima*

	Species					
Component	Trunk Wood	Min and Max	SD	Branch Wood	Min and Max	SD
Lignin (%)	25.19±0.178	24.99-25.33	0. 7	23.86±0.101	23.75-23.95	0. 4
Cellulose (%)	47.18±0.175	47-47.35	0. 4	44.12±0.053	44.06-44.16	0. 1
Extractive alcohol-benzene (%)	3.5±0.156	3.32-3.6	4. 5	3.2±0.125	3.06-3.3	3.9
Ash (%)	1.25±0.035	1.21-1.27	2.8	1.75±0.087	1.69-1.85	5.0

SD: standard deviation

Differences in lignin composition were also found between different parts of the tree as in *E. botryoides*, with S/G ratios of 0.7 (foliage petiole), 2.0 (root wood), 1.5 (heartwood) and 1.6 (sapwood) and in *E. regnans* with 3.8 (heartwood) to 4.6 (sapwood) [15]. For *E. globulus* and *E. camaldulensis* a decreasing radial trend in the S/G ratio was found and, additionally, a decreasing trend with tree height for *E. camaldulensis* [16]. Lignin heterogeneity also occurs among tissues in relation to the time of deposition in the cell wall [17]. For instance, in Betula papyrifera the lignin in the middle lamella and secondary walls of vessels is mainly the G type, whereas secondary wall of fibres and ray parenchyma is mainly S type [18].

The properties of *Ailanthus altissima* wood have never been explored in the literature. Therefore, in this Study the chemical composition Properties Trunk and Branch of Ailanthus altissima were investigated.

MATERIALS AND METHODS

Raw Material: In this research, 3 normal *Ailanthus altissima* trees were randomly selected from in the garden of Karaj. As from each of trees; two discs were taken at breast height and branches. The test samples from the skin (mature wood) were prepared.

Chemical Composition: According to TAPPI test methods the lignin, ash and ethanol/acetone extractable of *Ailanthus altissima* were determined. The cellulose contents of *Ailanthus altissima* was determined according to the nitric acid method, ash; T211-om 93: extractives soluble in alcohol acetone; T264-om 97: lignin; T222-om 98: respectively.

RESULTS AND DISCUSSION

Chemical Analysis of Wood: The one most important parameters which determine suitability of wood as raw material for pulp and paper industry is its chemical composition [19].

The purpose of this part of the study was to provide basic information on the chemical components of *Ailanthus altissima*. Lignocellulosic materials contain cellulose, hemicelluloses, lignin and extractives in various amounts and chemical compositions. Results of the chemical analyses of Ailanthus altissima are presented in Table 1.

The descriptive statistics for chemical properties of branch and stem in *Ailanthus altissima* wood are shown in Table 1. The analysis statistical showed that there are significant between cellulose content stem and branch wood in *Ailanthus altissima* species. The value of mentioned properties in stem wood (47.18 %) is higher than the amount of cellulose in branch wood (44.12%) about 6.5%.

The cellulose content of stem *Ailanthus altissima* was found to be 47.18% was found, which is satisfactory for pulp production (close to or above 40%). The result obtained for the cellulose content of *Ailanthus altissima* was close to an earlier finding *Eucalyptus streiaticalyx* (47.07%) [20], whereas the cellulose content of stem *Ailanthus altissima* was higher than that of of *Fagus orientalis* (42.9%) and *Pinus nigra* (35.3%) [21] and white birch (45%) [22] and lower than that of hornbeam (50.67%) [23].

The analysis statistical showed that there are significant between lignin content stem and branch wood in *Ailanthus altissima* species. The value of mentioned properties in stem wood (25.19 %) is higher than the amount of lignin in branch wood (23.86%) about 5.3%.

One of these procedures was used for the determination of lignin content of stem *Ailanthus altissima* in this study and was 25.19%. The lignin content of stem Ailanthus altissima was found to be lower than that of *Fagus orientalis* (29.2%) and *Pinus nigra* (33%) [21]. And higher than that *Eucalyptus streiaticalyx* (23.01%) [20], hornbeam (23.33%) [23] and white birch (23%) [22].

The analysis statistical showed that there are significant between extractive alcohol-benzene content stem and branch wood in Ailanthus altissima species.

The value of mentioned properties in stem wood (3.5 %) is higher than the amount of extractive alcohol-benzene in branch wood (3.2%) about 8.6%.

The organic solvent extractives of stem *Ailanthus altissima* are similar to those of *Fagus orientalis* (3.5%) [21] and white birch (3%) [22] and lower than that *Eucalyptus streiaticalyx* (4.88%) [20] and higher than that, hornbeam (1.98%) [23] and *Pinus nigra* (2.51%) [21].

The analysis statistical showed that there are significant between Ash content stem and branch wood in *Ailanthus altissima* species. The value of mentioned properties in stem wood (1.25 %) is lower than the amount of Ash in branch wood (1.75%) about 25.6%.

The ash of stem *Ailanthus altissima* higher than that, hornbeam (0.78%) [23], *Fagus orientalis* (0.4%) and *Pinus nigra* (0.90%) [21], *Eucalyptus streiaticalyx* (0.55%) [20] and white birch (0.3%) [22].

Keeping in view of the chemical characteristics of *Ailanthus altissima* wood it would suggest that relatively high pulp yield can be obtained.

CONCLUSIONS

Based on the findings in this study, average cellulose and lignin content were determined as 47.18 and 25.19%, respectively. These values are comparable with the values of typical hardwoods. It was found that the Ailanthus altissima contained high amounts of ash.

The results of present investigation supplement these findings. The result of chemical analysis of branch wood as presented in this report suggests that they can also be a potential source of pulp and paper industry.

REFERENCES

1. Hu, S.Y., 1979. Ailanthus. Arnoldia, 39: 29-50.
2. Cronk, Q.C.B. and J.L. Fuller, 2001. Plant Invaders: The Threat to Natural Ecosystems. Earthscan Publications, Ltd., Sterling, VA.
3. Tennessee Exotic Plant Pest Council (TN-EPPC). 1996. Tree of Heaven. Tennessee Exotic Plant Management Manual. Nashville, TN.
4. Jenkins, D., 2002. Virginia's Big Stink: Controlling Ailanthus. pp. 5. Virginia Tech Department of Forestry, Blacksburg, VA.
5. Dirr, M.A., 1990. Manual of Woody Landscape Plants. Stipes Publishing Company, Champaign, IL.
6. Fengel, D. and D. Grosser, 1975. Chemische Zusammensetzung von Nadel- und Laubholzern. Holzals Roh- und Werkstoff, 33: 32-34.
7. Pettersen, R.C., 1984. The chemical composition of wood, in The Chemistry of Solid Wood (ed. R.M. Rowell), Advances in Chemistry Series, 207, Am. Chem. Society, Washington, DC, pp: 57-126.
8. Sarkanen, K.V. and H.L. Hergert, 1971. Classification and distribution, in Lignins: Occurrence, Formation, Structure and Function (eds K.V. Sarkanen and C.H. Ludwig), Wiley Interscience, New York, pp: 43-94.
9. Chang, H. and K.V. Sarkanen, 1973. Species variation in lignin. Effect of species on the rate of kraft delignification. Tappi J., 56: 132-134.
10. Bland, D., Ho, G. and Cohen, W. 1950. Aromatic aldehydes from the oxidation of some Australian woods and their chromatographic separation. Australian Journal of Scientific Research, Series A, 3: 642-648.
11. Kawamura, I. and D.E. Bland, 1967. The lignins of Eucalyptus wood from tropical and temperate zones. Holzforschung, 3: 65-74.
12. Towers, G. and R. Gibbs, 1953. Lignin chemistry and the taxonomy of higher plants. Nature, 172: 25-26.
13. Creighton, R.H., R. Gibbs and H. Hibbert, 1944. Studies on lignin and related compounds. LXXV. Alkaline nitrobenzene oxidation of plant materials and application to taxonomic classification. J. the American Chemical Society, 66: 32-37.
14. Rodrigues, J., D. Meier, O. Faix and H. Pereira, 1999. Determination of tree to tree variation in syringyl/guaiacyl ratio of Eucalyptus globulus wood lignin by analytical pyrolysis. J. Analytical and Applied Pyrolysis, 48: 121-128.
15. Sarkanen, K.V. and H.L. Hergert, 1971. Classification and distribution, in Lignins: Occurrence, Formation, Structure and Function (eds) Sarkanen K.V. and C.H. Ludwig), Wiley Interscience, New York, pp: 43-94.
16. Ona, T., T. Sonoda, K. Itoh and M. Shibata, 1997. Relationship of lignin content, lignin monomeric composition and hemicellulose composition in the same trunk sought by their within-tree variation in Eucalyptus camaldulensis and E. globules. Holzforschung, 51: 396-404.
17. Terashima, N., K. Fukushima, L.F. He and K. Takabe, 1993. Comprehensive model of the lignified plant cell wall, in Forage Cell Wall Structure and Digestibility (eds H.G. Jung, D.R. Buxton, R.D. Hatfield and J. Ralph), Am. Soc. Agronomy Inc., Crop Sci. Soc. America Inc., Soil Sci. Soc. America Inc., Madison, pp: 247-270.

18. Fergus, B.J. and D.A. Goring, 1970. The distribution of lignin in birch wood as determined by ultraviolet microscopy. Holzforschung, 24: 118-124.
19. Kayama, T., 1979. Pulping and paper making properties and wood properties of tropical hardwoods. Forpride Dig., 8(42-45): 48-59.
20. Hosseinzade A., H. Arabtabar F. Golbabaei H. Familian N. Sadraei and M. Habibi, 2001. Wood Properties of Eucalyptus steriaticalyx grown in southern region of iran. Research Institute of Forests and Rangelands, N, 243: 62-123.
21. Akgul, M. and A. Tozluoglu, 2009. Some chemical and morphological properties of juvenile Woods from beech (*Fagus orientalis* L.) and pine (*Pinus nigra* A.) plantations, Trends in Appl. Sci. Res., 4(2): 116.
22. Tsoumis, G., 1991. Science and technology of wood, structure properties, Utization, Chapman and hall, England, pp: 494.
23. Talaeipour, M., A.H. Hemmasi, J. Ebrahimpour Kasmani, A. Mirshokraie and H. Khademieslam, 2010. Effects of fungal treatment on structural and chemical features of Hornbeam chips, BioResources (http://www.bioresources.com), 5(1): 477-487.