

Resource Diversity of Hippophae Rhamnoides and Its Application in Landscape

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Abstract

It introduces the diversity of the Hippophae rhamnoides resources in China, using the AHP (Analytic Hierarchy Process, the AHP method for short), from the ornamental characteristics, plant characteristics to ecological habits, etc, which is a total of 13 indexes to evaluate the value of Hippophae rhamnoides resources in landscape application, to clarify the diversity of seabuckthorn resources, to analyze the value of landscape application and expand the ways and methods used, to play a better role in the function of garden plants, and to discuss and provide theoretical references in methods of specific garden plant landscape value and how to evaluate it. In terms of the weight of evaluation indexes, Hippophae rhamnoides resources are widely distributed. The fruit is large, the fruit color is bright and diverse, the fruit bearing time is long, and the characteristics of high recognition and long ornamental period are more widely used. Hippophae rhamnoides subsp. sinensis and Hippophae rhamnoides subsp. mongolica have good ornamental, adaptability and application value in landscape application.

Keywords: Hippophae Rhamnoides, resources diversity, landscape application

I. Introduction

Garden plants and their applications are the main points to be considered in construction of urban gardens and green spaces, and the landscape quality of garden plants directly affects the overall landscape quality of gardens and green spaces[1-2]. In recent years, there have been some research reports on the landscape evaluation of garden plants[3-7]. However, there is no specific report on the landscape value evaluation of a particular garden plant[8]. It is necessary to select reasonable and feasible indicators from the factors that affect the landscape value of garden plants, establish an objective and reasonable indicator evaluation system, so as to accurately evaluate the landscape value of a garden plant[9]. The trait characteristics of garden plants are the most important factor influencing the landscape value of garden plants. Garden plants with different trait characteristics have different landscape values, which in turn affects the landscape configuration effect of garden plants.

Hippophae rhamnoides, a *Hippophae* L. in Elaeagnaceae, is a deciduous erect shrub or small arbor, usually 1-2m high. Sometimes it can be an arbor up to 8-18 m. The plant is distributed in the northern, western and southwestern regions of China, especially in Inner Mongolia, Hebei, Shanxi, Shaanxi, Gansu, Xinjiang, Qinghai, western Sichuan, Yunnan, Tibet provinces[10-11]. China has the most species of Hippophae rhamnoides, which is distributed in 19 provinces and autonomous regions. Hippophae rhamnoides is one of the few plants that can grow in soft sandstone areas, which is a tree species with extremely high ecological and environmental value and economic value in the development of the western region. These areas are exactly the key areas for poverty alleviation. Hippophae rhamnoides is a pioneer tree species for improving the ecological environment[12-13], which has high ecological and economic value. Deemed as a god-given treasure for China's poverty alleviation, it is a very important plant resource[14-16]. To this end, this paper takes Hippophae rhamnoides as an example, and uses Analytic Hierarchy Process (AHP method)[6,17-19] to evaluate the garden application value of Hippophae rhamnoides from ornamental characteristics, plant traits and ecological habits. The study aims to clarify the diversity characteristics of Hippophae rhamnoides resources, analyze its garden application value and expand its utilization, thus better giving play to its role of garden plants. The study will also provide a theoretical reference for exploring the methods and systems for evaluating the landscape value of specific garden plants.

II. Resource Use Diversity of Hippophae Rhamnoides

2.1 With root shoot characteristics and strong adaptability, it is an excellent tree species for soil and water conservation

Hippophae rhamnoides often grows in temperate regions, distributed in valleys, riverbeds, floodplains or mountain slopes at an altitude of 800-3800 meters. It likes sunshine and is a sunspecies. Hippophae rhamnoides does not favor stagnant water. Generally speaking, in area with annual precipitation of 400-500mm, it grows well, showing quite developed vertical root system and horizontal root system. Hippophae rhamnoides does not favor too sticky soil, which is often distributed on brown lime soil, grey desert soil, chestnut soil, heilu soil and meadow soil. In addition, Hippophae rhamnoides is not very demanding on temperature, which can withstand minus 50 °C at the lowest and 50 °C at the highest, demonstrating good cold and heat resistance. Hippophae rhamnoides has strong root shoot and is a wide ecological plant. With characteristics of drought tolerance, cold tolerance, poor soil tolerance, wind and sand tolerance, it is a pioneer tree species for wind prevention and sand fixation, water and soil conservation, as well as soil improvement.

2.2 With strong nitrogen fixation ability, it can improve soil and enhance soil fertility

Hippophae rhamnoides has powerful ability in nitrogen fixation through nodules. Most garden construction land is barren soil or raw soil. Therefore, the nitrogen fixation effect of Hippophae rhamnoides can be used to improve the soil environment. According to measurements, 1 hm²/a of nitrogen fixation by Hippophae rhamnoides is equivalent to the nitrogen content of 750 kg of urea per 1 hm². As a good companion tree species[8], Hippophae rhamnoides can be used for natural protection of ancient and famous trees in landscaping, which also can be mixed with other flowers and trees to supplement nutrients and enhance soil fertility[10].

2.3 Excellent fruit-effect ornamental tree species

Hippophae rhamnoides canopy is in various poses, and the shadow of the tree is whirling. The branches are open with thorns, and the branches and leaves are luxuriant; the buds are large, in golden or rusty color. The leaf surface is often densely covered with silver-white scales. In the breeze, the color wonderfully flips and changes between silver and green. The flowers are small, light yellow, which form short terminal racemes axillary on last year's branches. The fruit is spheroidal, broad-elliptic or obovate, which is orange-yellow, orange-red or purple-red in color. The bright and dense fruit often bends the branches and hangs on the tree throughout the winter. With a long fruit bearing period, it is an excellent fruit-effect ornamental tree. Hippophae rhamnoides meets the aesthetic requirements of garden plants for appearance viewing, color appreciation, smelling and sound hearing, which is an excellent landscaping tree species. With flowering period from April to May, fruiting period from August to October, it withers in March of the following year.

2.4 Good medicinal and food homologous plant

China is the country with the earliest medical records of Hippophae rhamnoides in the world. The Four Medical Tantras, Shel Gong Shel Phreng, Common Chinese Herbal Medicines in Tibet and Chinese Ethnological Herbal Medicines all have detailed records of Hippophae rhamnoides-derived medicines. In 1977, the Ministry of Health first formally listed Hippophae rhamnoides in Chinese Pharmacopoeia, and Hippophae rhamnoides is subsequently announced as a medicinal and food homologous variety[20]. Hippophae rhamnoides fruits and leaves are rich in nutrients and a variety of biologically active substances, demonstrating good cultivation value and economic benefits [11].

III. Species Diversity of Hippophae Rhamnoides Resources

3.1 Natural resources of hippophae rhamnoides subspecies in China

Hippophae rhamnoides is a plant that has persisted on the earth for more than 200 million years, which is older than ginkgo (about 100 million years). According to the records of Flora of China, this species was named after Linnaeus. In 1971, Arne Rousi from the Department of Plants of Turku University in Finland believed that Hippophae rhamnoides of Linnaeus should be a coastal plant in northern Europe. He divided the species into 9 subspecies. Among them, China has 5 subspecies of *Hippophae rhamnoides* subsp. *sinensis*, *Hippophae rhamnoides* subsp. *turkestanica*, *Hippophae rhamnoides* subsp. *mongolica*, *Hippophae rhamnoides* subsp. *yunnanensis*, *Hippophae rhamnoides* subsp. *gyantsensis* (Table1), which are produced in North China, Northwest and Southwest[21].

Table 1Seabuckthorn subspecies naturally distributed in China

Subspecies	Life form	Plant height	Habitat	Distribution
<i>Hippophae rhamnoides</i> subsp. <i>sinensis</i>	shrub or arbor	1-5m high, and those growing in mountain valleys can reach more than 10m, or even 18m.	It is mostly distributed in forest grasslands and grasslands at an altitude of 800-3600m, and sometimes in the sandy land of the eastern grassland area of Inner Mongolia, as well as the river valleys and mountains of the western semi-desert area.	Inner Mongolia, Hebei, Shanxi, Shaanxi, Gansu, Ningxia, Qinghai, Sichuan.
<i>Hippophae rhamnoides</i> subsp. <i>turkestanica</i>	Shrub or small arbor	1-5m high	Area of 800-3000m above sea level, often growing on hillsides, river valley terraces or river floodplains.	Xinjiang (Southern Xinjiang)
<i>Hippophae rhamnoides</i> subsp. <i>mongolica</i>	shrub	2-6m high	river floodplain with an altitude of 1800m-2100m.	Xinjiang (Ili, Cele, Nileke, etc.).
<i>Hippophae rhamnoides</i> subsp. <i>yunnanensis</i>	shrub or arbor	1-5m high, up to 18m in high mountains and valleys.	commonly found in dry river valley sandy land, gravel land or hillside dense forest, alpine grassland at an altitude of 2200-3700m.	Western and southwestern Sichuan, northwestern Yunnan, and eastern Tibet.
<i>Hippophae rhamnoides</i> subsp. <i>gyantsensis</i>	shrub or arbor	5-8m high	Gravel riverbed or river floodplains at an altitude of 3500-3800m	China Tibet Lhasa, Gyangze, Yadong area.

3.2 Main characteristics of hippophae rhamnoides subspecies resources in China

3.2.1 Branches and thorns

Abundant in number, Hippophae rhamnoides thorns are terminal or lateral. Tender branches are brown-green, densely covered with silver-white and brown scales, sometimes with white stellate pubescence. Old branches are gray-black and relatively rough. Simple leaves are nearly opposite or alternate, in narrow lanceolate or oblong-lanceolate, rarely in oblanceolate. The main characteristics of branches and leaves of each subspecies are shown in Table2. Hippophae rhamnoides thorns can develop into unique spiny form via hedge landscaping techniques.

Table2 Main characters of branches and leaves of sea-buckthorn

Subspecies	Branch	Leaf	Shoot thorn
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<i>Hippophae rhamnoides</i> subsp. <i>sinensis</i>	Tender branches are brown-green, densely covered with silvery white, brown scales or sometimes with white stellate pubescence; old branches are gray-black, rough; buds are large, golden or rusty in color.	The leaves are nearly opposite, in narrow lanceolate or oblong-lanceolate, green on the top, covered with white peltate or stellate pubescence, which is silvery or pale underneath, scaled, without stellate pubescence.	With many thick thorns, terminal or lateral, often branched.
<i>Hippophae rhamnoides</i> subsp. <i>turkestanica</i>	Tender branches are densely covered with silvery white scales, the scales on the branches of more than one year old are shed, the skin is white and bright, and the bark of the old branches is partially peeled; the buds are small.	The leaves are alternate, linear, silver-white on both sides, densely covered with scales, green on the top, and without rusty scales.	The thorns are thick and short, sometimes branched.
<i>Hippophae rhamnoides</i> subsp. <i>mongolica</i>	Young branches are gray or brown, and old branches are thick. The buds are big and rusty brown.	The leaves are alternate, in oblanceolate strips, the widest in shape above the middle, and the top is green or slightly silvery white.	The lateral thorns are long and slender, often unbranched.
<i>Hippophae rhamnoides</i> subsp. <i>yunnanensis</i>	Tender branches are brown-green, densely covered with silvery white and brown scales. Old branches are gray-black, rough; buds are big and rusty brown.	The leaves are often nearly opposite, in narrow lanceolate or oblong-lanceolate, green on the top, covered with white peltate or stellate pubescence, gray-brown in the bottom, with abundant big rusty scales.	The thorns are abundant and thick, terminal or lateral, often branched.
<i>Hippophae rhamnoides</i> subsp. <i>gyantsensis</i>	Young branches are gray or brown, and old branches are thick, often unbranched. The buds are small and rusty brown.	The leaves are alternate, papery, in narrow lanceolate, with slightly recurved edges. The top is green or slightly white, with scattered stellate white pubescence or tomentum. The bottom is gray-white, densely covered with silvery white scales and scattered with a few brown scales.	The lateral thorns are long and thin, with few branches.

3.2.2 Fruit

Hippophae rhamnoides fruits have rich species diversity (Table3). The fruit shapes are spherical, oval, sub-circular and oblate. The fruit colors are yellow, yellow-white, orange-yellow, red, orange-red and purple-red, etc. mostly orange-yellow. The stalk length is 1mm-3.5mm. Where, *Hippophae rhamnoides* subsp. *sinensis* has greatly different fruit sizes, mainly orange-yellow in color with short fruit stalk. *Hippophae rhamnoides* subsp. *mongolica* is orange-yellow, with big fruit and long fruit stalk. *Hippophae rhamnoides* subsp. *sinensis* and *Hippophae rhamnoides* subsp. *turkestanica* bear abundant fruits in bring color. The fruitbearing time is long, and the viewing period lasts for more than four months. *Hippophae rhamnoides* fruits are bright, distinct in color, and will not fall for a long time. Planted according to the gradient of fruit color, it can be used for garden appreciation.

Table 3 Main fruit characters of sea-buckthorn

Subspecies	Size/mm	Shape	Color	Stalk	Fruiting
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				length/mm	period
<i>Hippophae rhamnoides</i> subsp. <i>sinensis</i>	diameter 5-10	spheroidal, oblate,	Orange-yellow, orange-red or purple-red	1-2.5	September-December
<i>Hippophae rhamnoides</i> subsp. <i>turkestanica</i>	Length 5-7(-9), diameter 3-4	spheroidal	orange yellow or orange red	1-2.5	September-November
<i>Hippophae rhamnoides</i> subsp. <i>mongolica</i>	length 6-11, diameter 5-10	spheroidal or nearly spheroidal	orange-yellow	1-3.5	September-October
<i>Hippophae rhamnoides</i> subsp. <i>yunnanensis</i>	diameter 5-8	spheroidal	yellow-white, yellow, orange-yellow	>2	August-September
<i>Hippophae rhamnoides</i> subsp. <i>gyantsensis</i>	length 5-7, diameter 3-5	Ellipse, oval	Yellow	1	September-October

IV. Evaluation of Garden Application Value of Hippophae Rhamnoides Resources

4.1 Construction of the evaluation model

Evaluation of garden application value of Hippophae rhamnoides resources is a very complicated issue, involving many disciplines such as ecology, aesthetics, and botany. In recent years, the Analytic Hierarchy Process (AHP method) has been applied to the comprehensive evaluation of wild flowering shrub resources, and relatively objective evaluation results have been concluded[6,17-19]. This paper adopts analytic hierarchy process to build a comprehensive evaluation model for Hippophae rhamnoides resources (Table 4), and evaluates garden applications of Hippophae rhamnoides resources. According to the main characteristics of Hippophae rhamnoides and the general objective of garden application, considering the interrelated influence and affiliation of different indicators, as well as the interrelated influence and affiliation among different influence indicators, the indicators are aggregated and combined at different levels to form a multi-level analysis structure model, so that the problem ultimately comes down to the determination of the relative importance weight of the lowest level relative to the highest level[22]. The evaluation model is divided into four layers: the target layer, the constraint layer, the standard layer and the lowest layer. The target layer A is the highest layer, the constraint layer B is divided according to three aspects: ornamental characteristics, plant traits and ecological habits, and the standard layer C is divided according to 13 indicators. An evaluation indicator system is established to evaluate the 5 subspecies of Hippophae rhamnoides (the lowest layer D).

Table 4 Comprehensive evaluation model of landscape application value of sea-buckthorn resources

A target layer	B constraint layer	C standard layer	D lowest layer
A.Comprehensive evaluation	B ₁ Ornamental characteristics	C ₁ Leaf shape	D ₁ D ₂ D ₃ ...D ₅ subspecies of Hippophae rhamnoides
		C ₂ leaf color	
		C ₃ fruit size	
		C ₄ fruit color	
		C ₅ fruit shape	
		C ₆ stalk length	

		C7Fruit bearing time	
		C8branch thorn	
	B ₂ plant traits	C9plant type	
		C10plant height	
		C11branch angle	
	B ₃ ecological habits	C12distribution range	
		C13adaptability	

4.2 Potential scores of standard layer indicators for Hippophae rhamnoides garden application

A three-level scoring standard is determined according to the potential of standard layer indicators for Hippophae rhamnoides garden application (Table 5), and the relevant indicators of each Hippophae rhamnoides subspecies are scored separately (Table 6).

Table 5 Potential scoring criteria for landscape application traits of sea-buckthorn

Evaluation indicator	3 points	2 points	1 point
PLANT TYPE	The plant type is rich, diverse, and very ornamental.	The plant type is rich, diverse and ornamental.	The plant type changes little
PLANT HEIGHT	There is a wide range of changes and a wide range of applications.	There is medium change scope and wide application scope.	There area small change scope and a narrow range of applications.
BRANCH ANGLE	The branch angle changes greatly, the shape is easy, and there are drooping branches.	The branch angle changes greatly, and the tree is half-opened and easy to shape.	The branch angle changes little, the tree is concentrated and not easy to shape.
NUMBER OF BRANCH THORNS	There are no thorns, application range is wide	There are few thorns, application range is wide	There are many thorns, application range is limited
LEAF SHAPE	With great diversity and strong ornamental effect	with few changes and certain ornamental effect	Regular, with ordinary ornamental effect
LEAF COLOR	In silver gray, grayish green or green, with rich colors	In silver gray, grayish green, with rich colors	In grayish green, with single color
FRUIT SIZE	Big fruit, fruit weight > 30g, with strong ornamental effect.	Relatively big fruit, fruit weight 20-30g, with medium ornamental effect	Small fruit, fruit weight <15g, with poor ornamental effect
FRUIT COLOR	Rich in color, with big color difference	With rich and bright color, medium color difference	With little color change and small color difference
FRUIT SHAPE	The fruit shape is strange, with more than 3 types.	The fruit shape is common, often with 2 types.	The fruit shape is very common, with single type.
STALK LENGTH	>3mm	2-3mm	<2mm
FRUIT-BEARING TIME	long; after the fruit matures, the fruit often falls after November, and the fruit does not fall off during the whole winter	Medium, the fruit falls from October to November, and the fruit viewing period is relatively long;	Short, the fruit falls before October, and the peel is easy to crack
DISTRIBUTION RANGE	very wide	general	Relatively narrow

ECOLOGICAL HABITS	With strong adaptability and no habitat requirements	With strong adaptability and certain habitat requirements	With strong adaptability and strict requirements for habitat
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4.3 Comprehensive evaluation results regarding garden application value of *Hippophae rhamnoides*

XXXXXX	WET%	XXXXXE	ASH%ONCANE	ASH%ON
CE	1	2	4	5
TRJUICE	6	7	9	0

Table 6 Comprehensive evaluation index weight and judgment matrix consistency test

Constraint layer	Constraint layer weight	C standard layer	Standard layer weight	Consistency check value	Comprehensive evaluation indicator weight
B ₁	0.5813	C ₁	0.0347	CR=0.0106<0.1 λ _{max} =8.1044	0.0202
		C ₂	0.1235		0.0718
		C ₃	0.1822		0.1059
		C ₄	0.1822		0.1059
		C ₅	0.1599		0.0929
		C ₆	0.1241		0.0721
		C ₇	0.1724		0.1002
		C ₈	0.0210		0.0122
B ₂	0.1096	C ₉	0.5000	CR=0.0000<0.1 λ _{max} =3.0000	0.0548
		C ₁₀	0.3333		0.0365
		C ₁₁	0.1667		0.0183
B ₃	0.3092	C ₁₂	0.7500	CR=0.0000<0.1 λ _{max} =2.0000	0.2319
		C ₁₃	0.2500		0.0773

According to the model construction method in Table 4 and on the basis of the scoring standard in Table 5, the 1-9 scale method is used for pairwise comparison and scoring to construct a judgment matrix. It passes the consistency test (CR<0.1), that is, the matrix consistency is qualified. Then, the weight of each indicator is calculated. The indicator weights of each layer of the comprehensive rating model and the consistency test results of the judgment matrix are shown in Table 6. The result shows that:

(1) Seen from the weight of the evaluation indicator, among the 13 specific indicators, distribution range, fruit size, fruit color, fruit bearing time, fruit shape have relatively big weight, followed by ecological habits, stalk length, leaf color, plant type, and the other indicators have relatively small weight. It shows that in garden applications, *Hippophae rhamnoides* resources have wide distribution, big fruits, bright and diverse fruit color, and long fruit bearing time, with high recognition, long viewing period, and wide applications.

(2) The analytic hierarchy process is used to comprehensively evaluate garden applications of the 5 subspecies resources such as *Hippophae rhamnoides* subsp. *sinensis*. The result shows that the weights of *Hippophae rhamnoides* subsp. *sinensis* and *Hippophae rhamnoides* subsp. *mongolica* are both greater than 0.2, with a relatively high score in ornamental characteristics, plant traits, and ecological habits, so there are good ornamental effect, adaptability and application value in garden applications, with high application value. Other types of *Hippophae rhamnoides* should be appropriately developed in the application.

(3) Due to the limitations of the Analytic Hierarchy Process and the subjective factors in the evaluation criteria of the indicators, it is possible that individual classification results do not match the actual situation. Hence, in future applications, the system indicators should be more objectively and scientifically studied based on actual conditions.

V. *Hippophae rhamnoides* Resource Diversity in Garden Application

5.1 Space separation

Thorn plants with unique branch and thorn characteristics allow unique thorn hedges through hedgerow landscaping techniques[5]. *Hippophae rhamnoides* subsp. *Sinensis* has many thorns generally in a length of about 2 cm. Terminal or lateral, *Hippophae rhamnoides* has strong germination ability and rapid growth in branches and stems. This characteristic can be used in garden construction, for instance, building of protective ornamental hedgerows.

For example, it is more ideal to use *Hippophae rhamnoides* subsp. *sinensis* for highway isolation. For its reason, the metal isolation fence is prone to rust and corrosion, which needs to be replaced in about 5 years. *Hippophae rhamnoides* has strong stress resistance, deep roots and thick leaves, easy survival, low maintenance investment, good greening effect. The perennial thorny *Hippophae rhamnoides* with aesthetic appearance thus enables closed isolation effect of hedgerow plant[6]. Compared with hard fences, these soft landscapes fully demonstrate the harmonious coexistence of man and nature.

5.2 Greening along the highway

The selection of road greening plants should follow the principle of matching species with the site, so native tree species is the focus in selection. China is the country with the most abundant *Hippophae rhamnoides* resources in the world. *Hippophae rhamnoides* is easy to plant, survive, and manage, and has good landscape effects. Meeting the requirements of long road greening lines, diverse and harsh site conditions, it can replace monotonous tree species such as poplar, willow, and elm, thus rendering northern China to present a brand-new style. Planting *Hippophae rhamnoides* can not only reduce greening costs, but also achieve high environmental evaluation effects.

For example, the *Hippophae rhamnoides* protective belt along the Laoniupo Red Education Base Road in Qingshuihe County, Hohhot City, Inner Mongolia, demonstrates very good effect. The green spaces, parks, tourist areas, teaching areas, accommodation areas and ancient village sketching bases are effectively separated by line planting, thorn fences, etc. The trimmed *Hippophae rhamnoides* on both sides of the roadbed forms a neat tree wall, which can not only direct the traffic sight line, but also give pedestrians a sense of security. *Hippophae rhamnoides* has high canopy density and luxuriant branches, bringing aesthetic pleasure to people.

5.3 Greening of campuses, factories and mines

Hippophae rhamnoides tree is able to block dust, lower temperature in summer, and kill germs, while its fruit can be eaten by faculty and staff. In the spring and summer, the road sections with *Hippophae rhamnoides* greening showcase strong greenery, the forest is full of fruit fragrance, displaying unique natural beauty. In autumn and winter, orange-yellow *Hippophae rhamnoides* fruits hang all over the branches, rendering the campus, factory or mining area gorgeous and colorful, which forms a unique natural landscape in cold regions.

5.4 Bonsai planting

Fruit tree bonsai is praised by experts in the gardening industry as a work of art that gathers strangeness, wonder, novelty, and uniqueness in one. Potted fruit trees are increasingly used in parks and agricultural sightseeing gardens, gradually entering the homes of ordinary people. *Hippophae rhamnoides* has luxuriant branches and leaves, neat canopy. Easy to prune, it creates trees of different shapes for garden plant landscape.

In *Hippophae rhamnoides* cutting, one can choose semi-lignified branches. After the branches survive, they can be planted in flower pots with plant height kept within 1 meter, which can be used as bonsai for viewing in flowering

and fruit bearing periods. *Hippophae rhamnoides* fruit branches as a good flower material for fruits viewing can be used for flower-cut in autumn and winter. The fruit viewing period of *Hippophae rhamnoides* can last from September to the cold winter. The crystal clear small berries are hanged all over straight and branched stems. The vase life takes a long time, with rich and gorgeous colors throughout the process, displaying high ornamental value. Although the application of *Hippophae rhamnoides* in gardens is still in its initial exploration, its application in this field is increasing wider, demonstrating good ornamental value and market prospects.

5.5 Establish a special garden for *Hippophae rhamnoides*

Special *Hippophae rhamnoides* gardens require large-scale standardized construction[23]. By adopting appropriate planting design, cultivation methods and modeling in the garden, it is possible to display the ornamental characteristics of *Hippophae* L. plants in the best viewing period. Characteristic industrial base of *Hippophae rhamnoides* garden is built to further promote the development of related industries. With high standards, it has broad prospects for development and promotion.

The existing natural *Hippophae rhamnoides* forest can also be converted into *Hippophae rhamnoides* resource protection area[24]. For *Hippophae rhamnoides*, its biggest function lies in its outstanding ecological value in maintaining regional ecological balance and promoting sustainable economic and social development. For example, in the 20,000 mu *Hippophae rhamnoides* resource protection area construction project (Ant Forest Public Welfare Protection Project of China Green Foundation) in Qingshuihe County, Inner Mongolia, the *Hippophae rhamnoides* trees in the protection area are cleaned of diseased branches, densified and rehabilitated, with a certain proportion of male plants removed to improve the *Hippophae rhamnoides* productive capacity in the protection area, thereby increasing the use value of the area. The main contents of *Hippophae rhamnoides* resources protection in Qingshuihe County include the monitoring of the spatial distribution and dynamic changes of *Hippophae rhamnoides* forests in the project area, the monitoring of *Hippophae rhamnoides* forest biomass, and the monitoring of *Hippophae rhamnoides* forest ecological service functions. The protection area integrates picking, sightseeing, and characteristic industry development in one.

5.6 Ornamental application in winter gardens

The ornamental effect of *Hippophae rhamnoides* fruits in winter is incomparable for other garden plants. *Hippophae rhamnoides* fruits are magnificent and dazzling in diverse colors. The plump and bright *Hippophae rhamnoides* fruits are hanged all over the branches, becoming a scenic line in the winter garden landscape. For example, *Hippophae rhamnoides* fruits do not fall in winter, assuming colorful and dazzling fruit colors. This characteristic can be used as the icing on the cake for the Harbin International Ice and Snow Festival and other ice sculpture exhibitions.

VI. Main Conclusions

(1) In the garden application of *Hippophae rhamnoides* resources, it enjoys wide applications because of its wide distribution, long fruitbearing time, large fruit, bright and rich fruit color, long viewing period and high recognition. Among the 13 specific selected indicators, distribution range, fruit size, fruit color, fruit bearing time, fruit shape have relatively big weight, followed by ecological habits, stalk length, leaf color, plant type, and the other indicators have relatively small weight.

(2) The analytic hierarchy process is used to comprehensively evaluate garden applications of the 5 subspecies resources such as *Hippophae rhamnoides* subsp. *sinensis*. The result shows that *Hippophae rhamnoides* subsp. *sinensis* and *Hippophae rhamnoides* subsp. *mongolica* have good ornamental effect, adaptability and application value in ornamental characteristics, plant traits, and ecological habits, with high application value. Other types of *Hippophae rhamnoides* should be appropriately developed in the application.

(3) Diversity of *Hippophae rhamnoides* resources allows very extensive garden applications. As an excellent tree species for urban and rural greening, it has garden application functions of space separation, road greening, campuses, factories and mines greening, and fruit viewing in winter. It can also be used for bonsai planting and establishment of special *Hippophae rhamnoides* picking garden and so on.

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