Review Article

A Review on Potential Anti-microbial and Therapeutic Properties of Himalayan Plant *Tupistra nutans* (Nakima)

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ABSTRACT

At present multidrug resistance by several bacteria and fungi is becoming one of the major challenges for researchers all over the world. Previously used drugs are not that much effective and safe and can leads to various side effects to the body. Since ancient time many of the plants and herbs were used in Ethnic medicine for treatment of many disease. And we know more than 75% of total world population relies upon natural products for the formulation and treatment. Like multidrug resistance, diabetes is also emerging as a major problem in developed and developing countries like USA and India. Where nearly 1 million Indians die due to diabetes every year in India and about 34.2 million people or 10.5% of total U.S population have problem of diabetes. Some of the naturally present phenolic compounds in plants like protocatechuic acid, chlorogenic acid, *p*-hydroxybenzoic acid, caffeic acid, *p*-coumaric acid, ferulic acid and salicylic acid are reported to be much effective against several microorganisms, for cancer treatment and also for treatment of diabetes by inhibition of α- glucosidase activity. In this review we have discussed about several phenolic compounds which were naturally present in Himalayan plant *Tupistra nutans* (Nakima) and their antibacterial, antifungal, anticancer and antidiabetic properties.

Keywords: *Tupistra nutans*, Antibacterial, Antifungal, Antidiabetic, p-coumaric, α- glucosidase

INTRODUCTION

Tupistra nutans is a perennial, evergreen, glabrous herb under family *Liliaceae* with a growing height of 1.8 m and are mostly found in region of Eastern Himalaya in the world. Inflorescence occurs at the end of summer with fleshy bloom of flowers that remains for some period of time and root of this plant needs cool environment and moisture to grow. As these plants are easily cultivated by the locals living in Himalayas and during season the flower buds or Inflorescence of this plants shown in (figure 1) are sold in market along with the other vegetables.

Figure 1: Floral bud or Inflorescence of *Tupistra Nutans* (Nakima)

This plant shows wide spectrum of therapeutic and medicinal uses in indigenous and folk medicine and its root and flower part are powdered and taken as anti-diabetic medicine in order to control diabetes related problems.[1]

This plant is also a cheap source for several vitamin and minerals. Shoots and leaves of this plant can be cooked and are used for preparation of soup and salad.[2] The crop is gaining popularity amongst the consumer because of its medicinal properties. Powdery root and flowers of Tupistra not only taken to control diabetes but it are also used by local people as a tonic to relieve pain.[3] leaves of this plants grow up to 1-2 meter in length forming a clump of evergreen foliage and can be propagated through sucker.[4]

Components of *Tupistra nutans* (NAKIMA)

Tupistra nutans (Nakima) is not just like common vegetables but is important source of fiber, proteins and minerals like Ca, K,P and Mg which promotes good health. Low Na/K ratio in *Tupistra nutans* helps in reducing high blood pressure.[5] The low fat and more fiber content in Tupistra makes it one of the beneficial food against obesity problems and with maximum level of calcium and iron content in it helps in prevention of osteoporosis of bones and iron deficiency in anaemia.[6] From many previous studies it was found, *Tupistra nutans* is a potential source of natural antioxidant[7] and certain phenolic compounds present in its root extract.[8]

Polyphenols

Polyphenols are plants based secondary metabolites which provide defense mechanism against ultraviolet radiation and infection by the pathogens. At recent the use of plants based polyphenols in diet as antioxidant is becoming one of the research of interest for researchers all over the world. Many of the epidemiological studies suggested that consumption of polyphenols in diet for long period of time can provides protection against many diseases like diabetes, cancer, cardiovascular disease, osteoporosis etc.[9] l-phenylalanine, protocatechuic acid, chlorogenic acid, *p*-hydroxybenzoic acid, caffeic acid, *p*-coumaric acid, ferulic acid and salicylic acid are the polyphenols present in roots extract of *Tupistra nutans.* Among all of the polyphenols present in *Tupistra nutans*, salicylic acid and *p*-coumaric acid were the most available phenolic compounds in its root extract and chlorogenic acid with least amount in its root extract .[10] All of this polyphenols are shown in figure 2.

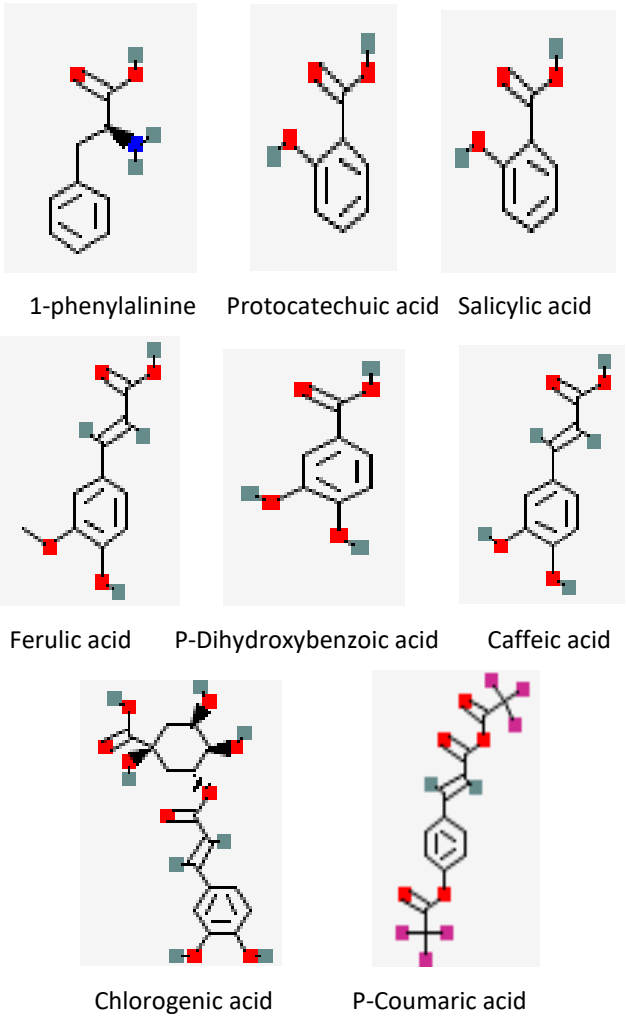


Figure 2: Phenolic compounds present in root wall extract of *Tupistra nutans* (Source: Pubchem)

Minerals

Minerals are element which plays a very important role in our body in order to perform necessary functions from building bones stronger to transmit nerve impulses for long and healthier life. For example minerals like (Co, I, Fe) plays an important role in erythrocyte cells formation, (Cr) in regulation of blood glucose level (Mo) in antioxidant enzymes activation, (Ca,K) in controlling high blood pressure etc[11]. Among all of the elements present in the root wall extract and inflorescence of *Tupistra nutans*, the most available mineral is potassium(K) followed by the Calcium (Ca), phosphorus(P) and magnesium (Mg), Iron (Fe) etc and other elements by their quantities in descending or decreasing order Cu, Mn, Mo and Zn.[12] all of the minerals present in *Tupistra nutans* are shown in Table 1.

Table 1: Elemental Profile (mg/100g of dry weight) of wall of *Tupistra nutans*

Essential Elements	(mg/100g of dry weight)
Potassium(K)	561.61
Calcium(Ca)	11.30
Magnesium(Mg)	86.82
Phosphorus(P)	110.88
Iron(Fe)	42.33
Manganese(Mn)	26.24
Zinc(Zn)	2.38
Copper(Cu)	52.63
Molybednum(Mo)	2.70
Non Essential Elements	
Sodium(Na)	19.06
Cobalt (Co)	0.52
Silver (Ag)	0.27
Berylium(Be)	0.10
Bismuth (Bi)	0.17
Caesium(Cs)	0.17
Gallium(Ga)	3.11
Lithium (Li)	1.612

(Source: phytojournal.com/archives/2018/vol7issue2/PartAY/7-2-432-510.pdf)

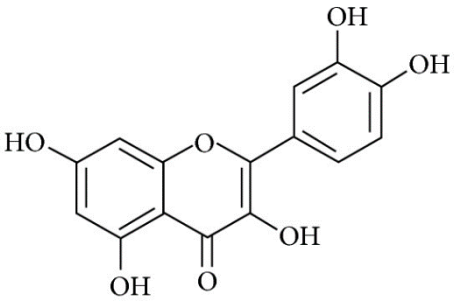
Vitamins

Vitamins are organic highly complex group of compounds naturally present in all foods including fruits and vegetables and are required for normal metabolism of the body and whenever vitamins are absent from the body or whenever not available in required amount to the body they cause symptoms of deficiency to the body. This deficiency symptom can be cured by proper intake or supply of vitamins to the body whenever required[13]. All of the vitamins are diverse in nature and are classified according to their chemical nature and function played by them.[14] Ascorbic acid or Vitamin C content was found to be highest in *Tupistra nutans*.[15] and also high ascorbic acid

content helps in radical scavenging activity against free radical.[16]

Flavonoids

Flavones are compounds which are having phenolic structures, consisting of one carbonyl group and if 3-hydroxyl group is added it gives rise to a flavonol and many of the flavonoids like Amentoflavone, eupomatenoid-5, conocarpan, orientin and Flavonoid derivatives like scandenone, kaempferol-3, 7-O-a-L-dirhamnoside shows potent antifungal activity against several fungi including C. albicans[17]. Results obtained from coloumn chromatography of methanolic extract of *Tupistra nutans* flower shows presence of one of the flavonoids called Quercetin[18] as shown in Figure 3.



Quercetin

Figure 3: Flavonoid present in methanolic extract of *Tupistra nutans* flower

Theurapetic Properties of *Tupistra nutans* (NAKIMA)

All the oxidative metabolic process produces free radicals or reactive oxygen species.[19] It cause damage to the cells and it leads to pathogenesis and several diseases like cancer, diabetes, heart disease and Alzhmeir's disease.[20] Antioxidants are the molecules which helps in reducing the oxidative reaction when produced by free racidals[21]. Synthetic antioxidants like butylated hydroxyl toluene and butylated hydroxyanisole leads to various side effects to the body and are not safe[22]. And recently there is increase in research about the natural antioxidants and polyphenolic compounds from the plant extract[23] and all this polyphenolic compound and antioxidants in root and flower wall of Tupistra shows different properties like Antibacterial, Anti fungal, Anti diabetic and Anticancer activity.

Anticancer activity

The ascorbic acid content of the plant *Tupistra nutans* is very much higher which shows high free radical or reactive oxygen scavenging effect with anti carcinogenic and anti antherogenic activity[24]. Due to the high fibre contain it also helps in reducing risk of coronary heart disease, constipation, diabetes, colon and breast cancer[25]. Salicylic acid and P-Coumaric acid are abundantly present polyphenol reported in root wall of Tupistra nutans. From recent study it is found that Salicylic acid metabolites and their derivatives inhibit CDK activity and showing Chemopreventive effect against colorectal cancer.[26] p-Coumaric acid helps in inhibition of growth of colon cancer cells by apoptosis.[27]

Antidiabetic activity

Many studies have demonstrated that plant extract contains effective and potential α glycosidase inhibitor.[28] This study also supports that plant phytochemicals especially the phenolic compounds have important role in α-glucosidase inhibition. All of this study on plant phytochemicals suggests that phenolic compounds are a major contributor for inhibition of α-glucosidase activity. Recently one of the studies on diabetic rats it is found that protocathechuic acid act as a good hyperglycemic agent and antioxidant[29]. One of the similar studies done by researchers found that p-coumaric acid plays a very important role in restoring level of plasma glucose, insulin and enzymatic antioxidants[30]. One more study proved that phenolic acid like chlorogenic acid, caffeic acid and ferulic acid inhibits α-glucosidase activity[31]. It is also believed that more concentration of this phenolic compound contributes with high α-glucosidase inhibition by the mechanism shown in the figure. 4.

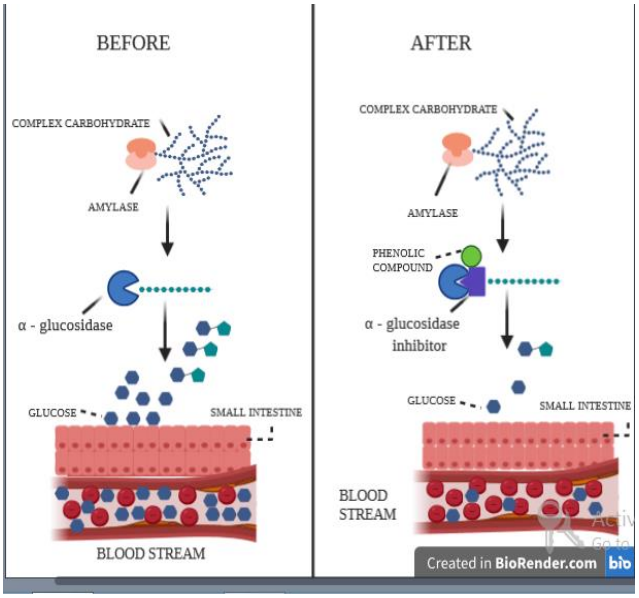


Figure 4: Mechanism of α-glucosidase inhibition by Phenolic compounds (p-coumaric acid, ferulic acid and caffeic acid). Initially α-glucosidase enzymes are active thus producing more amount of glucose in blood stream. At later stage phenolic compounds (p-coumaric acid,ferulic acid and caffeic acid) inhibited α-glucosidase enzyme thus preventing excess amount of glucose in bloodstream.

Antibacterial Activity

P-coumaric acid is a phenolic compound present in *Tupsitra nutans* and recently a study on P-coumaric acid it was found that P-coumaric acid shows bactericidal activity by dual action mechanism where it first disrupt the membrane of bacterial cell and another action by binding to genomic DNA of bacteria by inhibiting all bacterial cellular functions leading to bacterial cell death. In one of the sensitivities study done with P-coumaric acid on

several Gram positive bacteria like *S. pneumoniae* ATCC49619, *B. subtilis* 9372, *S. aureus* 6538 and Gram negative bacteria like *S. dysenteriae* 51302, *E. coli* ATCC25922, *Salmonella typhimurium* 50013 it was found that strongest inhibitory effect of P-coumaric acid is observed against gram negative *S. dysenteriae* as shown in (Figure 5) and for which MIC value is least about 10 mg/ml. Whereas MIC value for other bacteria like *E.coli* and *Salmonella typhimurium* are 80 mg/ml and 20 mg/ml.[32]

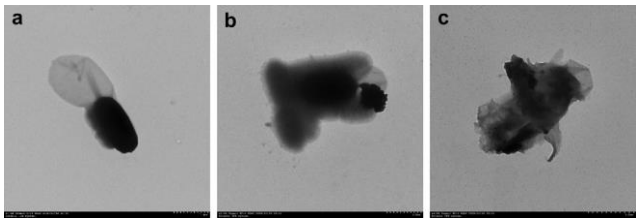
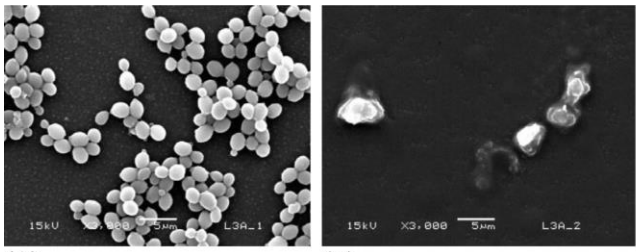


Figure 5: Transmission electron microscopy images of bacteria Shigella dysentery when treated with P-coumaric acid for time period (b) 90 min, (c) 3hr and (a) control (Source: doi:10.1016/j.foodcont.2011.11.022)

Antifungal Activity

The fungi *Penicillium expansum* is responsible for causing blue mold disease in various vegetables and fruits by spreading its conidia spores very quickly.[33] It is also responsible for synthesizing the mycotoxin called patulin which can cause food poisoning in humans.[34] In one of the study it was found that salicylic acid helps to prevent biosynthesis of mycotoxins and can be used as a better alternative for controlling diseases and also able to show antimicrobial effect against rot causing fungi.[35] In another study it was found that one of the melanized pathogenic fungi *Cryptococcus neoformans* responsible for causing pneumonia and meningoencephalitis in immunocompromised patients can be effectively inhibited using P-coumaric acid by inhibiting tyrosinase and melanine producing enzymes of *Cryptococcus neoformans.*[36] A study done on ethanol extract of propolis (T3 sample) where several phenolic acids like p-coumaric acid, caffeic acid phenethyl ester (CAPE), quercetin were identified and found to be effective against biofilms of *Candida glabrata* when treated with it[37] as shown in Figure 6.



(A) (B)

Figure 6: Figure showing effect on preformed biofilms of Candida glabrata where (A) untreated biofilms of Candida glabrata (B) Biofilms treated with T3 propolis containing phenolic compounds like p-coumaric acid, caffeic acid phenethyl ester, quercetin.(source: https://doi.org/10.1016/j.mycmed.2016.01.003)

CONCLUSION

According to WHO, India has more diabetic patient than any other country in the world and one in six people in world with diabetes is from India. Not only developing country like India but developed and super power country like USA is also affected by the problem of diabetes where 10.5% of total U.S population are affected with diabetes. Multidrug resistance by microorganism is another emerging problem for all of the countries over the world and previously used drugs were not safe and effective, often leads to several side effects to the body. Diabetes occurs due to high glucose level in blood which can be prevented with the help of plant based natural phenolic compounds like p-coumaric acid, chlorogenic acid, caffeic acid and ferulic acid etc which helps in inhibiting the α-glucosidase activity and are also reported to be effective against several microorganisms including fungi and bacteria like *S. dysenteriae*, *E. coli* and *Salmonella typhimurium*, *Crptococcus neoformans*, *Candida glabrata* etc. Many studies also demonstrated all of this phenolic acid in prevention and treatment of cancer. Therefore *Tupistra nutans* based phenolic compounds is a potential candidate for treatment of problem like cancer and diabetes and also the phenolic compounds present in *Tupistra nutans* can be used against multidrug resistant microorganism. However further research study is needed to quantify its potential effect so it can be used for various food and pharmaceutical applications.

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