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Study of altitude and selection on fiber biometry properties of *Fagus orientalis* Lipsky

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Abstract. *Zoghi Z, Azadfar D, Khazaeian A. 2013. Study of altitude and selection on fiber biometry properties of* Fagus orientalis *Lipsky. Nusantara Bioscience 5: 30-34.* This research reports to the influence of altitude above sea level and selection on fiber biometry of beech wood (*Fagus orientalis* Lipsky). In this research, six trees in 550 MASL (three plus trees and three non-plus trees) and six trees in 850 MASL (three plus trees and three non-plus trees) were selected. One sample from each tree was gotten with increment borer at breast height. Fiber characteristics such as fiber length, fiber diameter, lumen width, and two wall thicknesses were measured in Franklin method. Slenderness ratio, flexibility ratio and rankle ratio were estimated. The results showed that the altitude had a significant effect on fiber length, lumen width, wall thickness, and biometry coefficients. Tree quality has significant effect on fiber length, lumen width, and wall thicknesses and biometry coefficients. Fiber length, lumen width, slenderness ratio and flexibility ratio in plus trees were more than non-plus tree.

Keywords: *Fagus orientalis*, fiber, biometry properties, plus trees.

Abstrak. *Zoghi Z, Azadfar D, Khazaeian A. 2013. Studi ketinggian dan seleksi sifat-sifat biometri serat* Fagus orientalis *Lipsky. Nusantara Bioscience 5: 30-34.* Penelitian ini melaporkan pengaruh ketinggian di atas permukaan laut dan seleksi biometri serat dari kayu beech (*Fagus orientalis* Lipsky). Dalam penelitian ini dipilih 6 pohon dari ketinggian 550 m dpl. (3 pohon unggul dan 3 pohon non-unggul) dan 6 pohon dari ketinggian 850 m dpl (3 pohon dan 3 pohon non-unggul). Satu sampel dari setiap pohon diperoleh dengan alat pengebor pada ketinggian dada. Sifat-sifat serat seperti panjang serat, diameter serat, lebar lumen, dan ketebalan dua dinding diukur dengan metode Franklin. Rasio kelangsingan, rasio kelenturan dan rasio rankle dihitung. Hasil penelitian menunjukkan bahwa ketinggian berpengaruh signifikan terhadap panjang serat, lebar lumen, ketebalan dinding dan koefisien biometri. Kualitas pohon berpengaruh signifikan terhadap panjang serat, lebar lumen, dan tebal dinding dan koefisien biometri. Panjang serat, lebar lumen, rasio kelangsingan dan rasio kelenturan pada pohon unggul lebih tinggi dari pada pohon non-unggul.

Kata kunci: *Fagus orientalis*, serat, sifat biometri, pohon unggul.

INTRODUCTION

The wood properties vary as a result of variation in fiber morphology within each annual ring formed, between trees and between stands (Zobel and van Buijtenen 1989). Wood quality characteristics can be influenced by both tree growth condition and genetic factors (Jyske 2008; Gaspar 2009). Wood anatomical structure relates to wood product properties like flexibility, plasticity, resistance, and optical features (Panshin and Zeeuw 1980; Zhang 1997; St-Germain and Krause 2008). Fiber length, lumen size, and cell wall thickness have influence on the rigidity and strength properties (Oluwafemi and Sotannde 2007).

Plus tree selection is one of the first steps and used method of obtaining material for forest tree improvement programs (Zobel and Talbert 1984; Changtragoon 1996). Plus trees are phenotypes judged but not proved by test to be unusually superior in some quality and quantity, e.g. growth rate, desirable growth habit, high wood density and exceptional apparent resistance to disease and insect attack (Nieuwenhuis 2000).

Regarding wood economic importance and its usage on human life and limitation of natural recourses, determination of wood quality and appropriate application for suitable usage is necessary. This is dependent on identification of wood physical and anatomical properties (Doosthosseini and Parsapajouh 1996) and finding the relations between environmental and genetic factors on them. Some studies carried out to determine wood fiber properties of beech trees (*Fagus orientalis* Lipsky; Figure 1) and effect of them on strength properties (Akgul and Tozluoglu 2009). They found that utilization of juvenile woods on fiber production, can have contribution on raw material supply. In previous studies were found the latitude and altitude have major effects on variability in wood properties within species and, could have impact on juvenile wood rate production as well (Panshin and de Zeeuw 1980).

Figure 1. Beech tree (*Fagus orientalis* Lipsky): A. Flowers, B. Fruit. (photos: from many sources).

Related studies can also provide knowledge and guidance for Kiaei (2011) reported that altitude and height of tree have effect on wood density and fiber biometry properties of hornbeam-*Carpinus betulus* (L.). With increase of altitude from sea level, the wood density, cell wall thicknesses and rankle ratio were increased and the fiber length, fiber diameter, fiber lumen diameter, slenderness ratio, and flexibility ratio values were decreased. Varshoietabrizie et al. (2006) found that influence of altitude on fiber thicknesses of beech trees is significant however he did not find significant relationships between environmental factor and other biometry properties. On the other study altitude did not affect on fiber length (Hosseini 2006). Ishiguri et al. (2007) suggested that the basic density of core wood is a very important factor for the selection of a plus tree in tree breeding for wood quality. Gaspar (2009) studied the consequences of selection of wood quality traits of *Pinus pinaster*. They concluded that genetic selection based on growth will not result in a decrease of wood density, will not affect the occurrence of spiral grain, and is possible to obtain an increase in the radial modulus of elasticity. They suggest that selection for growth will probably not affect negatively the wood properties at future.

The wood of oriental beech is heavy, hard, strong and highly resistant to shock. It is one of the most important commercial woods in Iran. Oriental beech wood use as particleboard, furniture, flooring veneer, mining poles (props), railway tiles and paper (Kandemir and Kaya 2009). In this study were investigated fiber and biometry properties of beech wood and effect of altitude and selection on them because we can identify application of wood with knowledge about wood physical and anatomical properties, and we can find a way for operating silviculture programs for more genetic conservation and improvement and extension of generation of suitable trees. This is provided production plus quality wood in natural forest.

MATERIALS AND METHODS

Site study

Iranian beech forests are located on the northern slopes of Alborz Mountains, Hyrcanian forests, within an altitude of about 600-2000 m asl. They assemble a forest strip of 700 km length, located in three provinces of Guilan, Mazandaran, and Golestan (Salehi Shanjani et al. 2011).

This study was conducted at Shast Kalate forest, at the Gorgan University of Agricultural Sciences and Natural Resources on the Golestan province. It is located in northern Iran (36° 41’ to 36° 45’ northern latitudes and 54° 20’ to 54° 24’ eastern longitudes) with an area of about 3716 ha and an altitude ranging from 100 to 1000 m above sea level (Figure 2). This mixed deciduous forest is covered different forest community such as *Zelkova-Quercetum*, *Parrotio-Carpinetum*, *Fageto-Carpinetum*, and *Fagetum*

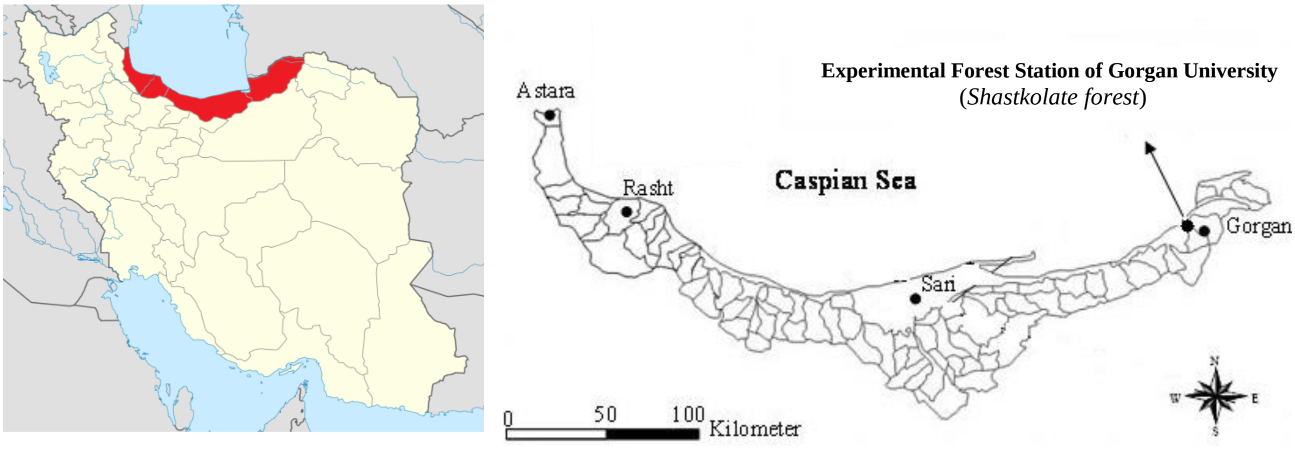

Figure 2. Location of the study site inside the Hyrcanian zone, the Central Caspian region of northern Iran.

(Habashi et al. 2007). *Fagetum* is located above 500 and the other communities are from 600-2400. In this study, two different areas (numbers 21, 24, 27 and 32) covered by beech (*Fagus orientalis* Lipsky) type were selected that those are located in district one of Shast Kalate forest. It is mentionable that selected areas had same slope percent. There were no signs of human or major natural disturbance.

In each altitude including 550 m asl and 850 m asl were selected 12 trees including 6 plus tree and 6 none plus tree. This plus trees have superior phenotype but not yet been tested for its genetic worth. They are marked based on the most important morphology characteristics including stem straightness, non-twisting bole, non-undulating bole, clear bole height (CBH), diameter polarity and crown polarity by comparison tree method on 2010 (Zoghi 2010). Then, final plus trees were determined using characteristics weighing and using scoring method based on calculation of the normalization equations (Zoghi 2010).

One sample was taken at breast height of each tree by increment borer. In addition to, 24 wood samples were taken (12 samples from 550 MASL and 12 samples from 850 MASL). They were placed special pipe and were named on different code in laboratory biometric coefficients of 30 fibers were measured in Franklin (1938) method. On each pipe were used acetic acid and hydrogen peroxide in equal proportion at 60ºC and 48 hours in an oven. Fibers of individual rings were prepared and stained with 1%water soluble safranin, then fixed on slides. The fiber length, fiber diameter, and fiber cell wall thicknesses were measured by Olympus microscope then biometry coefficients (morphological properties) were determined with these formulas:

Slenderness ratio= (Length of fiber/ Diameter of fiber)

Flexibility ratio= (Lumen width of fiber/ Diameter of fiber)* 100

Rankle ratio= (2* wall thickness) / (Lumen width of fiber)* 100

An Analyze of Variance (Two-way ANOVA) test was performed to determine the effect of altitude and selection on the fiber biometry properties. SPSS v. 17 software was used for all the statistical analysis.

RESULTS AND DISCUSSION

Effect of altitude

The results for each wood property were shown in Table 1. However, data analyzing showed that there were no significant differences between mean values of fiber length, fiber diameter, fiber lumen width and fiber wall thickness between two altitudes but the mean of fiber length, fiber diameter, fiber lumen width increased with increasing of altitude and the wall thickness decreased with increasing altitude. The altitude did not affect on slenderness ratio, flexibility ratio and rankle ratio too.

The result showed selection affected on fiber length, fiber lumen width, and fiber wall thickness, but there is no any difference in fiber diameter between plus and non-plus trees. The values of fiber length and fiber lumen width in plus trees were more than non-plus trees furthermore the mean of fiber diameter and fiber wall thickness in non plus trees were more than plus trees (Table 2). The mean of 2 wall thickness in trees that they have selected as plus trees was 14.56 µm, but the mean of it in non plus trees was 15.37 µm. Using two-way analysis of variance (ANOVA), significant differences among plus trees and non-plus trees were found for slenderness ratio, flexibility ratio and rankle ratio (Table 1). The mean of slenderness ratio and flexibility ratio value of plus trees were more than non-plus trees and the mean of rankle ratio of plus trees less than none plus trees (Table 3).

Interaction effect of altitude and selection was significant on fiber diameter and fiber wall thickness. There is no significant impact from interaction effect of altitude and selection on other properties (Table 1).

Table 1. The result of the analysis of variance for fiber properties of beech trees

Feature	source	F	Sig.
Fiber length	Corrected Model	4.84	0.00^{**}
	Altitude	1.45	0.23^{ns}
	Selection	11.54	0.00^{**}
	Altitude*Selection	1.53	0.22^{ns}
Fiber diameter	Corrected Model	2.81	0.04^{*}
	Altitude	0.03	0.87^{ns}
	Selection	1.23	0.27^{ns}
	Altitude*Selection	7.17	0.01^{**}
Fiber lumen width	Corrected Model	4.53	0.00^{**}
	Altitude	0.02	0.89^{ns}
	Selection	13.56	0.00^{**}
	Altitude*Selection	0.00	0.97^{ns}
2 wall thicknesses	Corrected Model	9.47	0.00^{**}
	Altitude	0.00	0.95^{ns}
	Selection	19.88	0.00^{**}
	Altitude*Selection	8.52	0.00^{**}
Slenderness ratio	Corrected Model	4.27	0.01^{**}
	Altitude	0.95	0.33^{ns}
	Selection	10.96	0.00^{**}
	Altitude*Selection	0.91	0.34^{ns}
Flexibility ratio	Corrected Model	7.72	0.00^{**}
	Altitude	0.00	0.95^{ns}
	Selection	21.73	0.00^{**}
	Altitude*Selection	1.43	0.23^{ns}
Rankle ratio	Corrected Model	7.61	0.00^{**}
	Altitude	0.00	0.98^{ns}
	Selection	22.73	0.00^{**}
	Altitude*Selection	0.09	0.77^{ns}

Note: *: Significant differences (level of significance $p < 0.05$); **: Significant differences (level of significance $p < 0.01$); ns: Not significant differences between the treatments; $P > 0.05$

Table 3. The mean of value (±standard deviation) belong to morphological properties of beech fibers

	Properties	Slenderness ratio	Flexibility ratio	Rankle ratio
Altitude (m)	550	78.39±15.15	27.32±9.03	3.15±1.63
	850	79.58±17.77	27.36±9.43	3.15±1.67
Phenotype quality	Plus trees	81.01±17.29	28.92±9.17	2.86±1.45
	Non-plus trees	76.96±15.46	25.76±9.03	3.44±1.78

Discussion

The fiber morphology affects the processing and properties of both lumber and paper (Seth 1990; Kibblewhite and Bawden 1991; Skinnarland et al. 1995; Seth et al. 1997; Vahey et al. 2007). Some factors such as soil, climate, and altitude and forest management lead to appear differences on wood properties of timber of same species (Doosthosseini and Parsapajouh 1997). The hardwood plant species had significant difference in wood density, fiber properties and mechanical strength (Kiaei and Samariha 2011).

Even though a difference in altitude of about 300 m could not seriously have effect fiber morphology and biometry coefficients in beech trees, it seems that altitude from sea level should play a positive role with beech trees when the difference is greater than it (Hosseini 2006). St-Germain and Krause (2008) found that latitude (along with a 500 km transect) did not affect tracheid length. Hosseini (2006) observed altitude in the range of about 500 m no important effect on beech fiber length.

In this investigation plus trees had long fiber, small fiber diameter, wide fiber lumen, and thin wall thickness. The value of slenderness ratio and flexibility ratio in plus trees was bigger than non-plus trees but the value of rankle ratio in plus trees was lower than non-plus trees. The beech plus trees are superior on phenotype in comparison with beech non-plus trees, they have good stem forms like stem straightness, non-twisting bole, non-undulating, more clear bole height (CBH), diameter polarity and crown polarity it causes to increase fiber length and decrease fiber diameter. The species with higher lengths, small diameter, thin wall cell, and large cell lumen are more desirable for paper formation and strength (Monteoliva et al. 2005; Gaspar 2009). Regard to beech plus trees have been selected to reach suitable industrial wood but results are shown that non-plus trees in comparison with plus trees have more desirable strength properties therefore they are can be used on fiberboard production and wood plus trees suitable for fiber plate, rigid cardboard production.

Regard to stem form is one of easiest and quickest ways to improve wood quality, because it can be controlled both genetically and silvicultural and because gains can be substantial and rapid (Zobel and Talbert 1984). Selection of plus trees does for changing some characteristics like growth rate, stem form, resistance to disease, branching habit and wood structure. It is also provided for reproduction of desirable characteristics. When these characteristics are controlled genetically, they can be affected on mean of gain of selected trees (Mahoney and Fins 2001) but some trees that have a high growth rate or good stem form do not always produce industrially desirable wood (Ishiguri et al. 2007). The differences in wood properties among provenances, families and/or individual trees provide an opportunity for breeding programmers to select superior trees for solid wood production (Gapare et al. 2012).

Table 2. The mean of fiber dimension (±standard deviation) in 2 different altitudes and 2 qualities

	Properties	Fiber length (μm)	Fiber diameter (μm)	Lumen width (μm)	2*Wall thicknesses (μm)
Altitude	550	1590.52±244.16	20.64±2.60	5.68±2.15	14.96±2.42
	850	1611.07±217.28	20.67±2.73	5.70±2.24	14.97±2.58
Quality	Plus trees	1629.83±214.14	20.54±2.69	5.99±2.21	14.56±2.47

Non-plus trees	1571.76±243.91	20.76±2.63	5.39±2.13	15.37±2.47

Since fiber morphology are usually highly inherited (Boyle et al. 1987; Longman 1993; Hylen 1999; Zubizarreta-Gerendiain et al. 2008) and the breeding programs for wood quality has a strong potential (Ishiguri et al. 2007), select of plus trees with desirable wood traits should be considered in tree improvement programs.

CONCLUSION

This study demonstrates that altitude of about 300 m could not seriously have effect on fiber morphology and biometry coefficients in beech trees. Selection of plus trees without examination of wood properties may be useless for improving programs. The results from this study suggest that identification of beech plus trees have to do with considering phenotype and desirable wood properties depend on final use. It is necessary to do progeny test to prove heritage of wood properties to gene conservation stands as well. Also, after they use as reproductive material for proper use.

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