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REVIEW ARTICLE **OPEN ACCESS**

A Review on *Aegle marmelos* and Its Various Properties especially as Green Nanoparticles

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ABSTRACT
India is regarded as the arboretum of the globe due to the enormous quantity of therapeutic plants that are produced there. Medicinal plants are well known and are widely accessible in rural and tribal communities for a variety of medical uses in herbal therapy. One of them known as Bail, is regarded as one of India's utmost significant therapeutic herbs since Charak (1500 B.C). Bael's leaves, stems, fruits, and roots are extremely valuable for their anti-inflammatory, anticancer, astringent, antidiarrheal, antidysenteric and antibacterial properties. The refined baelpatra chemicals, which are most effective against those infectious organisms, are used as a treatment of several serious illness, such as cancer, diabetes, as well as cardiovascular conditions. According to the many investigations done by the many researchers, compounds such asskimmianine, coumarins, alkaloids, tannins, carotenoids, seed oils, and other unidentified chemicals have all been extracted from this herb and have been shown to have variety of therapeutic properties.
KEYWORDS:-Bael, traditional medicine, digestive, antimicrobial, nanoparticles.

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INTRODUCTION

The "Herbal State," commonly known as Uttarakhand, has a wealth of medicinal plants and a wealth of ancient medical expertise. There is a lot of information available in many formats regarding the medicinal plants of Uttarakhand. The current version of the Uttarakhand Medicinal Plants Database (UMPDB) has 1127 data of medicinal plants from 153 different plant groups that are dispersed throughout 13 districts of Uttarakhand. Of all plants, this article primarily concentrates on the *Aegle marmelos* (baelpatra), which has various medicinal or pharmacological properties and is the most widespread and valuable plant. The family Rutaceae includes *A. marmelos* which is also called as Baelpatra [1]. The ancient Indians and other South Asian residents valued the usage of belpatra for ayurvedic therapy [2]. It is used to treat a variety of illness like diarrhea, irritability and chronic dysentery. Homeopathy, Unani and Sacred systems of remedy use all tree parts as herbal remedies. [3,4]. Essential oils extracted from various plant components are utilized extensively in food, beverage and perfume sectors andbeen in possession as antibacterial properties against a diverse array of bacteria and fungus [5]. About 158 genera and 1900 species makeup the Rutaceae family [6]. The history of the indigenous Indian baelpatra tree is recorded in theYajurveda, Early Sakyans and Jain article. The ancient Indian medical text "Charaka Samhita" describes its therapeutic powers. The ripe fruit is cooling, laxative, stringent, and scented. The unripe or partially ripe fruit has digestive, stomachic and antiscorbutic properties.

Botanical and Geographical distribution of *Aegle marmelos*

The Bail fruit tree reaching heights of 6.0 to 7.5 meters, 90 to 120 cm in girth, and 3.0-4.5 meters in length[7].The leaves are alternating, deciduous, and come in groups of two or three oval, leaflets that measure four to ten cm long and two to five cm wide. Each flower contains fifty or more grassy lemony filament and 4 bentleaflets. Fruits can be circular, elliptical or oblong in appearance with diameter of 5 to 20cm. The fruit pulp has 10 to 15 seeds embedded of 1cm long [8].It is chiefly root in barren forest and mountainous region. In practically all of India's states, including Himachal Pradesh, Bihar, Jammu and Kashmir, Kerela etc. Moreover, it is grown in Asiatic, Burma, Vietnam, Thibet, Bangladesh, Bangkok etc.

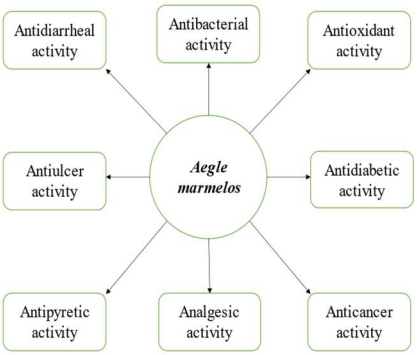

Figure 1: Various properties of *Aegle marmelos*Fig 2: Plants of *A. marmelos*

VARIOUS PROPERTIESOF *AEGLE MARMELOS*

Chemical properties of*Aeglemarmelos*(Table 1)

Moisture:

A close examination of information reveals that pulp, seed and pericarp of bail fruit had moisture contents of 61.06, 31.08 and 38.92 % respectively, demonstrating the fruit's great perishability. The pulp's moisture content gradually dropped as the rise in the amount of dry matter [9,10] reported a very close value of 61.50%. Similar findings were reported by [11].

PH:

The pH was measured and the results were reported as 4.95, 5.49 and 5.28 for pulp, seed and perfume respectively (Table 1). Bail fruit pulp had a PH between 5-5.3 according to [12] and from 4.7-5 according to [13].

Acidity:

The bail fruit pulp had an acidity of 0.3% whereas the seed and pericarp had an acidity of 0.006% and 0.296% respectively.

Crude protein:

The presence of protein in*A. marmelos* fruit pulp, seed and pericarp determined to be 3.64, 1.01 and 1.31 respectively. Both [9,10] claimed that the bail fruit's protein content was 1.80%. Although the amount of crude protein gradually decreased as the fruit developed.

Ash:

According to reports, the ash level of bail fruit pulp, seed, and pericarp was 2.85, 4.02 and 3.18 percent respectively. It was found that the ash content was 1.7 mg per 100 gm [9,10]. Nevertheless, [14] recorded a higher number for ash content, i.e 2.66 percent.

Crude fiber:

In comparison to the results of the current investigation, the value reported by [9] for the crudefiber cont ent of bail fruit was rather low (0.31%). The current values, however, were concluded with the values supplied by 4.5%. According to [10], the value was 2.90%.

Crude fat:

Bael fruit pulp's crude fat content was found to be 0.43 percent, comparable to the previously reported value[10].

Minerals:

P, K, Ca, Mg, Fe, Cu and Zn values for several minerals discovered in bail fruit pulp were 51.6, 603, 78, 0.55, 0.19 and 0.28 mg/100g respectively [11](Table 2)

Sugars:

The sugar contents of bail fruit, pulp [14] reported a total sugar content of 8.36 percent, [12] published results that showed a substantially higher value for total sugars, ranging from 12.5 to 16.7 percent.

Table 1- Chemical composition of *A. marmelos* (%)

PARAMETER	PULP	SEED	PERICARP
Moisture	61.06	31.08	38.92
PH	4.95	5.49	5.28
Acidity	0.30	0.06	0.29
Crude Protein	3.64	1.01	1.31
Ash	2.85	4.02	3.18
Crude Fiber	4.80	-	30.65
Crude Fat	0.43	1.08	0.06
TSS Brix	36	-	-

Table 2- Mineral constituents of bail (%)

MINERAL	PULP	SEED	PERICARP
Phosphorus	51.60	3.30	2.80
Potassium	603	108	210
Calcium	78.00	-	6.00
Magnesium	4.00	0.82	0.91
Iron	0.55	0.08	0.02
Copper	0.19	0.01	-
Zinc	0.28	0.03	0.02

Pharmacological Properties of *Aegle marmelos*

Antioxidant activity

These plants have been found to exhibit antioxidant activity because of the existence of flavones, phytochemical, polyphenols, catechins etc. A no. of studies demonstrated the antioxidant activity of *A. marmelos* opposed to a range of free radicals.According to the findings, ripe fruit extract had higher levels of enzymatic antioxidants than immature fruit extract. Immature fruit had a higher portion of free radical forbid than ripe fruit [15].

2. Antimicrobial activity

Aegle marmelosis used to treat a range of conditions of infectious disorders, and it has been extensively documented to suppress a wide variety of pathogenic microbes. Gram negative organisms have stronger antimicrobial activity than gram positive strains [16]. *Aegle marmelos* leaves have been shown to have antifungal efficacy against clinical isolates of jock itch, ringworm, M. gypseum etc. were all susceptible to the fungicidal effects [17] .It has been observed at the Aegle marmelos leaves also exhibit antibacterial properties. The disc diffusion method was used to evaluate the antibacterial activity of the various extracts. E. coli, Pseudomonas, S. aureus, S. typhi etc. were all highly susceptible to the antibacterial effect [18].

Activity Against many diseases and physiological disorders

The antidiarrheal effect of A. marmelos has recently been supported by several in vivo and in vitro studies. It was recognized that the dried fruit pulps of bail have antidiarrheal properties in vitro. The MIC technique was used to provide antidiarrheal activity against the diarrhea causing pathogens such as bacillary dysentery, Sh. sonnei and Sh. flexneri [19].

a. Antidiabetic activity

All of the solution of leaves of bail found to have antidiabetic potential decreased blood glucose levels in Zanosar diabetic rabbits; and shows strongest anti-diabetic effects [20].*A. marmelos* sugar levels were measured on day 12 after continuous administration of methanolic extractwhich lowers blood sugar levels. Blood sugar level started to drop on sixth day as 54% [21].

b. Anti- inflammatory activity

It has been suggested that the immature fruit puree of bail has anti-inflammatory properties. S Prague Dawley rats received an injection of 0.1 ml of 1%carrageenan into sub planer side of left hind paw to cause inflammation. Inflammation caused by carrageenan in the inflamed rats was decreased after extract administration [22].

Anticancer activity

Bail leaf extracts were found to be efficient in preventing the proliferation of leukemic K 562, breast cancer cell lines MCF7 and MDA-MB-231 in preclinical studies[23]. In ER negative breast cancer cells,bail extracts may boost ERa gene expression and limit cell growth [24].

NANOBIOTECHNOLOGY ASPECTS

About nanoparticles

Richard P.Feyman. a recipient of the Nobel Prize in physics, was the first to discuss nanotechnology. He presented his research as "There's plenty of room at the bottom," at the American Physical Society meetings in December 1959 [25]. Nanoparticles are extremely small particles, ranging from one to hundred nm.NPs are formed of three layers because they are not simple molecules themselves: (a) The surface layer, which may be completed with a range of tiny particles, ore, emulsifiers and compound.(b) The sheath layer, which is made entirely of materials that are chemically distinct from the core. (c) The core, which is the NPs core according to its constitution.

Types of nanoparticles

There are various types of nanoparticles includes: Silver nanoparticles, Gold nanoparticles**,** Alloy nanoparticles**,** Magnetic nanoparticles

Silver nanoparticles:

One of the most important and exciting nanomaterials is AgNPs. They are crucial to nanomedicine, nanotechnology and other related fields. AgNPs have also been promises a cancer symptomatic and curative tool. AgNPs are widely employed in a variety of fields such as in medical, food, or industrial sectors [26,27,28]. They have been employed in numerous of applications such as antiseptic agents, in trade, tribe, and health maintenance related products, and beauty products, therapeutic, orthopedics, as anticarcinogenic agents, and have tumor killing properties [29].

Gold nanoparticles:

AuNPs are used in immunochemical investigations to pinpoint protein interactions. They are used as lab tracers in DNA fingerprinting to detect the presence of DNA in a sample. Additionally, they are used to find antibiotics such streptomycin, gentamycin and neomycin.

Alloy nanoparticles:

Ag flakes are the most frequently used metal filler because they have the highest electrical conductivity of all metal fillers[30]. Both metals have an impact on bimetallic alloy nanoparticles characteristics and exhibit greater advantages than those of regular metallic NPs [31].

Magnetic nanoparticles:

Two varieties of magnetic nanoparticles, magnetite and maghemite are recognized as being biocompatible. Magnetic Resonance Imaging (MRI), guided drug delivery, gene therapy. DNA analysis, and targeted cancer treatment have all been extensively researched with them [32].

Methods for production of Nanoparticles

Nanoparticles Production may be carried out by mainly three types of methods: Biological production of nanoparticles, Chemical production of nanoparticles, Physical production of nanoparticles

Table 4: Critical review literature on *A. marmelos* of last ten years

AUTHOR'S NAME	PARTS OF PLANT	WORKDONE	FINDINGS
Rakulini,R. and Sounthararajan, K. [42].	Unripe fruit	A Review of Anti–Diarrheal Activity	Anti- diarrheal activity
Dey et al [43].	Leaves	Through GC-MS Analysis of a Methanolic Extract of The Leaves a neuro steroid molecule was discovered	Neuro-Steroid compound
K. J. et al [44].	Leaves	Green production of silver nanoparticles using aqueous solution	Green synthesis of Ag nanoparticles
Sarkar T, et al [45].	Leaves	In-depth pharmacological and nutritional properties	Pharmacological properties
Sharma G. N. et al [46].	Seed	Assessment of wound healing progress	wound healing activities
Abdallah I. et al [47].	Fruit	Evaluation of A. marmelos fruit extract's antidiabetic and antioxidant effect	antidiabetic and antioxidant activity
Thangarasu, V., & Ramanathan, A. (2019) [48].	Seed	A.marmelos correa seed oil is used to make biodiesel for use in fuel cell application.	Production of biodiesel
Wangkahart E et al [49].	Fruit	Growth performance, immunological reactions, digestive enzymes, and disease resistance of a medicinal plant	growth performance, immunological reactions, digestive enzymes, and disease resistance
Thanthri S.H. et al [50].	Flowers	Cu2+ ions adsorption research from aqueous solutions	Adsorption study of Cu2+ ions
Azmi L. et al [51].	Flowers	Activity for wound healing in vitro	wound healing activity

Role of nanoparticles on *Aegle marmelos*

The various bail herb crude extracts, as well as silver nanoparticles have significant antibacterial properties that make them excellent starting points for the creation of novel herbal medicine compounds that could benefit humanity.India has accumulated a wealth of knowledge on the use of herbalism for both curative and preventive medicine almost 88% of people worldwide use plant base treatments or medicines [33,34].The specialized metabolites that herb deploy as defences opposed to several bacteria, insects and herbivores include tannic acid, alkaloids, polysaccharides, glycosides etc.[35,36]. In comparison to contemporary synthetic pharmaceuticals, it is thought that herbalism is more palatable to the human body [37]. AgNPs are one of the most important nanoparticles out of all the many types of nanoparticles. They are used in a variety of biological advantages including antiseptic, antimycotic, antiviral, and ant-inflammatory effects [38]. Plant extracts may function in the creation of nanoparticles as both reducing and stabilizing agents [39].*A. marmelos* is used in Ayurvedic and traditional remedies to treat conditions like gastric ulcers, diabetes, diarrhea, hypertension and tuberculosis. Alkaloids, terpenoids, fatty acids, amino acids and other phytoconstituents are among those found in *A. marmelos* [40,41].

CONCLUSION

According to this thorough information, *A. marmelos* is a crucial medicinal herb that is widely utilized in Homeopathy, Sacred, and another medical system.Many phytoconstituents found in *A.marmelos* are the main contributors to this plant's therapeutic usefulness. Practically each and every part of this plant such as the leaf, fruit, seed, bark, and root used to treat a variety of illness. The new medications *A. marmelos* being developed by pharmacologists will be used to treat and control a variety of illness such as antidysentery, antimicrobic, analgesic, photoprotective, anticarcinogenic, antifever, sore healing, antimutagenic, contraceptive, and anti-inflammatory characteristics of *Aegle marmelos* make it useful in the treatment and prevention of a variety of illness.

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Conflict of Interest

No conflict of interest

Author's Contribution

Each author contributed equally to prepare and review the literature of the manuscript. SP reviewed the literature, UG helped to prepare rough draft, MR help to arrange figures and tables, RV overall reviewed the article.

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NA

Informed Consent

NA

Data Availability

NA

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