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Overview of Himalayan yellow raspberry (*Rubus ellipticus* Smith.): A nutraceutical plant

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Abstract: The constantly increasing demand for nutraceuticals is paralleled by a more pronounced request for natural ingredients and health-promoting foods. The multiple functional properties of *Rubus ellipticus* fits well in this trend. Recent data (49.5 µg/ml) revealed the high content of antioxidant and other phytochemical properties, which can give added value to this fruit on both nutritional and nutraceutical basis. With different essential compounds such as 2-Deoxy-D-ribose, potassium ferricyanide, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), L-ascorbic acid, ellagic acid, quercetin, catechin, 1,1-diphenyl-2- picryl-hydrazyl (DPPH) and nicotinamide adenine dinucleotide (NADH) being present in different parts of plant a thorough research is well awaited into this underrated and underutilised plant. With no due care and agronomic operations needed, *R. ellipticus* may be used for varied horticultural benefits which may further reduce the surmountable pressure of few fruit crops.

Keywords: Antioxidant, Ethno Medicine, Nutraceuticals, total phenolic compound of *R. ellipticus*

INTRODUCTION

Rubus ellipticus belonging to family Rosaceae is commonly known as Yellow Himalayan Raspberry is mostly found in forest edges, and numerous forests exist over wide areas of mountains and lowlands of India and Srilanka (Wu *et al.*, 2013) The genus Rubus is very diverse, includes over 750 species in 12 subgenera, and is found on all continents except Antarctica (CABI, Cambridge, MA 2008.) Due to useful Ethnomedicinal and pharmacological properties; Rubus species has been used in folk medicine (Patel *et al.*, 2004).The phytochemical, antioxidant and medicinal attributes and health promoting constituents of cultivated *Rubus* berries are usually well recognized (Milivojevic *et al*., 2011; Wang and Lin 2000; Kafkas *et al*., 2008). It is a wild raspberry.The fruit is edible medicinally have astringent, febrifuge, kidney, miscellany, stomachic properties. The juice of the fruit is used in the treatment of fever, colic, coughs and sore throat. The inner bark is used in Tibetan medicine, it is said to have a sweet and sour flavour plus a heating potency. A renal tonic and ant diuretic, it is used in the treatment of weakening of the senses, vaginal/seminal discharge, polyuria and micturation during sleep. In recent years, multiple drug/chemical resistance in both human and plant pathogenic microorganisms have been developed due to indiscriminate use of commercial antimicrobial drugs/ chemical commonly used in the treatment of infectious diseases (Saklani *et al.*, 2011).

Use of medicinal plants as a source of relief and cure from various illness is as old as humankind. Even today, medicinal plants provide a cheap source of drugs for majority of world's population. Plants have provided and will continue to provide not only directly usable drugs, but also a great variety of chemical compounds that can be used as a starting points for the synthesis of new drug with improved pharmacological properties (Ballabh *et al*., 2008). Modern scientific studies have found that an alcoholic extract of the root of the Yellow Himalayan Raspberry has antioxidant properties and antimicrobial ones. It was also shown to have anti-inflammatory properties when tested on rats in the lab. Ten new triterpenoid saponins have been found and research is continuing in this plant. Additionally, some of the constituents show promising characteristics in terms of functionality. Although fruits of *R. ellipticus* are shown to be highly nutritious, delicious, and rich in vitamins and sugars (Parmar and Kaushal, 1982), their antioxidant and anti proliferative potentials remain under explored. Therefore, the present review has summed up to date knowledge on chemical composition, with particular emphasis on nutraceuticals and on functionality of *R. ellipticus*.

Botanical description: *R. ellipticus* is a thorny shrub of 1–3 m tall. Branches are purplish brown or brownish, pubescent, with sparse, curved prickles and dense, purplish brown bristles or glandular hairs. Leaves imparipinnate, 3- foliolate; petiole 2–6 cm, petiolule of terminal leaflet 2–3 cm, lateral leaflets

subsessile, petiolule and rachis purplish red bristly, pubescent, with minute prickles; stipules linear, 7–11 mm, pubescent, with intermixed glandular hairs; blade of leaflets elliptic or obovate, terminal leaflet much larger than lateral leaflets, abaxially densely tomentose, with purplish red bristles along with prominent veins, adaxially veins impressed, pubescent along midvein, base rounded, margin unevenly minute sharply serrate, apex acute, abruptly pointed, shallowly cordate, or subtruncate. Inflorescences terminal, dense glomerate racemes, Flowers: Calyx abaxially pubescent, intermixed yellowish tomentose, sparsely bristly; sepals erect, ovate, abaxially densely yellowish gray tomentose, apex acute and abruptly pointed. Petals white or pink, spatulate, longer than sepals, margin premorse, densely pubescent, base clawed. Ovary is pubescent; styles glabrous, slightly longer than stamens. Aggregate fruit is golden yellow, subglobose, glabrous or drupelets pubescent at apex; pyrenes triangular-ovoid, densely rugulose. Fruits of *R. ellipticus* are aggregate, etaerio of drupes, borne on a nipple-shaped thalamus, which is 6 mm long and 7 mm in diameter at the base; weight, 444 mg; volume, 567 microlitres; colour, yellow; fruits, very easily detachable from the thalamus and fall down at maturity. Seeds are numerous, very small in size around 1 to 1.5 mm in diameter; weight, 246 mg per 100 seeds; volume. Flowering time March–April and fruiting time is April–May. Chromosome number is 2n = 14 (Khan, 2010).

Traditional use of *Rubus ellipticus*: This fruit offers excellent opportunities of cultivation as a hedge or fence plant. There is practically no cost of cultivation involved except the cost of picking. This fruit can give some extra income to the farmers without any investment. The fruit has laxative properties, and is used in traditional medicine in Tibet for a number of purposes. The whole plant has astringent properties and has been used to reduce fevers, especially typhoid. The inner bark of the Yellow Himalayan Raspberry is used as a kidney tonic and an anti-diuretic. The juice extracted from the root has also been used for fevers, gastric problems (including infant colic when the young shoots are used too), diarrhoea and dysentery and the root paste, applied to wounds promotes healing. The fruit juice is also used to bring down the temperature of a fever and for colic, and is good for sore throats and colds too. The inner bark is said to help when the senses are weakening and when people have seminal or vaginal discharge. In summer it is used to promote sweating as a diaphoretic, and as a diuretic, and as the fruit is fibrous it aids the digestive processes. Due to useful medicinal properties of *Rubus* species, it has been used in folk medicine (Patel *et al*., 2004). Roots and young shoots of *R. ellipticus* are used for colic pain (Bhakumi, 1987). The inner bark of the *R. ellipticus* plant is valued as a medicinal herb in traditional Tibetan medicine, including its use as a renal tonic and anti-diuretic. Its fruits are edible and can also be used to produce a purplish blue dye (Plants for Future, 2002). The juice of *R. ellipticus*, which has an attractive colour and rich flavour, can be preserved as such and can also be used for squash making. A very good jam can also be prepared from this fruit.

Traditionally it is used for gastralgia, wound healing, dysentery, antifertility, antimicrobial, analgesic, epilepsy, diabetes mellitus and ulcer (Vadivelan *et al.*, 2009). Different part of the plant have been claimed to be useful in ailments like diabetes, diarrhoea, gastralgia, dysentery, epilepsy and as wound healing agent, anti-fertility agent, antimicrobial, analgesic and as renal tonic (Anonymous, 2004) As it is one of the important ethno medicinal plants of Manipur. The Naga tribe of Manipur uses the root bark of the *R. ellipticus* for curing fever since ancient times. They dwell in the hilly terrains and totally depend on nature for their livelihood. For curing various ailments they use the medicinal plants from the wild since ages. *R. ellipticus* is one among the shortlisted plants used as antipyretics, (Ringmichon *et al.,* 2013). The decoction of root bark is recommended twice a day for curing fever by the Nagas. The root bark is also used in diarrhea, dysentery, as abortificient, emmenagogue and in fractured bones (Kirtikar and Basu, 2001). *R. ellipticus* root paste is used as poultice for the treatment of bone fracture, applied on forehead during severe headache; fruit is edible (Pradhan and Badola, 2008). Ripe fruits are laxative and are used in the case of constipation, paste of young fruits are taken in case of gastritis, diarrhea and dysentery (Maity *et al*., 2004).The root juice drunk against urinary tract infection and its fruits are edible and were listed in the top ten wild edible medicinal plants in Tanahun District of Western Nepal (Upreti, *et al.,* 2011) *R. ellipticus* is used for curing different ailments by the Lepcha tribe of Dzongu valley in North Sikkim, India. The young shoot is chewed raw to relieve sudden stomach pain. Root decoction given to the children to get rid of stomach warm. The inner root bark of the plant is valued as a medicinal herb in tradi-

Table 1. Macro and micro minerals (mg/100 g on dry weight) contents in *R. ellipticus* (Source: Ahmad *et al.,* 2015).

Macro Minerals	Value	Micro Minerals	Value
K	680.16 ± 1.27	Fe	4.249 ± 0.15
N	700 ± 0.08	Zn	12.77 ± 0.05
P	1.26 ± 0.001	Cu	0.020 ± 0.01
Na	89.43 ± 0.01	Pb	0.02 ± 0.18
Ca	450 ± 0.22	Mn	1.948 ± 0.03
Mg	118.72 ± 0.48	Cr	0.47 ± 0.19

Table 2. Proximate composition of *R. ellipticus* (Source: Ahmad *et al.*, 2015).

Parameters	Value
Moisture	66.36 ± 0.58
Ash	2.97 ± 0.01
Crude protein	4.37 ± 0.52
Crude lipids	2.73 ± 0.06
Crude fibre	3.53 ± 0.17
Carbohydrate	86.4 ± 0.38
Energy value in Kcal/ 100 g	374.0 ± 1.56

(Moisture content in g/100 g of fresh weight while other nutrients in g/100 g of dry weight and energetic value in kcal/100 g of dry weight).

tional Tibetan medicine, including its use as a renal tonic and anti-diuretic (Pfoze *et al*., 2012).

Composition and main neutraceuticals: Saklani *et al.* (2012) reported in *R. ellipticus* the level of nutrient such as crude protein, carbohydrate; crude fibre and ash content are 3.68, 27.12, 2.35 and 1.30 per cent, respectively. Minerals as calcium, magnesium, potassium and phosphorus are 0.95, 5.60, 1.82 and 0.20 mg/100 gm, respectively. They also revealed that the fruit contained higher value of fat, protein, fibre and minerals as compared to the cultivated fruits with apple and 200 g fruit contain sufficient amount of nutrient require, per day by a person. The mineral content and its proximate value of *R. ellipticus* fruits are given in tables 1and 2, respectively (Ahmad *et al*., 2015).

Phytochemical analysis of *R. ellipticus* fruit revealed the presence of flavonoids, carbohydrates, steroids, tannins and phenolic compounds (Sharma and Kumar, 2011). The antioxidant activity of flavonoids has attracted much attention in relation to their physiological functions. Dietary flavonoids are considered to aid in the prevention of coronary heart disease because epidemiological studies have shown an inverse relationship between the intake of dietary flavonoids and coronary heart disease (Hertog *et al.*, 1993). Bidhani *et al.* (2011) reported that the level of total phenolic content in *R. ellipticus* fruit was 3.95 ± 0.05 mg GAE/ 100 g fresh weight, total flavonoid 4.99 ± 0.15, total Anthocyanin 0.58 ± 0.02, Vitamin C 4.46 ± 0.53 and β- carotene 1.81 ± 0.02. Two phenolic acids like galic acid and caffic acid were also found in highest amount of 40.45 mg/100gm fresh weight and 40.55 mg/ 100 gm fresh weight, respectively. Author revealed that the fruit of *R. ellipticus* showed highest total phenolic acid (81.00 mg/ 100 gm fresh weight) as compared to *Frageria indica, Prunus armeniaca and Pyracanthacrenulata*. It is well known that the phenolic compound contribute to fruit quality and nutritional value by modifying colour, aroma, taste and flavour also by providing beneficial health effect so they also carried out the antioxidant activity assay to access the medicinal extract by DPPH assay and found that *R. ellipticus* exhibits the highest antioxidant activity (29.22 ± 0.88 mM AAE/ 100g fresh weight). *R. ellipticus* methanolic extract also exhibited relatively high antioxidant activity ranging from 45.97 to 84 per cent (Ahmad *et al.*, 2015). Flavonoids and phenolic compounds are also reported from *R. ellipticus* roots (Vadivelan *et al*., 2009) which may be responsible for the antioxidant activity.

Table 3. Major phyto- chemicals compounds of *R. ellipticus* (Source: Karuppusamy *et al.*, 2011).

Major compounds	Value
Anthocyanin (CGE/100g)	1.71 ± 0.08
Ascorbic acid (AAE/ 100g)	44.0 ± 4.95
Total phenolics (GAE/100g)	72.0 ± 1.25
Total flavonoids (QE/ 100g)	86.4 ± 2.04
Antioxidant Activity (DPPH/ μg/ml)	196.4 ± 1.80

The overall antioxidant activity of *R. ellipticus* was the strongest, Phenolic compounds have been shown to exhibit bioactive properties, and in particular antioxidant effects, in this context, Sharma *et al.* (2014) evaluate the total phenolic content, antioxidant properties of different leaf extracts of *R. ellipticus* All the plant extracts had Phenolic content except Cold water, among all Methanol extract had High phenolic content and Hexane had very less. Similarly free radical scavenging activity by methanol extract had higher activity. Free radicals have been implicated in many disease conditions, the important ones being superoxide radicals and single oxygen. Herbal drugs containing free radical scavenger are gaining important in treating such diseases. The presence of total content of anthocyanin, ascorbic acid, phenolics and flavonoids and antioxidant activity of *R. ellipticus* fruits had reported by Karuppusamy *et al.* (2011).

Ringmichon *et al.* (2013) reported that the root bark of *R. ellipticus* is 0.8 – 1.0 cm in thickness. It is longitudinally, slightly curved or at times single quilled in shape. Outer surface is grey to dark brown while inner surface is grey to light brown to dark brown or slightly black in colour. It is fibrous in fracture, aromatic odour with strongly bitter and astringent in taste. Histochemical analysis in the study shows presence of starch, lipids, proteins, tannins, saponins, glucosides and mucilage. It is found that the Phelloderm of root bark is filled with simple and compound type of starch grains and tannin cells. Each cell contain nucleus. Secondary Phloem consists of compactly arranged parenchymatous cells measuring (25.50- 37.52 - 45.56 μm in diameter). Parenchyma cells are filled with simple and compound starch grains, tannin filled cells and few prism shaped calcium oxalate crystals are also found.

Ursolic acid and Acuminatic acid has been reported in the roots of *R. ellipticus* (Talapatra *et al*., 1989). New Pentacyclic Triterpene Acid "elliptic acid" from the leaves of *Rubus ellipticus* has been isolated (Dutta *et al*., 1997). Leaves of *Rubus* species contains tannins (Marczal, 1963; Okuda *et al*.,1992), derivatives of kaempferol and quercetin, phenolic acids, triterpenes, mineral salts as well as vitamin C are reported in *Rubus* species (Gudej and Rychlinska, 1996; Krzaczek, 1984; Wojcik, 1989). The leaves of raspberry contain

some derivatives of ellagic acid, quercetin and kaempferol (Gudej, 2003). Methyl gallate and Methyl brevifolincarboxylate is also reported with another known compound from *Rubus* speceis (Gudej *et al*., 1998). 1-Octacosanol was isolated previously from roots of *R. ellipticus* (Bhakuni *et al*., 1987). *R. ellipticus* leaves were found to have anticonvulsant activity against electrically induced convulsions, it potentiated the hypnotic effect of pentobarbitone sodium, it also possessed positive inotropic and chronotropic effects (Rana *et al.*, 1990). The extract of *R. ellipticus* is active against hypothermia (Bhakumi *et al*., 1971). The roots of *R. ellipticus* possess antiprotozoal activty against *Entamoeba histolitica*, and hypoglycaemic activity (Abraham *et al*., 1986). Antifertility activity of *R. ellepticus* has been reported in Ayurvedic and Unani literature. Sharma *et al.* (1981) reported anti implantation activity in roots and aerial parts of *R. ellipticus.*

Saini *et al.* (2012) results showed existence of a potent free radical scavenging activity along with strong ferric reducing and lipid per oxidation inhibition activities in the *R. ellipticus* fruit extracts. In addition, *R. ellipticus* fruit polyphenols also possessed potent anticancer activity against cervical cancer cells C33A. The anti proliferative activity of *R. ellipticus* fruit extracts against cervical cancer cells is supported by the HPLC analysis which showed presence of high gallic acid and ellagic acid contents in the fruit extracts. Both the gallic acid and ellagic acid were earlier shown to possess anti proliferative activity against cervical cancer cells (Losso *et al.*, 2004; You *et al.*, 2010).

George *et al.*(2013b) studied the anti-inflammatory, analgesic and antipyretic activities of *R. ellipticus* leaf methanol extract and the data revealed that the 400 mg/kg leaf methanol extract of *R. ellipticus* possess potent anti-inflammatory effect in the carrageenan-induced inflammation. It is evident from the study that *R. ellipticus* exhibits significant peripheral analgesic effect in mice comparable with standard. *R. ellipticus* leaf methanol extract at two doses possessed a significant antipyretic effect in yeast-induced elevation of body temperature in rats and its effect is comparable to that of paracetamol (100mg/kg).

It has been reported in the literature that the plant extracts have antioxidant potential. Presence of flavonoids and tannins in the extracts is known to possess antidiabetic activity (Sharma and Kumar, 2010). The protective effects of *R. ellipticus* fruit on the glucose tolerance test and alloxan-induced diabetes were evaluated by (Sharma and Kumar, 2011).The *R. ellipticus* fruit extracts exhibited a significant antidiabetic effect in experimental models of diabetes mellitus. Their studies revealed that the petroleum ether, ethanolic and aqueous extracts from *R. ellipticus* fruits (200 mg/kg) administered orally for 15 days produced a significant decrease in the blood glucose level in the model of alloxan-induced diabetes and glucose tolerance test in rats and proves the traditional claim regarding *R. ellipticus* for its anti-diabetic activity, the observed antidiabetic potential of test extracts may also be due to presence of phyto constitutes viz. flavonoids, carbohydrates, steroids, tannins and phenolic compounds which were evident by preliminary phytochemical screening, and also due to the reported antioxidant potential of the plant.

George *et al.* (2013a) studied on antitumor and wound healing properties of *R. ellipticus* and found that the leaf methanol extract of plant processed significant wound healing and appreciable ascites and solid antitumor activities, more than likely due to its strong in vitro and in vivo antioxidant properties. It may also stimulate the NK cells to elevate the anticancer immune functions of acupuncture-enhanced cancer therapy. The studies also demonstrated that RELM was effective in wound healing and reduction of tumor progression. This may lead to the utilization of *R. ellipticus* as a phytotherapeutic agent for the treatment of free radical related or generated disorders. The author suggests that *R. ellipticus* is a valuable natural antioxidant and that it is immensely effective for treating skin diseases, wounds, and tumors. Sharma and Kumar (2010) studied on therapeutic efficacy of *R. ellipticus* (smith) fruits extracts in acute acetaminophen induced nephrotoxicity in rats and result suggests that the petroleum ether, ethanolic and aqueous extracts of *R. ellipticus* fruits possesses nephroprotective potential and improves histological derangements associated with acute dose acetaminophen nephrotoxicity.

Conclusion

The fruits of yellow *R. ellipticus* are an important source of natural antioxidants and their consumption may play vital role in reducing the oxidative stress and preventing the degenerative diseases including cancer, diabetes etc. The present study put forward a scope to develop an effective drug from *R. ellipticus* against inflammatory disorders as this plant has been used in folk medicine to treat various other ailments. This study confirms presence of various phytochemicals in *R. ellipticus* essentially needed to treat various disorders and proves an eye opener to the researchers to find out the mechanism for responsible compound behind these pharmacological properties of this highly valued fruit crop which stands underutilised. Moreover, with fruits like *R. ellipticus* the gross pressure levied on few fruit crops like mango, papaya and guava will ease profoundly for different nutraceautical properties. As this being hard crop grown in waste land in mountainous region, without any care or agronomic practices, its cultivation and utilization will prove beneficial.

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