Study result of Mongolian natural wild seabuckthorn *(Hippophae rhamnoides L.)*

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Abstract

Seabuckthorn sub specie (Hippophae rhamnoides L. ssp mongolica Rous.) is distributed in confluence of Orkhon-Selenge and basins of Zavkhan Tes, Uvs Tes, Bukhmurun, Tortkhilog Buyant, Khovd, Zavkhan, Borkh and Bulgan rivers. Natural wild seabuckthorn's permanent distribution is in the western part of Mongolia's mountainous region of Altai, Khangai and at the Tes, Zavkhan and Khovd rivers with internal flow to Great Lake concave, which starts from Altai and Khangai ranges' branch mountains and at the Bulgan and other rivers' valley, which have an external flow.

By natural and weather condition, Bulgan aimag is located in humid cool, Selenge aimag is in arid cool, Zavkhan aimag is in arid coolish, Govi-Altai and Khovd aimags are in very arid, Uvs aimag is in arid cool region, respectively. Soil humus was in 0-20 sm depth 1.1-2.3%, 20-40 sm depth 0.6-1.7% at the research area. Soil of Zavkhan river basin had lowest humus content (0.76-1.2%), this includes Mongolian sand area and areas with sandy soil.

Frame of this study included 18 soums of Selenge, Bulgan, Zavkhan, Govi-Altai, Khovd aimags along six big river basins and revealed resource of 13.5 thousand hectare coverage by Mongolian natural wild seabuckthorn and conducted a mapping.

Fruits biochemical analysis was done by oil, vitamin C, sugar content in types of natural population. Analyze result were classified into three groups such as high, medium and low. Oil content was fluctuated between 3.1-4.0% oil content in average 3.5%, sugar 6.0-8.9%, vitamin C content was medium in research sample types.

To compare fruit colors with pulp oil and sugar content, fruits with higher content of sugar have from orange to bright yellow color and fruits with higher content of oil have red color. This is explained by synthesis of bio active substance, which belongs to carotenoid group, in the cell of fruit skin.

50-87.6% of total natural wild seabuckthorn has below 10 years age, 13-50% has 10-18 age. Selected 21 forms were taken local MK numbers, registered according to International cultivars, stored in the genebank of the PAI.

Keywords: *Natural wild seabuckthorn, distribution, form, generation, resource, gene bank*

Introduction

Seabuckthorn is a plant, which is exclusively adapted in Mongolian climate, soil and geographical condition and has unique resistance to drought freeze; great significance of food, treatment and nature protection.

Mongolian seabuckthorn sub specie (*Hippophae rhamnoides* L. ssp mongolica Rous.) is distributed in confluence of Orkhon-Selenge and basins of Zavkhan Tes, Uvs Tes, Bukhmurun, Tortkhilog Buyant, Khovd, Zavkhan, Borkh and Bulgan rivers.

However, Mongolian seabuckthorn natural wild distribution is determined by aimags and estimated that it distributed in 30,0 thousand hectare (Ts.Dorjgotov, L.Zdanevich 1974), many years are gone and it's resource is decreased by 50% due to nature and climate change, people's misuse.

Lately, substantial works are evolving for seabuckthorn production in many countries of the world. Fruit and berries are started to grow in Mongolia from mid 1950s, and the fruit and berry husbandry is started to develop. Since that time selection of prospective varieties had done and fruit berry orchards were established.

Researcher Ts.Tsendeekhuu (1966) made pheno-geographical map of seabuckthorn population and determined seabuckthorn's distribution origin by pheno-grafical drawing and registered that there are about 30 different forms in Mongolia.

He made a hypothesis that Mongolian seabuckthorn was first originated from Asian certain area and it may be migrated to Europe. He determined different natural forms, which differ by maturity period, bush height, weight, color and taste of fruit, pedicle length, oil content (Ts.Tsendeekhuu 1969).

Researcher had stated that the native land of sub specie Mongolia (*Ss.mongolica* Ronsi) within the (*Hippophae rhamnoides*.L) biological specie is Mongolia and its western part (Finnish A. Ronsi 1971, Mongolian Ts.Tsendeekhuu 1996, Chinese Lian Yougchan et.al, 1998).

The bushes of natural seabuckthorn are formed in moist meadows and landscapes of river valley in groups with brush (*Salix*), aspen (*Populus*), birch (*Betula*), other bushes and mesophite grassy plants. Subspecies of Mongolian seabuckthorn (*Hippophae Rhamnoides* L.ssp *Mongolica Rous*.), which are propagated in our country, occur in the basins of rivers Orkhon-Selenge, Tes river of Zavkhan province, Tes, Bukhmurun and Tohilog Buyant rivers of Uvs province, Khovd river, Zavkhan river, Borkh river and Bulgan river. (Ts.Tsendeekhuu, 1969) Botanic-Geographical zone includes the Khangai, Mongol Daguur, Khovd, Mongol Altai, depression of Ikh Nuuruud, circles of Gobi-Altai areas.

Natural wild seabuckthorn's permanent distribution is in the western part of Mongolia's mountainous region of Altai, Khangai and at the Tes, Zavkhan and Khovd rivers with internal flow to Great Lake concave, which starts from Altai and Khangai ranges' branch mountains and at the Bulgan and other rivers' valley, which have an external flow.

To see seabuckthorn distribution, natural wild seabuckthorn is distributed in 40-50% of the Orkhon-Selenge rivers' basin, in 30% of the Zavkhan river basin, in 15-20% of the Bulgan river, in 40% of the Khovd river basin, in 40-50% of the Bukhmurun river basin and 20-30% of the Tes river basin. They have been no special succession change revealed (research team 2013).

Research aim

For determining Mongolian natural seabuckthorn's resource, location, inventory conducting, revealing of its extra ordinary useful form and making out of gene pool following objectives were estimated. Herein:

1. Mapping of resource area, conducting of complete inventory in that area, geo-botanical writings of the population should be done, succession should be determined.
2. Evaluation should be done for the natural forms and extra ordinary useful forms should be revealed.
3. Seabuckthorn aging, regrowth, ratio of male and female bushes, soil structure and water supply should be estimated and guidance for rational utilization, protection and rehabilitation should be processed.

Research methodology

1. *Using of GIS in mapping of natural seabuckthorn's resource*

High resolution information, which based on the GIS and remote sensing system, was used for the mapping of natural seabuckthorn's resource, determining locations and estimating expansion field amount.

Geographical data were processed by two modern vector models (dot, linear, polygon), raster by the GIS, Arc/INFO, Arc/VIEW, ArcGIS programs according to the global standard.

Green vegetation spectrum curve was used for checking available vegetation on the remote sensing information and comparative evaluation was done for different plants spectrum curve.

2. Determining of plants within seabuckthorn population, conducting geo-botanical writings and determining of their succession

Common method was used for geo-botanical writings of the population forming plants and 13 characteristics are used for evaluation of three, bush and grassy plant species.

Succession (autogenic or allogeneic) of the natural bushes was determined. Recreation succession influence was determined in each bush.

3. Estimating of seabuckthorn aging, regrowth and ratio of male and female bushes

Natural seabuckthorn aging was estimated by following method

- Seabuckthorn age from 1 to 10 years was determined by following formula:

$$A = t + 1$$

A- Seabuckthorn age

t- amount of branch junctions and nodules

- Seabuckthorn age above 10 years was determined by following formula:

$$A = \frac{t * H}{H - h}$$

t- amount of branch junctions and nodules

H- bush height /m/

h- main stem height from soil surface to the first branch junctions and nodule /m/

4. Biological and morphological evaluation of the natural populations

Morphological evaluation was done according to the work program, which elaborated by the I.V.Michurin's Research institute of Fruit and berry, for variety testing and multiplication of fruit and berry cultivars.

Total sugar content was determined by the Bertran's method, oil content by Kokslet method, Vitamin C content by Murr's method, respectively. Samples were taken from each type and forms for storing life genetic resources, registration was done and stored in Agricultural cultivars gene pool.

Research result

1. Natural and weather condition

Primary research of the natural wild seabuckthorn conducted in 1974. Therefore we took 1961-1990 periods as basic for our study and compared to last 20 years (1991-2010) and made analysis in climate change in the regions, basing on six weather stations data.

Table 1. Weather characteristics

Name of aimag	Air mean temperature,C		Active temperature above 10^{O}C		Percipitation, mm		Number of frost free days	
	1961-1990	1991-2010	1961-1990	1991-2010	1961-1990	1991-2010	1961-1990	1991-2010
Selenge	0.1	1.1	1999	2086	244.5	274.3	190	192
Bulgan	-0.8	0.2	1792	2012	334.7	260.8	194	203
Zavkhan	-2.4	-1.4	1413	1592	218.4	209.4	184	189
Uvs	-3.5	-2.0	2087	2143	137.7	150.7	187	190
Khovd	-0.2	1.5	2117	2409	127.7	128.6	199	209
Govi-Altai	-1.7	-0.6	1186	1344	176.5	180.8	214	222

Annual mean temperature is raised by 1.1^{O}C in last 20 years compare to previous 30 years, active temperature sum (above $+10^{O}$C) raised by 87^{O} in Selenge aimag, 220^{O} in Bulgan aimag, 179^{O} in Zavkhan aimag, 56^{O} in Uvs aimag and by 292^{O} in Khovd aimag, respectively. Maximum raise of active temperature sum was detected in Kovd aimag 2117-2409^{O}C, but this is not an effecting factor to seabuckthorn growth.

Annual mean precipitation was increased by 0.9-29.8mm in last 20 years. But Bulgan aimag's annual mean precipitation was decreased by 73.9mm. By natural and weather condition, Bulgan aimag is located in humid cool, Selenge aimag is in arid cool, Zavkhan aimag is in arid coolish, Govi-Altai and Khovd aimags are in very arid, Uvs aimag is in arid cool region, respectively /Table1/.

2. Soil condition of research area

Lately soil productive fertility is diminishing so fast, adjacent to it desertification, soil erosion processes are going intensively globally.

Among the soil fertility formation factors, organic matter role and significance are very essential and it is stated by the scientists (V.G.Mineev 1978). Seabuckthorn grows in light soil, light soil allows its root distribution and formation of natural plantations as woodland. Therefore seabuckthorn is cultivated for protecting soil erosion.

As the soil analyze result, soil humus was 1.1-2.3% at 0-20sm depth, 0.6-1.7% at 20-40sm depth /Table2/.

Table 2. Soil analyze report of certified laboratory, Nr10/01

Name of aimag	Depth, sm	Humus %	pH (H_2O)	N-NO_3 mg/ kg	P_2O_5 mg/100g	K_2O mg/100g
Zavkhan	0-20	1.2	8.1	4.12	2.0	7.3
	20-40	0.76	8.1	2.0	1.5	5.4
Khovd	0-20	1.9	8.2	6.5	2.8	9.2
	20-40	1.3	8.2	5.1	2.1	7.0
Uvs	0-20	2.3	8.8	5.2	2.0	10.0
	20-40	1.7	8.8	4.0	1.4	6.9
Selenge	0-20	2.2	7.7	4.9	2.9	8.3
	20-40	1.2	7.8	4.4	2.3	6.5
Bulgan	0-20	1.9	7.8	6.8	2.6	9.4
	20-40	1.3	7.8	5.7	2.0	8.3
Govi-Altai	0-20	1.8	7.2	2.7	1.7	4.5
	20-40	1.0	7.2	3.2	2.1	5.2

To compare soil humus content by aimags, soil of Zavkhan river basin has the lowest humus content (0.76-1.2%), that was the Mongolian sand area has sandy soil.

Figure1.Distribution of the Mongolian natural wild Seabuckthorn, field amount

Frame of this study included 18 soums of Selenge, Bulgan, Zavkhan, Govi-Altai, Khovd aimags along six big river basins and revealed resource of 13.5 thousand hectare coverage by Mongolian natural wild seabuckthorn and a mapping was done.

Table 3. Natural wild seabuckthorn orchards of Mongolia, by aimags

№	Aimag name	Number of locations, piece	Field amount, hec	Total field, hec
			From low to high	
1	Govi-Altai	1	53,3	53.3
2	Bulgan	2	77.5-237.0	309.5
3	Selenge	6	17-1162.5	2216.0
4	Uvs	6	161.9-1861.9	5183.7
5	Khovd	6	2,4-1045.6	1171.8
6	Zavkhan	11	1.5-209.9	4579.9
Total		**32**	-	**13513.5**

By the natural seabuckthorn woodland location numbers, and fields minimum field was 1.5 hectare the biggest field was 1861.9 hectare. Outlasting big woodlands along big river basins were in Uvs, Zavkhan and Selenge aimag, mainly /Table3/.

4. Biological peculiarity of the natural wild seabuckthorn

Natural seabuckthorn's populations are different from cultivated seabuckthorn. Useful characters are hidden (recessive) in cultivated varieties, but they are dominant in natural seabuckthorn (Ts.Tsendeekhuu 2005).

Fruit biochemical characters oil, vitamin C, sugar contents were determined in natural seabuckthorn's populations' forms and each characters were grouped as high, medium and low content.

Oil content

Oil content was fluctuating between 3.1 and 4.0%, average was 3.5% in selected forms.

Table 4. Fruit oil content of selected forms

	Form	Oil,%
1	Uvs-Umnugovi+Buurugiin baruun davkharga 01	4.0
2	Uvs-Bukhmurun-Tsagaanburaa02	3.3
3	Uvs-Bukhmurun-Tsagaanburaa01	3.1
4	Zavkhan-Durvuljin-Khar butnii ekh 01	3.5
5	Khovd-Sumiin ganuu 02	3.2
6	Bulgan-Khangal-Munkhtsagaan 01	3.9
Average		3.5

To compare the river basins, seabuckthorn oil contents of Bukhmurun, Bulgan rivers are high /3.1-4.0/, this is related to the location, weather and elevation (Table 4).

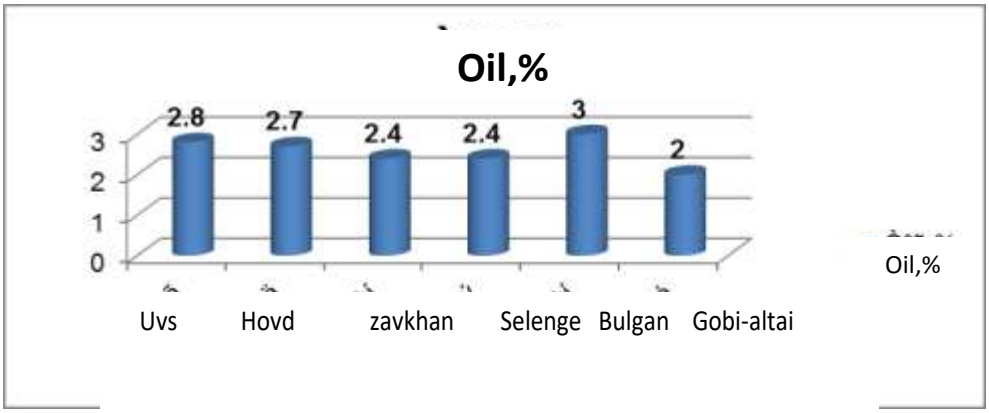


Figure 1. Oil content of seabuckthorn fruit

Sugar content

Cold resistance doesn't detect in normal condition, but in the case of cold stress the adaptation response arises. Due to cold stress, there formats osmosis regulating substance. Such protecting substance is sugar.

General sugar content was fluctuating between 6.0 and 8.9% in selected forms.

Table 5. Fruit sugar content of selected forms

№	Form	Sugar, %
1	Zavkhan-Borkhiingol-Khukhtolgoin bulan 01	8.9
2	Zavkhan-Borkhiingol-Chatsarganatiin tohoi01	8.4
3	Zavkhan-Kharganat-Mongol els 03	8.3
4	Zavkhan-Zuriin bor khoshuu 01	8.3
5	Uvs-Bukhmurun-Arzgariin gol 01	7.2
6	Khovd-Sumiin ganuu 01	6.1
7	Uvs-Dundgol-Dankhariin aral 01	6.0
8	Govi-Altai-Ar uvur chatsarganat	7.8

Sugar content of seabuckthorn forms in Zavkhan and Govi-Altai aimag (along the Zavkhan river basin) was higher (8.3-8.9%) than other seabuckthorn forms, this indicates that sugar content is related to local soil, weather condition, geo-graphical location and elevation (Table 5).

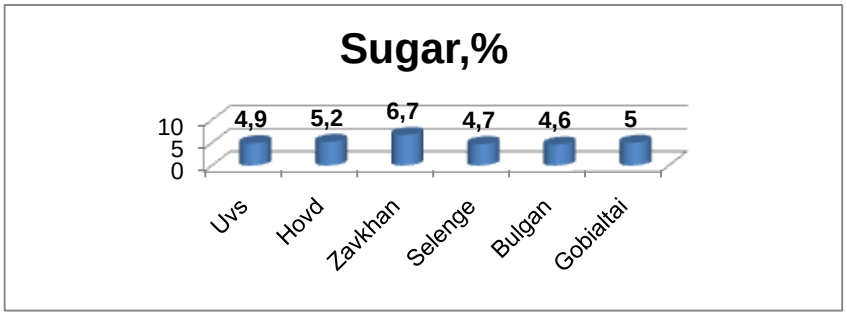


Figure 2. Sugar content of seabuckthorn fruit

Zavkhan and Govi-Altai aimag area is elevated by 1357.5-1537.7 m above sea level, but Orkhon-Selenge basin's elevated by 621.1-771.4m. Seabuckthorn sugar content, which grown in Orkhon-Selenge area was lower.

Content of vitamin C

Vitamin C content was between 161.9 and 251.7 mg/% in average 206.8 mg/%. To see this result vitamin C content was medium in general.

Table 6. Fruit vitamin C content of selected forms

№	Form	Vitamin C mg/%
1	Uvs-Umnugovi-Buurugiin baruun davkharga 01	251,7
2	Selenge-Tsagaannuur-Deed khooloin ekh 01	237,6
3	Selenge-Tsagaannuur-Aral 02	228,8
4	Zavkhan-Borkhiin gol-Khukh tolgoin bulan	211,2
5	Selenge-Zuunburen Narin 02	197,1
6	Selenge-Zuunburen Tami r02	184,8
7	Selenge-Zuunburen Norovbanzadiin tokhoi 03	161,9
8	Zavkhan-Bayan tes-Khosiin gol 01	181,3
Average		206.8

Seabuckthorn of Orkhon-Selenge river basins have higher vitamin C content (Figure 3).

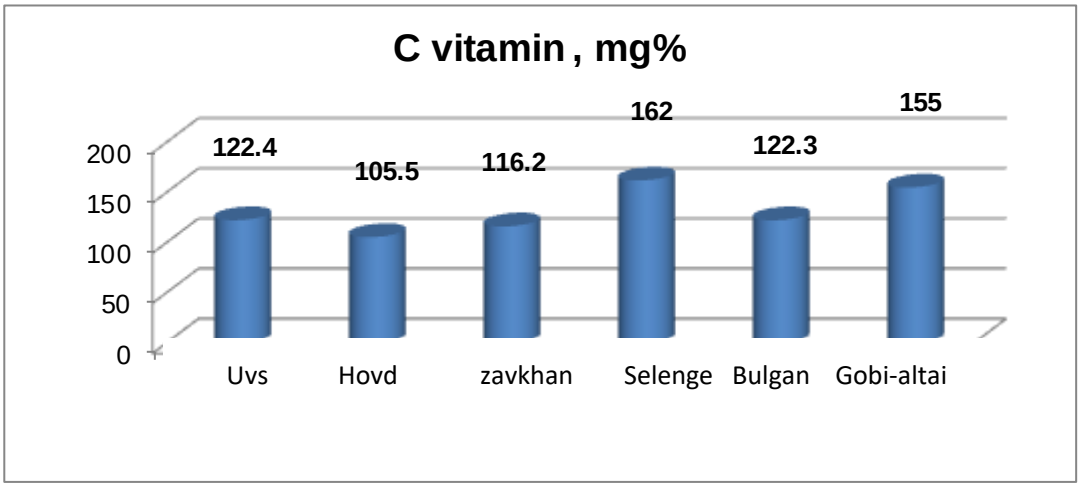


Figure 3. Vitamin C content of seabuckthorn fruit

In all populations of Mongolian areal, yellow color was 58%, orange 35% and red 7% in average respectively. But the red color was different in each population. For instance, all seabuckthorn berries in major area of Uvs aimag had red color and higher oil content (Table 7).

Table 7. Relation of fruit some biochemical characteristics and color

Name of selected from	biochemical characteristic	Fruit color
Oil content, %		
Uvs-Umnugovi-Buurugiin baruun davkharga 01	4.0	Red
Uvs-Bukhmurun-Tsagaanburaa 02	3.3	Golden yellow
Uvs-Bukhmurun-Tsagaanburaa 01	3.1	Red yellow

Zavkhan-Durvuljin-Khar butnii ekh 01	3.5	Red yellow
Khovd-Sumiin ganuu 02	3.2	Reddish
Bulgan-Khangal-Munkhtsagaan 01	3.9	Reddish
Sugar content, %		
Zavkhan-Borkhiingol-Khukhtolgoin bulan 01	8,9	Yellow
Zavkhan-Borkhiingol-Chatsarganatiin tohoi 01	8,4	Reddish yellow - orange
Zavkhan-Kharganat-Mongol els 03	8,3	Тод шар
Zavkhan-Zuriin bor khoshuu 01	8,3	Yellowish
Uvs-Bukhmurun-Arzgariin gol 01	7,2	Reddish yellow - orange
Khovd-Sumiin ganuu 01	6,1	Red
Uvs-Dundgol-Dankhariin aral 01	6,0	Yellow

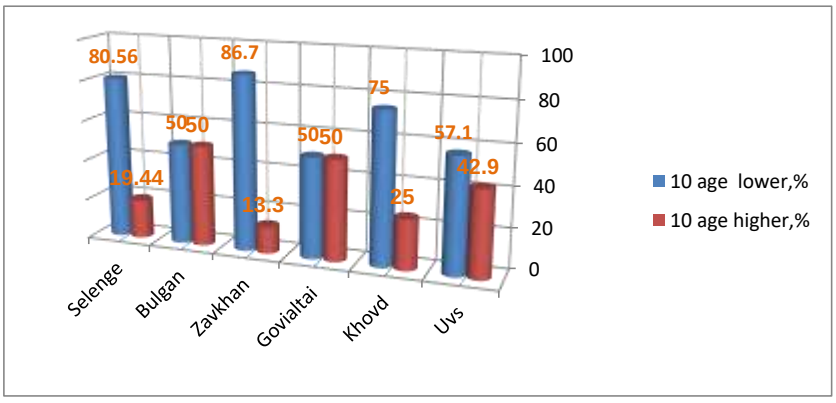
Sugar content was higher in seabuckthorn of Borkh River and Mongolian sand of Zavkhan aimag, Arzgar river of Uvs aimag, but those seabuckthorn had from orange to bright yellow color (Table 7). To see the results, color of forms with higher content of sugar was from orange to bright yellow, but color of higher oil containing forms was red. This is explained by formation of bio-active substances, which synthesis inside the cell of berry's shell.

5. Seabuckthorn aging and statement of regrowth

Bush aging was determined by the methodology of Forest resource and aging /S.Dashdavaa, 2009/.

50-87.6% of total natural wild seabuckthorn has below 10 years age, 13-50% has 10-18 age. To see this result trees and bushes are relatively young. Potential age of fruit productivity for fruit and berry plant is 7-25 years.

Figure 4.Seabuckthorn aging



Seabuckthorn aging in Selenge aimag varies between 7-20 years and this is related to their good regrowth.

6. Ex vitro storing of selected forms and genes

Basic of plant diversity existence is its genetic source. Therefore plant gene pool is called center of plant genetic resource.

We evaluated 43 natural wild seabuckthorn forms of 45 soums of six aimags Mongolia and samples were taken from each forms and analysed.

21 forms were selected by their special characters taken local or MK numbers, registered in the PAI's genebank according to International cultivars genebank's rule, and given to the main and work collection.

Picture 1.Stored samples of agricultural cultivars gene bank

SUMMARY

1. Mongolian natural wild seabuckthorn is covering 13.5 thousand hectare area along six river basins such as Orkhon-Selenge, Bulgan, Khovd, Zavkhan, Tes and Bukhmurun.
2. Within the frame of the study, 43 forms were selected by their morphology biology characters. There determined 21 forms as important selection basic material and genetic resource.

3. By chemical composition, Mongolian natural wild seabuckthorn contains medium sugar, low oil, and medium vitamin C content, respectively. Here high sugar content was revealed in seabuckthorn orchards along Zavkhan rivers, high oil content in orchards in Uvs aimag and high vitamin C content in orhcards along Orkhon-Selenge and Tes rivers but high acidity was revealed in Bayantes river in Zavkhan aimag, respectively.

4. 50-87.6% of total natural wild seabuckthorn has over 10 years age, 13-50% has 10-18 age. To see this result trees and bushes are relatively young at the natural orchards.

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