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Full Length Research Paper

Under-story indigenous woody species diversity in hardwood and coniferous tree plantations at Berenjestanak lowland forest in the North of Iran

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Plantations can help speed up secondary forest succession by improving soil conditions, attracting seed-dispersal agents and providing shadow necessary for under-story growth, in the present research, the naturally under-story regenerated native woody species diversity was studied in four tree plantations 22 years of age and it covers 42 ha, composed of *Pinus brutia*, *Populus nigra* L., *Acer velutinum Boiss* and *Fraaxinus excelsior* L. species, which is located in the South of town of Ghaemshahr in Berenjestanak lowland forest in the North of Iran, where there was remnant natural forest in each site, three plots 20 × 20 m are selected and one plot also implemented as the witness in natural forests around. Species-Area Curve was used for determining plots area. The number of woody plants (trees and shrubs) were enumerated and identified in each plot, and diameter and height of generated species were measured up to 1.3 m height. In order to analyse of biodiversity was applied heterogeneity Indicators of Shannon Wiener, Simpson, Brillouin, MacArthur's N1 and Hill's N2 as well as evenness by using Simpson, Smith and Wilsons, Camargos and modified Nee indices. Results of this study illustrate that about nines trees and shrubs species belonging to eights families were observed in study sites naturally that the highest and lowest number of woody species was nine and five in the *F. excelsior* L. and *A. velutinum Boiss* plantation, respectively. In all study sites, the highest and lowest value of heterogeneity indices is related to MacArthur's N1 and Simpson, respectively. The highest value of evenness indices in *P. brutia, P. nigra* L. *and A. velutinum Boiss* plantations belonged to the Simpson's Index and in *F. excelsior* L. plantation and natural forest is related to Camargos index. The lowest value of evenness in all study areas was Modified Nee index. Results demonstrate that significant differences were observed in indices of heterogeneity (*P* = 0.0009) and evenness (P < 0.0001) amongst the planted areas and natural forest. Moreover, the highest value of heterogeneity and evenness were found in *P. nigra* L. (2.556) and *A. velutinum Boiss* (0.612) and the lowest values of these indices were in the nearby natural forest (1.818) and *F. excelsior* L. (0.257), respectively. There were no significant difference in species heterogeneity between *F. excelsior* L. and *P. brutia* as well as between *F. excelsior* L. plantations and natural forest at P = 0.05. Overall, species heterogeneity and evenness in the plantations was more than the surrounding natural forest. These results indicated that hardwood and coniferous tree plantations at this region not only reduce biodiversity (species heterogeneity and evenness), but also it has increased regeneration of woody species in all the plantations than the natural forest around. This could be effective tools in rehabilitating degraded lowland forest in the North of Iran.

Key words: Plantation, woody species diversity, heterogeneity indices, evenness indices, Mazandaran.

INTRODUCTION

Any change between living creatures in all resources including terrestrial communities, marine communities, and other aquatic ecosystems and its ecological processes called Biodiversity to describe and determine different levels of a biological and living organization such as genes, species (intraspecific and interspecific diversity),

and ecosystems and different forms of plant and animal communities in the earth. Biodiversity evaluation improves human perception about environmental and forests changes that is necessary for continuation of human beings life, economical problems, consistency and application of ecosystems and environmental health in any region (Wehenkel et al., 2006; Ardakani, 2008; Sohrabi et al., 2007; Pourbabaei and Ahani, 2004; Mahmoudi, 2007; Esmaeilzadeh and Hosseini, 2007). The first step for protection of biodiversity is determining and estimating in the field natural resources. Study of woody species diversity in forestry designs for planning, improved management and sustainable development of now and future is so important. Today, in order to know existing changes in ecosystems, estimate woody species diversity and composition in the world forests (Pourbabaei and Dado, 2005). On the other hand, existing statistic and information all over the country of Iran indicate that representing about 91% of total forests consists of degraded forests (73.2% of West forests, 12.5% of South forests and 4.5% of North forests) which do not have ability of wood production (Fattahi, 1994). Among this, forest areas in the North of Iran during past 30 years had declining trend, in a way that only during ten years (from 1986 to 1996) about 140000 ha (7%) reduced (Resaneh et al., 2001). Regarding that each year natural forest areas in the north of Iran reduced due to destruction and intense logging and on the other part need to woods had increasing trend due to improvement of population, therefore plantation with native species and exotic ones for rehabilitating degraded forests and providing requirements of society is necessary for our country.

On one hand, plantation and its replacement instead of degraded natural stand due to having its special characteristics, could have many effect on natural fauna and flora composition in region, soil changes and finally change of plant species composition and entrance or biological extinction of some native species (Moraghebi et al., 2005; Pilehvar, 2007; Roostami and Pourbabaei, 2007; Vatani, 2006). According to those studies, plantations can speed recovery of biodiversity and promote woody species regeneration on degraded lands in tropical regions by speeding up forest succession processes, increase of soil fertility and improving site conditions (Bernhard-Reversat, 2001; Cusack, and Montagnini, 2004). The proximity to natural forest, seed dispersal characteristics and site qualities influenced woody regeneration (Koonkhunthod et al., 2007). High species diversity of the forest depended on small trees in lower layers. Therefore, conservation of small trees in lower layers, especially bottom layer, is indispensable for sound maintenance of forests (Hagihara et al., 2008; Feroz et al., 2006).

However, regarding the necessity of plantation development in degraded forest areas in the north of Iran, we will have the question that how much plantation could have primary role for protection natural balance between organisms? Did plantation in degraded forest areas at this region caused to increase of woody species diversity than remained natural forest around them? Meanwhile, some researchers believe that plantations caused increase biodiversity and someone believed vice versa. Forest yield and its presenting public services will be permanent when the most important elements of those including: trees and shrubs should be protected. For finding of woody species situation, it is necessary to have information about trees and shrubs species and their population. The purpose of the present study was to assess the naturally regenerated woody species diversity in four tree plantations and subsequently determine the utilisation potential of these tree species for the restoration of native woody species on degraded lowland forest in the north of Iran. Furthermore, the specific aims were: (i) to compare the woody species diversity at these plantations and remnant natural forest in the vicinity and (ii) the effects of these plantations on under story species diversity in order to the recruitment, establishment and succession of native woody species. The obtained results of this study could be used in planning of plantations (especially, in species selection) and managing of biodiversity in them and will also help devise strategies for forest conservation in this region.

MATERIALS AND METHODS

Study area

Study areas are located in Berenjestanak lowland forest in the Southern of Ghaemshahr city (36° 23′ 30" N and 52° 54′ 30" E, respectively) (Figure 1). This study was carried out in four tree plantations, 22 years of age and cover 42 ha and in surrounding degraded mixed hardwood natural forest. The plantations composed of *P. brutia*, *P. nigra* L., *Acer velutinum Boiss* and *F. excelsior* L. species. These plantations were planted in 1987. The altitude at the plantation site ranges from 180 to 220 m, and the slope varies between 0 and 30%. Mean annual precipitation and temperature are 1043.6 mm and 14°C, respectively. Edaphically, soil consists of semi heavy (Clay Loam) to heavy texture (Clay and Silty Clay) with weak drainage and pH ranges from 5.9 to 7.7 in the studied compartments (hand book of management plan of Berenjestanak forests, 1996)

Field survey

At first, a map of the study areas with scale 1:25000 was provided and then in each site three plots 20 × 20 m were selected and one plot also implemented as the witness in natural forests around (Hasanzadehnavrody, 2003; Pourbabaei and Ahani, 2004; Vatani et al., 2007; Chittibabu and Parthasarathy, 2000; Cusack and Montagnini, 2004; Firn et al., 2007; Butler et al., 2008; Kramer and Holscher, 2009). Species-area curve was used for determine plots area (Mesdaghi, 2001). The number of woody plants (trees and shrubs) and number of individuals of each species were

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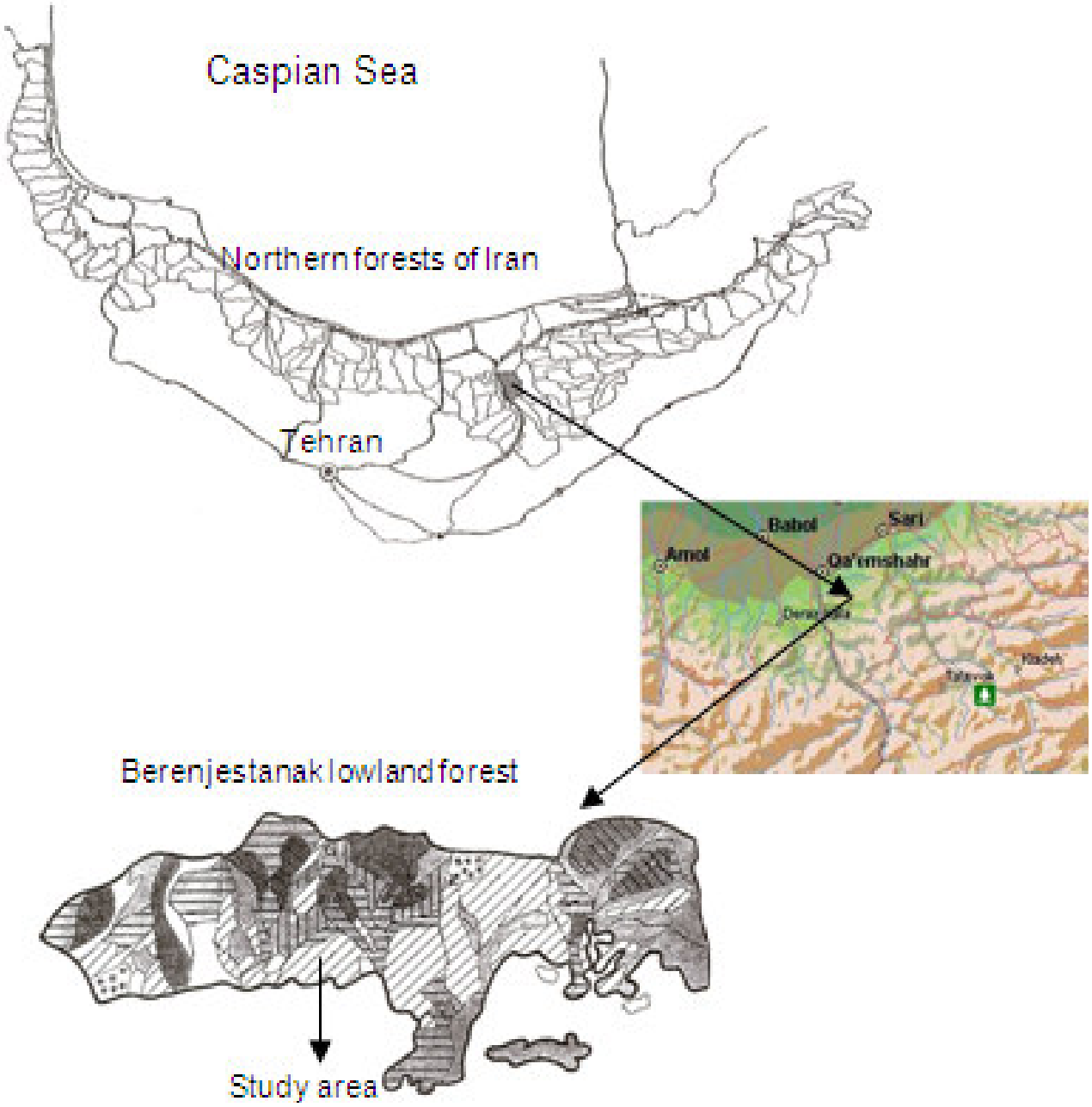

Figure 1. Location map of studied area at Berenjestanak lowland forest in the north of Iran.

enumerated and identified in each sample plot and diameter and height of generated species were measured up to 1.3 m height. The altitude, slope and aspect at each sample plot were also measured (Table 1). Life forms were determined by Raunkiaer system.

Data analysis

Regarding the species diversity which consist two elements of richness and population of species therefore, for better interpretation of it, several biodiversity indices were used to measure the woody species diversity in plantations and the nearby natural forest (Basiri and Karami, 2006; Roostami and Pourbabaei, 2007; Sohrabi et al., 2007). These heterogeneity indices included Simpson (1-D), Hill's N2, Shannon- Wiener (H´), Brillouin (Hˆ) and McArtthur's N1. Evenness value was calculated using indices of Wilson and Smith (Evar), Camargos (E′), Modified Nee (EQ) and Simpsons (E1/D) (Krebs, 1999). Sorensen's index was used to measure the similarity in species composition among plantations and natural forest. Kolomogrov-Smirnov test showed that heterogeneity, evenness data were followed of normal distribution. A one-way ANOVA was used to detect variations in heterogeneity and evenness among the plantation species and the natural forest while Duncan's new multiple range test was used for mean comparison (Bihamta and Zarechahoki, 2008; Valizadeh and Moghadam, 2007). All diversity calculations and statistical analyses

were conducted using Ecological Methodology ver. 6.0 (2001) (Krebs, 1999) and SAS 9.1 for windows softwares, respectively.

RESULTS

Results of this study illustrated that a total of 9 naturally regenerated woody species consist of 7 trees and 2 shrubs species belonging to seven and one families were observed in planted sites, respectively. The highest and lowest number of naturally regenerated woody species was nine and five in the *F. excelsior* L. and *A. velutinum Boiss* plantations, respectively. Number of two species consists of *Parrotia persica (dc.)* and *Gleditschia Caspica Desf*. were endemic of Iran flores (Table 2). Species of *Carpinus betulus* L. in *A. velutinum Boiss* plantation, species *of Querecus castanifolia C.A.M*. in natural forest, species *of Diospyrus lotus* L. and *Gleditschia Caspica Desf.* in *A. velutinum Boiss* and *P. nigra* L. plantations and species *of Acer insign Boiss*. in *P. brutia* plantation and natural forest haven't been seen. Species of *Prunus divaricata Ledeb*. was the only in *F. excelsior* L. plantation (Table 3).

Results of diversity measurements in woody species related to heterogeneity and evenness indices in planted areas and natural forest investigated in Table 4. In all study sites, the highest and lowest value of heterogeneity indices is related to MacArthur's N1 and Simpson, respectively (Figure 2). The highest value of evenness indices in *P. brutia, P. nigra* L*. and A. velutinum Boiss* plantations belonged to the Simpson's Index and in *F. excelsior* L*.* plantation and natural forest is related to Camargos Index. The lowest value of evenness in all study areas was Modified Nee index (Figure 3). One-way ANOVA showed that the plantations effects with different species on heterogeneity index ($F = 8.08$, $P=0.0009$) and evenness indices ($F = 16.56$, $P = 0.0001$) was significant amongst the planted areas and natural forest (Tables 5 and 6). Results demonstrate that significant statistical differences were observed in indices of heterogeneity ($P = 0.0009$) and evenness ($P < 0.0001$) amongst the planted areas and natural forest. Moreover, duncan's new multiple range test indicated that the highest value of heterogeneity and evenness were found in *P. nigra* L*.* (2.556) and *A. velutinum Boiss* (0.612) and the lowest values of these indices were in the nearby natural forest (1.818) and *F. excelsior* L. (0.257), respectively. There were no significant difference in species heterogeneity between *F. excelsior* L. and *P. brutia* as well as between *F. excelsior* L*.* plantations and natural forest at $P = 0.05$. Overall, woody species heterogeneity and evenness in the plantations were more than the surrounding natural forest (Figures 4 and 5).

Results of ANOVA indicated also that different indices of heterogeneity ($F = 140.08$, $P = 0.0001$) and evenness ($F = 28.00$, $P = 0.0001$) had significant differences in relation to different ways of heterogeneity and evenness measurement in the different plantations and natural forest (Tables 5 and 6). There were not significant statistical differences in species heterogeneity measurement between Brillouin (Hˆ) and Shannon- Wiener (H´) indices and amongst Wilson and Smith (Evar), Camargos (E′) and Simpsons (E1/D) indices for species evenness measurement at $P = 0.05$ (Figures 6 and 7). The highest and lowest values of Sorensen's similarity coefficient in woody species layer were found between *A. velutinum Boiss* and *P. nigra* L. (90.9%) and amongst *A. velutinum Boiss* and *P. brutia* (66.7%) plantations, respectively (Figure 8).

DISCUSSION

Biodiversity measurement was one of the most difficult, time-consuming and costly works and in this field, framed guides didn't exist that it made determination of biodiversity of all species impossible and hard in forest ecosystems. Tree species composition and presence of all tree species was the main feature of forest ecosystems. Forest management to diversify tree species is now being promoted to favor biodiversity (Barbier et al., 2008).

The aim of this study was to quantify woody species diversity in the *P. brutia*, *P. nigra* L., *A. velutinum Boiss* and *F. excelsior* L. plantations in Berenjestanak lowland forest, North of Iran. In order to do this research we also sampled from natural forest in the proximity, sinceprimary natural forests close to a restoration site can provide baseline data that can be used in the evaluation of the extent and rate of plant species regeneration and establishment in plantations. Comparative studies of species diversity between plantations and other forest types have shown that plantations have higher diversity (Nagaike, 2002; Nagaike et al., 2006; Koonkhunthod et al., 2007). The higher diversity in plantations was mainly due to invasive and ruderal species. Such patterns imply increased species diversity after severe human disturbance. Biodiversity in the forest plantation site from the cutting time to planting and during growth of seedling will be fluctuating. In primary stage after clear cutting due to intensive light, increase herbaceous species and non-woody species diversity, rapidly. But diversity trend will be changed by quick growth of tree seedlings and start of its effects over the soil and decrease of light amount. Some of studies showed that species richness and diversity in the under-story increased in primary years after clear-cutting, but decreased during the next years. This decrease corresponded closely with a steady increase in leaf area index of the forest canopy. Generally, value of woody species diversity and evenness reduced within final stages of forest succession (Daneshvar et al., 2007; Gondard et al., 2001). According to this study, presence of nine naturally regenerated woody species in plantations compared with natural forest around them that number of woody species will be increased, have a good expectancy for rehabilitating

Table 1. Site characteristic features and physiographic factors of study plots in the plantations and natural forest at Berenjestanak low land forest in the north of Iran.

Forets type	Elevation (m)	Aspect	Slope (%)	Canopy (%)
A. velutinum Boiss	210	Western	15	80
P. nigra L.	194	South western	7	75
F. excelsior L.	200	Southern	10	85
P. brutia	200	South western	15	80
Natural forest	210	Southern	10	70

Table 2. Florestic table of the plantations containing species name, life form and vegetation chorology.

Species	Life form *	Chorotype**	Endemic	Family
Carpinus betulus l.	Ph	H		*Betulaceae*
Parrotia persica (dc.)	Ph	H	*	*Hamameliadaceae*
Querecus castanifolia c.a.m.	Ph	H, M, IT		*Fagaceae*
Diospyrus lotus l.	Ph	H, IT		*Ebenaceae*
Gleditschia Caspica Desf.	Ph	H	*	*Caealpinaceae*
Acer insign boiss.	Ph	H		*Acearaceae*
Mespilus germanica l.	Ph	H, M, IT		*Rosaceae*
Cratagus microphilla C. koch	Ph	H, M, IT		*Rosaceae*
Prunus divaricata Ledeb.	Ph	H, M, IT		*Rosaceae*

*(*Ph*: *Phanerophytes*), **(H: Hyrcanian; H, M, IT: Hyrcanian - Mediteranian-Iranoturanian; H, IT: Hyrcanian - Iranoturanian).

Table 3. Naturally regenerated woody species found in the plantations and natural forest.

Regenerated species	Forest type				Natural forest
	Pinus brutia	***Fraaxinus excelsior* L.**	**Populus nigra L.**	**Acer velutinum Boiss**	
Carpinus betulus l.	+	+	+	-	+
Parrotia persica(dc.)	+	+	+	+	+
Querecus castanifolia c.a.m.	+	+	+	+	-
Diospyrus lotus l.	+	+	-	-	+
Gleditschia Caspica Desf.	+	+	-	-	+
Acer insign boiss.	-	+	+	+	-
Mespilus germanica l.	+	+	+	+	+
Cratagus microphilla C. koch	+	+	+	+	+
Prunus divaricata Ledeb.	-	+	-	-	-
Number of species	7	9	6	5	6

(+): Presence of species; (-): Absence of species.

destroyed lowland forest in the North of Iran and finally transformation these plantations to the productive forest. Furthermore, according to the Raunchier plant life form classification system and the biological spectrum, phanerophytes (100%) were dominant life forms of the studied area that was explanatory characteristic feature of broadleaf deciduous forest of temperate climate Species diversity of forests is influenced by many abiotic and biotic factors such as temperature, precipitation, floristic history, disturbances, grazing, forest logging (legal and illegal) topography and soil. On the other hand, some of studies suggest a mechanism, the fertility effect, by which increased plant species diversity may increase community productivity over time by increasing the supply of nutrients via both greater inputs and greater retention (Cao and Peetrs, 1997; Dybzinski et al., 2008). Also, neighboring of this plantation with villages and presence of rural dweller domestic livestock in the around of plantations which overgrazed as a most obvious and destructive biotic factor on these plantations due to lack of suitable fencing and accurate conservation, along with illegal cutting of trees for construction materials,

Table 4. Values of heterogeneity and evenness indices in the plantations and natural forest.

Biodiversity indices		Forest type				Natural forest
		A. velutinum Boiss	*P. nigra* L.	*F. excelsior* L.	*P. brutia*	
Heterogeneity indices	Simpson (1-D)	0.68	0.73	0.64	0.58	0.71
	Hill's N2	3.04	3.67	2.77	2.30	3.31
	Shannon- Wiener (H´)	1.76	2.10	1.98	1.64	2.05
	McArtthur's N1	3.37	4.28	3.94	3.12	4.15
	Brillouin (Hˆ)	1.63	2.00	1.89	1.45	1.90
Evenness indices	Simpsons (E1/D)	0.76	0.61	0.31	0.38	0.47
	Camargos (E′)	0.71	0.57	0.34	0.41	0.46
	Wilson and Smith's (Evar)	0.74	0.47	0.26	0.35	0.40
	Modified Nee (EQ)	0.24	0.17	0.12	0.14	0.17

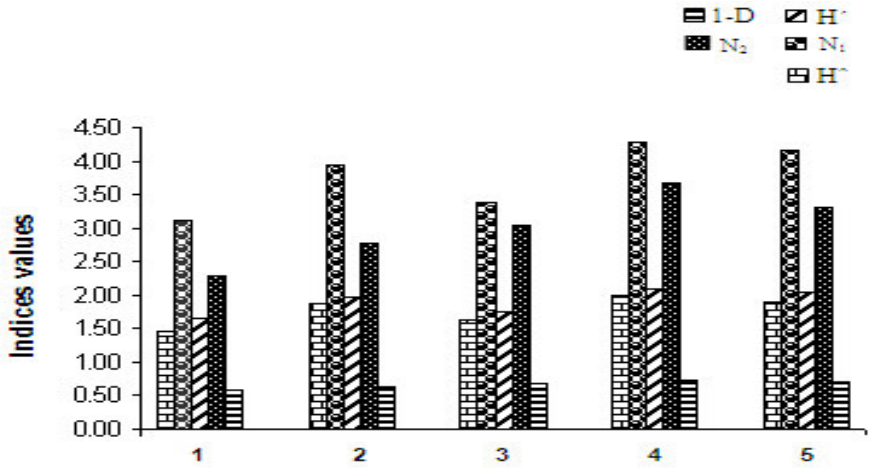

Figure 2. Values of heterogeneity indices in the different plantations and natural forest (that is 1: a surrounding natural forest; 2: *F. excelsior* L.*;* 3*: A. velutinum Boiss;* 4*: P. nigra* L. *and* 5*: P. brutia*.).

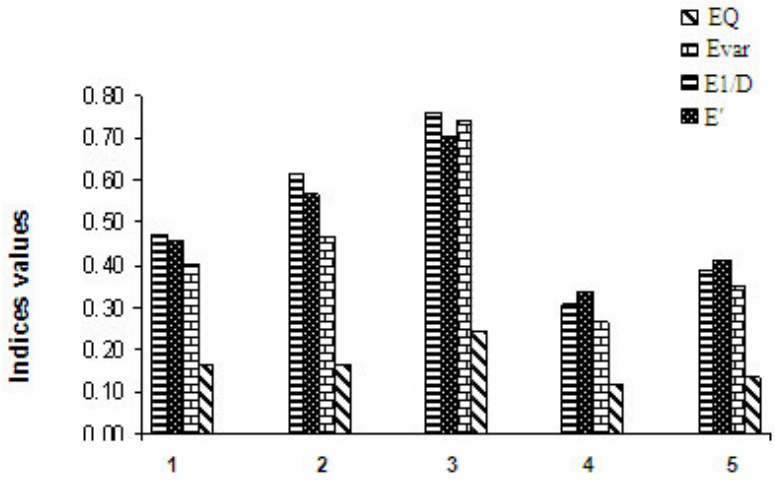

Figure 3. Values of evenness indices in the different plantations and natural forest (that is 1: *P. brutia*; 2: *P. nigra* L.; 3: *A. velutinum Boiss*; 4*: F. excelsior* L.. and 5: a surrounding natural forest.).

Table 5. Analysis of variance of heterogeneity and in relation with methods of heterogeneity measurement in the different plantations and natural forest.

Source of variation	Factors	DF	SS	MS	F value	Pr > F	C.V.
Model		8	30.42	3.80	74.08	0.0001**	10.17
	Plantations and natural forest	4	1.66	0.42	8.08	0.0009**	
	Methods of heterogeneity measurement	4	28.76	7.19	140.08	0.0001**	

**significant in alpha = 0.01.

Table 6. Analysis of variance of evenness and in relation with methods of evenness measurement in the different plantations and natural forest.

Source of variation	Factors	DF	SS	MS	F value	Pr > F	C.V.
Model		7	0.68	0.10	21.46	0.0001**	16.71
	Plantations and natural forest	4	0.30	0.08	16.56	0.0001**	
	Methods of evenness measurement	3	0.38	0.13	28.00	0.0001**	

**significant in alpha = 0.01.

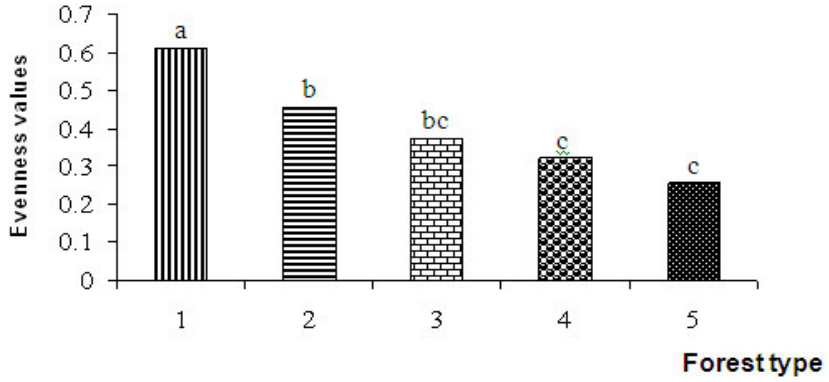

Figure 4. Mean evenness measures in the different plantations and natural forest (that is 1: *A. velutinum Boiss*; 2: *P. nigra* L.; 3: *P. brutia*; 4: a surrounding natural forest and 5: *F. excelsior* L. Means sharing the same letter are not significantly different at *P* = 0.05 for each computed indices).

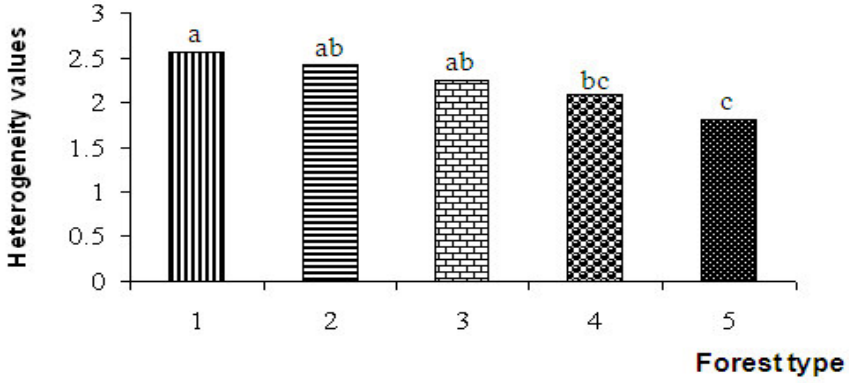

Figure 5. Mean heterogeneity measures in the different plantations and natural forest (that is 1: *P. nigra* L.; 2: *P. brutia*; 3*: F. excelsior* L.; 4*: A. velutinum Boiss* and 5: a surrounding natural forest. Means sharing the same letter are not significantly different at *P* = 0.05 for each computed indices).

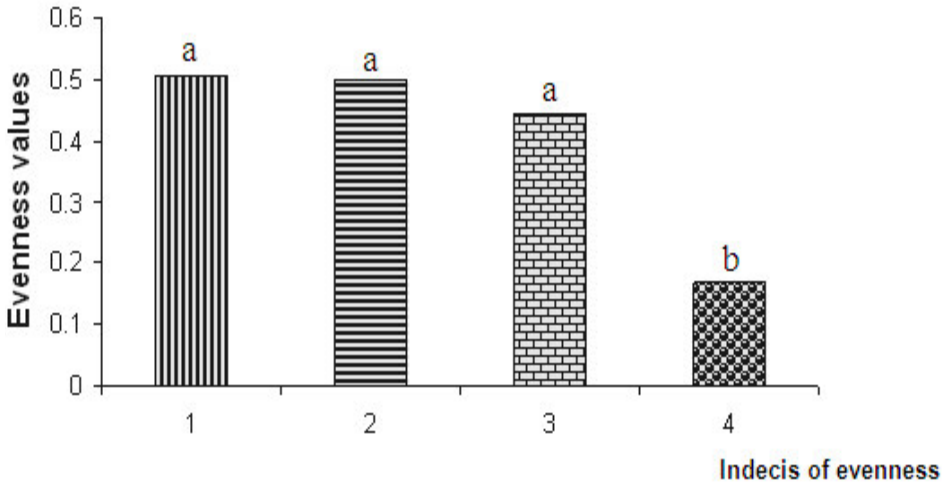

Figure 6. The mean evenness measures in relation to methods of evenness measurement in the different plantations and natural forest (that is 1: Simpsons (E1/D); 2: Camargos (E′); 3: Wilson and Smith's (Evar) and 4: Modified Nee (EQ). Means sharing the same letter are not significantly different at P=0.05 for each computed indices).

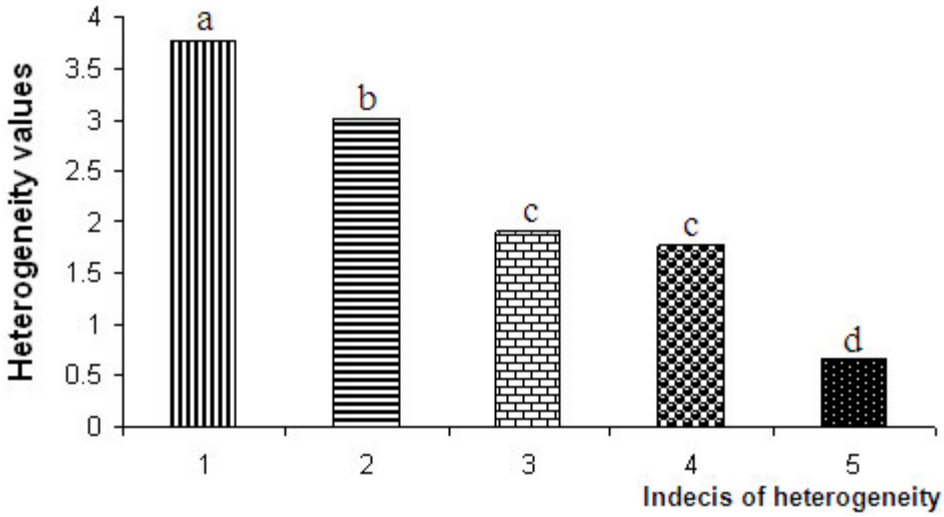

Figure 7. Mean heterogeneity measures in relation to methods of heterogeneity measurement in the different plantations and natural forest (that is 1: McArtthur's N1; 2: Hill's N2; 3: Shannon- Wiener (H´); 4: Brillouin (Hˆ) and 5: Simpson (1-D). Means sharing the same letter are not significantly different at P = 0.05 for each computed indices).

household goods and other purpose by rural dwellers and people living around plantation areas which are the factors of serious problems and destruction in management plans of Northern forest of Iran. These factors have led to decrease of naturally regeneration of trees and change of diversity, stand composition and density. Finally, all these caused to enumeration and identified of woody species less than the true measurement. This subject affect directly on species diversity and heterogeneity and evenness indices revealed a progressive reduction in diversity in the plantations with increasing disturbance. This finding has been corroborated with the other researcher findings (Veach et al., 2003; Fornwalt et al., 2009; Chittibabu and Parthasarathy, 2000; Salami et al., 2007).

These results indicated that hardwood and coniferous tree plantations at this region not only reduce biodiversity, but also it has increased the regeneration of woody species so far compared with the surrounding natural forests and all these caused to increasing the species heterogeneity and evenness in all the plantations than the natural forest. This could be effective tools in

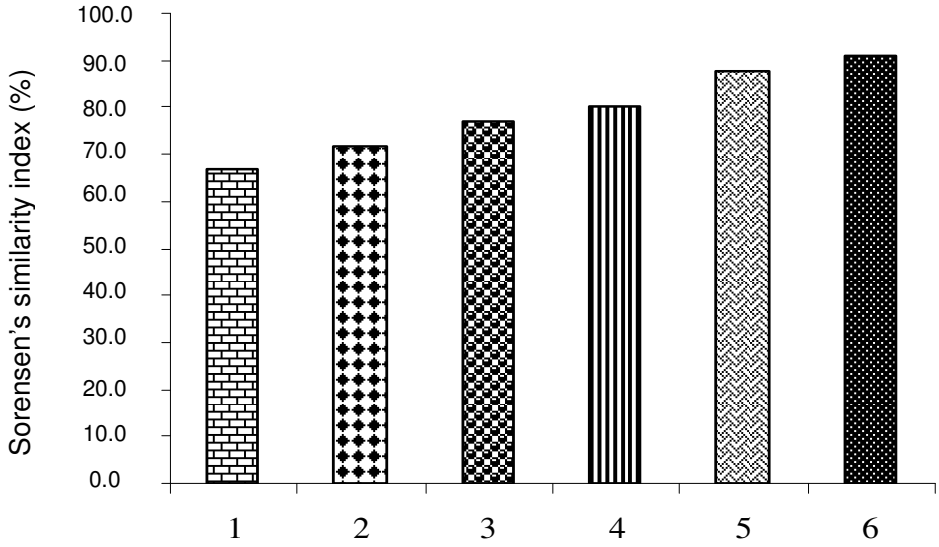

Figure 8. Values of sorensen's similarity index (in percent) between the plantations (that is 1: *P. brutia and A. velutinum Boiss; 2: A. velutinum Boiss and F. excelsior* L.*; 3: P. brutia and P. nigra* L. *; 4: P. nigra* L. *and F. excelsior* L. *; 5: P. brutia and F. excelsior* L. *and P. nigra* L. *and A. velutinum Boiss).*

rehabilitating degraded lowland forest in the North of Iran. Study on the effect of Haloxylon plantation on the under-story plants diversity, some characteristics and vegetation cover conducted that the minimum diversity occurs in the reference site. Also, cover percentage, yield and homogeneity of vegetation increased and species composition in the plantation lands were better than the remnant natural forest (Bakhshi and Biroudian, 2008; Jafari et al., 2003).

In present study, value of species evenness in the *P. brutia* plantation was also more than in the adjacent natural forest. This finding has been corroborated in three plantation sites of *Cupressus sempervirens* L. *var* horizontalis (Mill*)* Gord. in northern lowland forests of Iran (vatani, 2006). This finding is also consistent with the findings in mixed coniferous stand (*Picea abies* and *P. nigra var. caramanica* spesies) in the Kelardasht region in the North of Iran (Memarian et al., 2007).

In addition, neighboring of this plantation with natural forest has been resulted in dispersion of hardwood trees seeds within the plantation, which causes increase in the woody species regeneration and demonstrates the crucial role of the remnant small patches of natural forest, as a source of diaspores for the restoration of the woody species diversity in degraded forest areas (Yirdaw and Luukkanen, 2003). While mixture of coniferous and broadleaf species will affect on the biodiversity of plantation under-story, therefore, these plantations at this region must be directed to mixed stands by correct planning and management. This subject must be attended for marking, tending operations and afforestation project because of richness and species composition depends on each plantation species or species assemblages in case of the mixtures (Butler et al., 2008). Also, silviculture and tending of forest has got a 'masking effect' on plant species diversity within managed forests by making uniform tree layers that outshine the under-story vegetation diversity (Decocq, 2000). On the other part, role of protection and conservation as one of the important factor of biodiversity must not be ignored.

Although, the main purpose of these plantations was timber production, the diversity and abundance of woody regeneration found in the plantation under-story indicated that these plantations could be effective tools in rehabilitating tree diversity. The recovery of native forest plant species is a measure of restoration success (Yirdaw, 2001; Koonkhunthod et al., 2007). On the other part, some studies have shown that plantation management may have severe consequences on biodiversity compared with naturally regenerated forest, since the former system has usually replaced canopy tree composition with valuable timber species (Wesenbeeck et al., 2003; Ito et al., 2004; Maestre and Cortina, 2004; Nagaike et al., 2006; Pourbabaei and Roostami, 2007). Because the plantation canopies were completely replaced by *P. brutia*, *P. nigra* L., *Acer velutinum Boiss* and *F. excelsior* L.*,* they would have affected species diversity and composition. High woody species diversity in plantations indicate that the high potential of plantations for restoring biodiversity in the studied sites. This finding has been confirmed by Yirdaw (2001) in the Ethiopian highlands. Therefore, these plantations have not decreased plant species diversity in the studied area. It is recommended that the degraded lands or clear- cut areas to be planted with these tree species in the adjacent destroyed natural forests and the same regions.

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