## Sea Buckthorn (Hippophae Spp. L): A Sanjeevani (Elixir) Of Cold Arid Trans-Himalayan Region Of India

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## ABSTRACT

In the holy Ramayana, a "magical herb" called "Sanjeevani Booti" or "Life-giving herb" which is found in Indian Himalayas has been mentioned. Sea buckthorn (Hippophae spp. L.) is popular as Sanjeevani of the Cold Desert of India. It is known for its magnificent effects from ancient times. It was believed that this magical herb has unique properties for all known and unknown ailments. Every part of the plant including fruit, flowers, leaf, twig, roots and thorns is traditionally used by the communities of the cold arid zone as medicine, nutritional supplement, fuel and fence. Therefore, it is important to explore more and more about this wonder herb mentioned in the Ramayana. In the present paper, an effort has been made to explore the sea buckthorn which is an ecologically and commercially significant actinorhizal plant. Its habitat, distribution, and economic benefits to society, as it contains a range of secondary metabolites such as alkaloids, flavonoids etc., have been discussed in this paper.

Keywords: Hinduism, Hippophae spp. L., Ramayana, resurrection, Sanjeevani, Mritasanjeevani, Sea buckthorn (SBT).

## INTRODUCTION

In the holy Ramayana, there is a mention of Sanjeevani which provided life to the younger brother of Lord Rama i.e. Lakshmana who was fatally injured and almost killed by Ravana through a formidable arrow. A medicine was prepared by mixing four herbs of Mrutha-sanjeevani (restorer of life), Vishalya-karani (remover of arrows), Sandhana-karani (restorer of the skin) and Savarnya-karani (restorer of skin colour) brought by Hanuman from the mount Dronagiri i.e. Mahodaya in the Himalayas (Shastri, 1952: Srimad Valmiki Ramayana; Murthy, 2003). He immediately woke up, just as he was in a deep sleep. The Sanjeevani has been interpreted to infer that the herb is capable of 'resurrecting' life from death itself (Ganeshaiah et al., 2009, Yadav et al., 2017, Balasubramanian, 2016). Etymologically, the word sanjeevani is a Sanskrit word meaning "immortal", "the infinite life" or "life-giving".

The sea buckthorn is popular as sanjeevani of the cold desert of India and known to occur in the Himalayan region (Thakur, 2015). In the 80's, the Russian Space Department used to give sea buckthorn to astronauts as a nutritional supplement and to combat radiation in space (https://berlinplants.wordpress.com/2011/09/05/seabuckthorn-suncreen-for-astronauts-and-superfruit-for-all/)). It is a part of the diet of Indian soldiers also, who are serving in the extreme cold conditions. Sea buckthorn is a wonder alpine plant, which comprehensively fulfils the need of the human body, particularly in the cold arid region (Nagrath, 2016).

It is a kind of plant having the power to reanimate/revive or restore the dead to life (Sanjeevani). Looking at the manifold applications and broad-spectrum benefits (ecological, nutritional, ornamental, therapeutic, etc.), it is a genuine multipurpose species of huge significance to the inhabitants of the cold arid region of India, Mr Narendra Modi, Honorable Prime Minister of India has called sea buckthorn as Sanjeevani in one of his regular radio broadcast to the nation.

#### **GENERAL CHARACTERISTICS OF SEA BUCKTHORN: AN ELIXIR**

## Habitat

Sea buckthorn (Hippophae spp. L.) is an actinorhizal plant of the Elaegnaceae family. Traditionally every part of the plant including fruit, leaf, twig, root and thorns has been used as medicine, and nutritional supplements, besides its use as fuel and fence. Its numerous benefits to the natives of cold alpine region designate the sea buckthorn as a 'Wonder Plant', 'Ladakh Gold', 'Leh Berry', 'Golden Bush' or 'Gold Mine' (Stobdan, et al., 2011) (Figure 1). Its height range from 1.5 to 9 m in India but grows up to 18 m height in China. The roots of Sea buckthorn bushes go up to 65 m deep into the ground to collect nutrition and to survive in the harsh climate of the Himalayas (Yadav et al., 2017). Sea buckthorn is a windpollinated dioecious multibranched spinescent shrub. Its leaves are linear or linear-lanceolate, 2-6 cm long, with short petioles and entire margin, acutish, covered on both sides with silvery deciduous scales. The berries are bright red, orange, or yellow berries that stay on the bush throughout the winter season. It grows naturally mainly along rivers, channels and around agricultural fields. It is also found growing in sandy, rocky, barren, wasteland and even in salt-affected soils (Table 1) (Singh et al., 2005). Sea buckthorn has ubiquitous distribution in Leh and Kargil districts of Ladakh with an excellent ability to tolerate abiotic stresses like soil, moisture and nutrient, besides extreme temperatures (up to -30° C) during winter months (Dwivedi et al., 2002). The plant is hardy and drought-tolerant (Li, 2002). The Jammu and Kashmir State Forest Department in India had taken the lead in managing soil erosion and land reclamation by planting sea buckthorn (Dwivedi et al., 2006; Thakur, 2015).

Table 1: General characteristics of Hippophe sp. found inIndia

| Species     | Distribution           | Growing      | Plant height | Flowering | Fruit ripening |
|-------------|------------------------|--------------|--------------|-----------|----------------|
|             |                        | altitude (m) |              | time      | time           |
| Hippophae   | India, China, Tibet,   | 600 - 4200   | 2-6 m        | Мау       | September-     |
| rhamnoides  | Kyrgyzstan, Uzbekistan |              |              |           | October        |
| Hippophae   | India, Tibet, Bhutan,  | 2700 - 3700  | 3-10 m       | June      | October        |
| salicifolia | Nepal                  |              |              |           |                |
| Hippophae   | India, Tibet, China    | 3000 - 5200  | 0.8–1.2 m    | Мау       | August –       |
| tibetana    |                        |              |              |           | September      |

Source: Dwivedi et al., 2006

#### Distribution

Hippophae rhamnoides, H. salicifolia and H. tibetana are the predominant sea buckthorn species in India. tSer-Mang, tSer-Sa-Lu-Lu, Shib-Shu-LuLu and sTar-Bu are the most popular term used for Hippophae species (Gurmet, 2011). It is distributed in Himachal Pradesh, Jammu and Kashmir, Ladakh, North East and Uttarakhand. It is also found in Russia, Europe and Canada. H. Rhamnoides, which is widely distributed in the country (Dwivedi et al., 2002) is a distinct plant species known for its numerous qualities and manifold uses. It abundantly grows naturally in the eight major valleys, Lahoul, Spiti, Changthang, Indus, Nubra, Daras, Suru and Zanskar of Trans-Himalaya. Husain et al. (2018) reported it in a few places of Nathula in Sikkim State. H. rhamnoides spp., turkestanica is a widely distributed species of Ladakh and whereas, H. tibetana has been distributed at higher elevations in Zanskar valley of Ladakh. These species grow naturally in all five valleys of Ladakh viz. Indus, Nubra, Suru, Zanskar, and Changthang have altitudes ranging from 8500 to 12500 ft. above mean sea level around the villages like Stakana, Chhuchot, Thiksey, Shey, Nimboo, Bazgo etc (Dwivedi et al., 2006). Limited patches of the species are noticed at Shani and Manda villages (Zanskar) at 13600 ft above MSL and Tangtsey (Changthang) at an altitude of 15400 ft above MSL (Bali et al., 2016). It also grows on the banks of the Suru and Drass rivers in the Kargil district (Dwivedi et al., 2002).



Figure 1: (a) Sea buckthorn plant (b) Sea buckthorn plant with bloomed berries

Conditions for consideration as Sanjeevani Plants

In Ramayana, some characters are highlighted to qualify a shrub as Sanjeevani. They are:

1. The plant must have been referred to in various languages in India with terms close to Sanjeevani.

2. It should be a plant that grows at high altitudes.

3. It should be a very potential medicinal plant.

4. It should be able to revive life.

5. Sanjeevani should have the property of bioluminescence or emit light.

6. Every part of the plant should have medicinal value.

7. Plants should have a distinct fragrance.

8. It should contain bioflavonoids because only most of them add discrete flavour.

9. It only grows in winter, but becomes dry in summer.

## HARVESTING OF SEA BUCKTHORN

The ripe fruit is orange and it is harvested manually during August and early September when it is mature. The window for harvesting fruits is very small due to the onset of the snowfall period. The plucking of fruits due to the availability of spines on the bush is very difficult and labour-intensive (1500 hrs/ha). A common modification to hand harvesting is to cut the branches from the tree and place them in a freezer until frozen. Frozen twigs are then pounded on the inside of a drum, knocking off the frozen berries. This process damages the berries and makes them unsuitable for further processing. The mechanical harvesters have had little success. Other techniques for removing the branch from the tree are still very labour-intensive. However, given the high economic potential of sea buckthorn, since 2002 some farmers have started collecting sea buckthorn fruits from the dense sea buckthorn forests in Ladakh and selling them to traders. But, despite rich resources of about 12,000 ha area under natural sea buckthorn, with access to at least 60% of the forests, mostly in Ladakh, hardly more than 150-200 tons are collected by the farmers against the production of 24000 tons. Consequently, most of it remains uncollected and wasted. The main reasons for the low fruit harvest from natural forests are the low fruit price (Rs.50/kg), exploitation of farmers by traders and lack of market security, as well as poor fruit production (about 0.2-2.00 kg/plant) and the poor fruit harvest (10 kg/person/day) by traditional methods (Vatsa et al. 2011).



Figure 2: Collection of sea buckthorn berries by the rural population in large quantities and sold to the Government agency at an approved rate

### ECOLOGICAL BENEFITS OF SEA BUCKTHORN

Many environmental advantages are provided by the plant, including soil and water conservation, desertification management, land reclamation, erosion and water loss control, reforestation, and the construction of wildlife habitats, particularly in sensitive ecosystems of the cold arid zone. It has the potential to fix atmospheric nitrogen and establish a vast root system, which contributes to soil erosion management, land reclamation, and soil fertility enrichment in temperate regions. The symbiotic relationship of roots with Frankia fixes atmospheric nitrogen in the soil, boosting soil fertility in nutrient-deficient desert soils. According to Jike and Xiaoming (1992), every year, sea buckthorn plantations are estimated to fix 180 kg of nitrogen per hectare and this species has an efficient symbiotic relationship with a bacterium of the genus Frankia, which generally improves soil fertility. Furthermore, the thorny and bushy growth of sea buckthorn provides a protective cover for plants and wildlife, therefore, helping in the delicate environment preservation of the cold desert of India. Because of the enormous ecological advantages of sea buckthorn, the Ministry of Environment, Forest and Climate Change, Government of India has made a plan for large-scale cultivation of this shrub in the Green India Mission.

## **USAGES OF SEA BUCKTHORN**

Unlike other horticultural crops, sea buckthorn in Ladakh has an unmatchable adaptability and excellent capability to enhance the environment and economic condition of the region. The berries and seeds are commonly utilised in ayurveda medicine to treat a variety of ailments. For ages, sea buckthorn has been used in Ladakh's ancient 'Amchi' medical system. The therapeutic efficacy of sea buckthorn was first described in the 8<sup>th</sup> century in the Tibetan medical classic rGyud-bZhi (Four Text of Fundamental Tibetan Medicine), which is the classical medical textbook of Sowa-Rigpa (Amchi/Tibetan medicine). More than 200 sea buckthornbased formulations have historically been used, either alone or in combination with other medicinal plants. Gurmet (2009) mentioned that the most common formulations of sea buckthorn are used to treat lung and phlegm diseases, blood disorders, menstruation problems, throat infections, liver problems, spleen and stomach disorders, cancer, and diabetes. The polyvitaminous characteristics of these light orange to dark orange-purple coloured, pea-sized fruit berries are well known, and the most notable aspect is that the fruits of this species are one of the best sources of vitamin C (780 mg/100 g). Gupta et al. (2001) informed that it also includes all required polyunsaturated fatty acids, including omega-3 and omega-6, as well as high-quality, late-maturing berries (Figure 3). Aside from that, the sea buckthorn fruit berries, juice, and seeds include a variety of mineral ingredients.



Figure 3. Characteristics of Sea buckthorn

Sea buckthorn (Hippophae rhamnoides) is a rare plant that is now being cultivated. Although the leaves are occasionally processed into sea buckthorn tea, the fruit is the major component of value (Figure 4). The berries provide two primary sources of important products: juice from the fleshy tissue and seed as a single seed from each berry. The juice is a healthy beverage that is high in suspended solids and rich in vitamin C and carotenes. Sea buckthorn fruit berries and seed oil contain 190 and 106 different types of bioactive compounds, respectively. The seed oil contains vitamin K (109.8 to 230 mg/100 g), which promotes blood clotting. The oil is extremely unsaturated and is used in cosmetics, phytopharmaceuticals, or UV skin protectant preparations due to its light absorption and emollient qualities.





Figure 4: Various products of sea buckthorn (a) jam, (b) dried leaves used as a tea, (c) juice, (d) pulp, (e) Oil, (f) dried berries

Sea buckthorn has gained popularity in India after the Defence Institute of High Altitude Research (DRDO, Government of India) developed technology for producing a beverage from its highly acidic fruit (Stobdan and Singh, 2009). The technique has been enthusiastically embraced by manufacturers, and ready-to-serve beverages are now available in the Indian market under the brand names of 'Leh Berry,' 'Ladakh Berry,' 'Power Berry,' and so on (Stobdan et al., 2009). The tea prepared from its leaves is high in flavonoids, vitamins and therapeutic properties (Dwivedi et al., 2006). An array of products such as antioxidant herbal supplements, sea buckthorn oil, soft gel capsule, sea buckthorn beverage, jam, jelly, UV protection oil, bakery items, animal feed, etc. are at various development and commercialization stages. Sea buckthorn fruit worth Rs 1.4 crore was sold in 2007 from the Leh district alone, generating employment and rural income (Stobdan et al., 2011). In the year 2007, the average collection per household was about 152 kg per year resulting in a net annual income of Rs 3344 per household in Nubra block and 117 kg per household per year resulting in a net annual income of Rs 2574 per household in Leh block (Stobdan et al., 2011).

## Box 1. Benefits of Sea-buckthorn

Its consumption:

- Helps in the proper growth and development and keeps the body healthy.
- Serves as a building block for other cell structures.
- Provides insulation for the cold body.
- It also helps an athlete perform better.
- Along with increasing the stamina of the athletes, it helps them to regain energy and keep healthy quickly after the competition.
- According to researchers, the presence of Phosphatidylserine (PS) protects the tissues of the body from breakdown.
- Mental stress
- Prevents the development of cancer.
- Controls diabetes, thyroid and weight.
- Provides strength to muscles.
- Helpful in keeping the liver healthy.
- Existing antioxidants prevent the development of brain tumours.
- Its radio-protective properties help in protecting the body from radiation.
- Keeps the heart, joints, eyes, hair, nails and skin healthy.
- Increases immunity in the body.
- Helpful in getting rid of Alzheimer's
- Also beneficial in the diseases like cirrhosis, eczema, pigmentation problem and acne.

## THERAPEUTIC PROPERTIES

For hundreds of years, sea buckthorn has been used in Russia, China and the cold arid region of India for its medicinal and nutritional properties. Sea buckthorn is believed to scavenge free radicals - molecules that can damage cells. Sea buckthorn is the only plant that contains omega fatty acids 3, 6, 7 and 9 in abundance. It is exceptionally rich in antioxidants. It also contains vitamin C, amino acids, lipid beta, carotene, lycopene, pro-vitamins, minerals and biologically active elements (Sharma, 2003; Sah, 2008). This is a great plant for boosting the immune system (Antony, 2011; Balasubramanian, 1989).

The sea buckthorn contains a variety of secondary metabolites and bioactive compounds such as alkaloids, phenolic (flavonoids, tannins, saponins), and terpenoids (triterpenes, steroids). The main secondary metabolites of this herb were bioflavonoid, which varies according to the species. Bioflavonoids are naturally occurring compounds that are ubiquitous in all vascular plants and have many beneficial biological and pharmacological effects (Kritikar and Basu, 2005; Lahkar et al. 2015). These compounds act as antioxidants, anti-stress, anti-inflammatory, anti-cancer, antiallergic, anti-microbial, anti-fungal, anti-bacterial, anti-viral, anti-protozoal, antispasmodic, vascular relaxant, cardio-tonic, hypotensive, anticlotting, and affect the metabolic enzymes assessing anti-microbial activities (Varier et al., 1994; Sah et al., 2005; Prajapati and Kumar, 2005). This evidence helps to support and quantify the importance of screening the sea buckthorn (Annon., 1972; Bhutani, 2010; Tejaswi and Rajan, 2018). The bioactive components vary depending on fruit ripeness, fruit size, species, geographical location, climate and method of cultivation (Zeb, 2004, Leskinen et al., 2010) (Table 2).

Usually, sea buckthorn is used to:

- Treat stomach or intestinal problems
- Improve blood pressure or blood cholesterol
- Prevent or manage blood vessel or heart disease
- Complement cancer treatment
- Boost immunity and prevent infections
- Treat obesity
- Improve symptoms of cirrhosis
- Improve eyesight or dry eyes
- Treat respiratory problems such as asthma, colds, and pneumonia
- Major-phytochemicals in Sea buckthorn and their medicinal properties.

People also use sea buckthorn as a sunscreen or cosmetic and for a variety of skin-related complications such as:

- Radiation damage
- Exanthemata, a skin rash usually found in children
- Bedsores, burns, or cuts
- Acne, dermatitis, or dry skin

# Table 2. Major-phytochemicals in Sea buckthorn (SBT) andtheir medicinal properties.

| SBT phytoconstituents | Medicinal properties  | References           |
|-----------------------|---|----------------------|
| Tocopherols           | Acts as an antioxidant, minimize lipid oxidation, helps to relieve pain | Kallio et al. (2002) |

| SBT phytoconstituents                 | Medicinal properties   | References                     |
|---------------------------------------|--|--------------------------------|
| Carotenoids                           | Acts as an antioxidant and helps in collagen synthesis and epithelialization   | Andersson et al. (2009)        |
| Vitamin K                             | Prevents bleeding; promotes wound healing; anti-ulcer effect   | Jamyansan and Badgaa<br>(2005) |
| Vitamin C                             | Acts as an antioxidant and sustains cell membrane integrity<br>Accelerates collagen synthesis  | Kallio et al. (2002)           |
| Vitamin B complex                     | Stimulate cell repair and nerve regeneration   | Jamyansan and Badgaa<br>(2005) |
| Phytosterols                          | Improves microcirculation in the skin, is anti-ulcer, anti-<br>atherogenic, and anti-cancer, and regulates the inflammatory<br>process               | Yang et al. (2001)             |
| Polyphenolic<br>compounds             | Antioxidant, cytoprotective, cardioprotective, wound healing   | Upadhyay et al. (2010)         |
| Polyunsaturated fatty<br>acids (PUFA) | Immunomodulatory, neuroprotective, anti-tumour   | Yang and Kallio (2001)         |
| Organic acids                         | Lower the risk of heart attack and stroke, anti-ulcer, wound healing, anti-arthritic   | Yang and Kallio (2001)         |
| Coumarins and triterpenes             | Control of appetite, sleep, memory and learning  | Grey et al. (2010)             |
| Zinc                                  | Strengthen blood circulation, anti-tumour<br>Aids in cell proliferation, acts as a cofactor for enzymes and<br>enhances the utilization of vitamin A | Gupta and Singh (2005)         |

Source: Suryakumar and Gupta (2011)

## **FUTURE STRATEGIES**

The value addition of this agricultural product has changed the entire status of the sea buckthorn plant. This is becoming very useful for the security force personnel posted on very high mountains. Mega-projects on sea buckthorn have been undertaken by the Ministry of Environment, Forests and Climate Change, and various R&D organisations due to their environmental, biotechnological, neutraceutical, pharmaceutical, and socioeconomic potential. Traditional usage, along with economic value and scientific studies, provides enormous benefits to modern civilization from a lesser-known Himalayan plant (Stobdan et al., 2008). Since the early 1990s, the Defence Research and Development Organisation (DRDO) has been at the forefront of sea buckthorn research in India, initiating various R&D programmes. The government of India is gearing up to utilize the complete potential of this wild shrub and is encouraging Farmer Producer Organisations (FPOs) and other research and development agencies/groups to explore the value-addition potential of sea buckthorn for new products.

There is a need to provide farmers with better remunerative prices and market security, develop and use fruit harvesting machinery and convert these natural forests into productive stands by adopting modern forest management techniques that will enhance the rate of fruit production and collection and ensure ample supply to sea buckthorn based industries. There is a need to provide farmers with high-quality and characterized planting material for peripheral plantations on marginal lands, better extension and training services and value addition to their products to increase market demand. There is a requirement to improve agro-techniques such as standardization of spacing and pit sizes for better growth performance. Also, using black polythene sheets or artemisia as mulch will significantly suppress weeds (91.6-91.9%) in sea buckthorn orchards. Pruning severity of the wild sea buckthorn results in a higher number of fruits per fruiting branch.

Apart from the interior and inaccessible areas of Ladakh, the expansion under sea buckthorn is declining due to the proliferation of urban extent and large-scale construction activities for tourists. The cultivable wasteland excluding fallow land accounts for 3.4% of the total area of Leh district and can be best utilised for the cultivation of sea buckthorn. Regardless, popularising the sea buckthorn is vital to raising awareness about its cultivation and conservation.

## PROBLEMS IN DEVELOPING SEA BUCKTHORN PRODUCTS

The sea buckthorn plant offers multipurpose benefits but is still an underutilized and somewhat neglected medicinal plant. It requires much greater attention and techno-scientific efforts for the conservation and popularisation in the following areas:

- Organized cultivation of sea buckthorn is required. It is critical for the conservation of this species, which is restricted to the Trans-Himalayan area only.
- The plant is a dioecious wind-pollinated shrub, and the female bears berries after two or three years. The gender of sea buckthorn seedlings cannot be identified until they blossom, which takes 3-4 years. As a result, a DNA-based marker for early-sex determination should be developed.
- Problems associated with harvesting sea buckthorn fruits in Leh district: The thorny nature of the plants is a big

impediment to their optimum harvesting. The inner cores of the huge clusters of sea buckthorn plants are almost inaccessible at present resulting in the harvesting of only about 30% of fruits from the periphery. The main sea buckthorn growing areas generally remain cut off from the rest of India for six months a year. In addition, labour shortages also create problems for harvesting.

- Problems associated with the marketability of sea buckthorn products
- The thorniness of the shrub makes harvesting timeconsuming and labour-intensive. To find and develop thornless variants, extensive screening and selection are required.
- Macro- and micro-propagation methods must be standardised for faster and organised multiplication, which is critical for plant conservation and mass multiplication.
- Because it has multidimensional applications and soil nutrient enrichment capabilities, it should be incorporated in agroforestry systems such as hortipasture, silvi-agri-systems, alley cropping, hedge-rows, border plantings, and organised solitary plantation.
- There is no suggested cultivar of sea buckthorn in India's cold desert. To produce the cultivars, production features like yield, harvestability, fruit nutritional profile, and disease resistance must be considered.
- The most time-consuming aspect of sea buckthorn cultivation is fruit harvesting. Currently, it is harvested by pounding with a stick. However, the appropriate mechanical harvester must be developed.
- The fruits of sea buckthorn are soft, delicate, delicious, and tiny. Because berries are highly perishable and have a low pulp content, they are more difficult to handle after harvest. As a result, long-distance transportation imposes a huge challenge.
- In Ladakh, less than 5% of the natural sea buckthorn accessible is harvested. A government programme is required to convert the dense sea buckthorn cultivar into a profitable stand.
- No standard package of practices for large-scale sea buckthorn cultivation exists.

## CONCLUSION

The invasive behaviour of sea-buckthorn, its extensive use in several aspects and the intensive efforts to enrich the

mountainous terrain of the cold arid zone of Trans-Himalaya which is affected by water erosion with this species, have drawn attention towards its spread and naturalization in large areas. In this brief literature review, H. rhamnoides should be considered a very useful multi-purpose shrub species with a high potential for wasteland reclamation. From the ecological point, seabuckthorn plantation would increase flora and fauna, provide fodder to the animals, conserve water resources, purify air and drinking water, improve the waterholding capacity of the soil, prevent the loss of nutrients from the soil and check the soil erosion in one hand. On the other side of social issues/ livelihood system concerns its cultivation will promote nutritional security. Due to multifarious advantages, it is anticipated that the economic importance of this species will proliferate in the future due to its high ecological bounty and organic characteristics that make it suitable for cold arid lands. Therefore, such industries should be developed in the Trans-Himalayan region where the sources of livelihood are inadequate.

## **CONFLICTS OF INTEREST**

The authors declare that they have no conflicts of interest.

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