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THE PHARMACOLOGY, TOXICITY, AND PHYTOCHEMISTRY OF IPOMOEA CARNEA: AN OVERVIEW

Anjali Kumari Maurya*[1] and Prashant Kumar Singh[2]

[1]Research Scholar, Saraswati Higher Education and Technical (SHEAT) College of Pharmacy, Varanasi, U.P.

[2]Assistant Professor, Saraswati Higher Education and Technical (SHEAT) College of Pharmacy, Varanasi, U.P.

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***Corresponding Author**
Anjali Kumari Maurya
Research Scholar, Saraswati Higher Education and Technical (SHEAT) College of Pharmacy, Varanasi, U.P.

ABSTRACT

Ipomoea carnea is a plant commonly known as Besharam or Behaya tree. It belongs to the Convolvulaceae family and is native to America. The plant grows quickly and has spread widely in India. If pregnant animals eat this plant, it can lead to a lack of bonding between the mother and her offspring. In this article, we focus on controlling the uncontrolled growth of Ipomoea carnea and using it as a source of biogas along with cow dung cake. Different species of Ipomoea can be found in various parts of India. We have gathered information and recent advancements regarding the medicinal importance of I. carnea. The plant's extracts have shown antibacterial, antifungal, antioxidant, anticancer, anticonvulsant, immunomodulatory, antidiabetic, hepatoprotective, anti-inflammatory, anxiolytic, sedative, and wound healing properties. However, there have also been reports of some toxic effects. This study discusses the major phytochemicals associated with the plant's bioactivity. Researchers in phytotherapy might find this review article helpful, as I. carnea has the potential to be a valuable source for drug development.

KEYWORDS: Ipomoea carnea, phytoconstituent, Besharam, Behaya, Shameless,flavonoid, quercetin.

INTRODUCTION

Plants have been our natural companions since ancient times, providing us with food, clothing, shelter, and medicine. They are self-sufficient organisms that produce various chemicals called phytochemicals. These phytochemicals are not essential for the basic

functions of plants but serve additional purposes such as defense against pests, microbes, viruses, or other plants, as well as attracting animals for pollination or seed dispersal. Some of these compounds can even mimic the molecules found in our own cells, like hormones or signaling molecules, and have effects on our bodies [Wink et al., 2003]. Others perform the similar function of human metabolites, probably because of similar molecular target. Such as brassinolides are plant steroid hormones, which regulate cell division and cell development in the plant, and are structurally similar to human growth-regulating steroids [Grove et al., 1979]. Tracing the history of medical knowledge claims that plants are the root of medicine. Archaeological, anthropological and historical evidences support the use of medicinal plants by thousands of years ago [Sumner et al., 2000]

Ipomoea carnea is also known as besharm or behaya because it has been claimed that eating its leaves causes pregnant goats to lose their relationship with their mothers. In Western India, it is widely available. It flourishes along roadsides, riversides, and wetland edges. Ipomoea carnea is found in India in 60 different species on average. It is a member of the family Convolvulaceae. Their height typically ranges from 1 to 5 metres. In the manufacturing sector (paper manufacture), it is helpful. It is widespread throughout Rajasthan, Madhya Pradesh, Kota, Chandigarh, and Maharashtra. [Sharma et al., 2013]

Ipomoea carnea: basic features and traditional usage

Scientific Classification

Kingdom- Plantae

Sub kingdom- Tracheobionta

Division- Spermatophyta

Subdivision- Magnoliophyta

Class- Magnoliopsida – Dicotyledons

Subclass- Asteridae

Order- solanales

Family- Convolvulaceae

Genus- Ipomoea Species- carnea

Local Name

Hindi- Beshram, Behaya,

English- Bush Morning glory

Oriya- Behayo

Marathi- Beshram

Bengali- Beshram

Phytochemical properties of Ipomoea carnea

The fundamental element responsible for a plant material's pharmacological and therapeutic activities is its phytochemical makeup. The existence of bioactive phytochemicals was suggested by a long history of traditional medical use, but most of these substances were unknown. L-rhamnose, D-fucose, D-chinovose (6-deoxy-D-glucose), D-glucose, convolvulinolate (11-hydroxy-pentadecane acid), jalapinolate (11-hydroxypalmitic acid), 7-hydroxy-decane acid, and ipurolic acid (3, 11-dihydroxy-tetradecane acid) were found in the latex of I. In their report on the phytochemical analyses of I. carnea leaves, Tirkey et al. [Tirkey et al., 1988] discovered that the dried powdered leaves of the plant contain alkaloids, reducing sugars, glycosides, and tannins, while the latex of the plant contains acacetin-7-galactoside, flavone glycoside, and an unidentified saponin known as ipomotocin.

According to recent studies, I. carnea's leaves, stem, and flowers contain a respectable quantity of polyphenols (30-70 mg of catechol equivalent per g of dry material) and flavonoids (80-120 mg of quercetin equivalent per g of dry material) [Khatiwora et al., 2010]. Alkaloids, carbohydrates, tannins, phenolic chemicals, proteins and amino acids, terpenoids and sterols, and saponins were all found in the methanol extract of I. carnea's leaves and flowers, according (Arora et al., 2013). Only the terpenoid in the leaves, flowers, and seeds, as well as alkaloids of the polyhydroxylated class, have been partially characterised among these phytochemicals.

Chromatographic study on the leaves, flowers and seeds resulted in the isolation of swainsonine, 2-epi-lentiginosine, calystegines B1, calystegines B2, calystegines B3, calystegines C1 and N-methyl-trans-4-hydroxy-L-proline at varying combination and concentration [Adsul et al., 2009].

In case of protein, only one protein molecule has been isolated and characterized from the latex of I. carnea, known as “Carnein”, which is a serine protease with a molecular weight of 80.24 kDa [Patel et al., 2007].

Ipomoea carnea contain variety of bioactive components such as phenolic acid, alkaloids, flavonoids, coumarins and sterols1-4

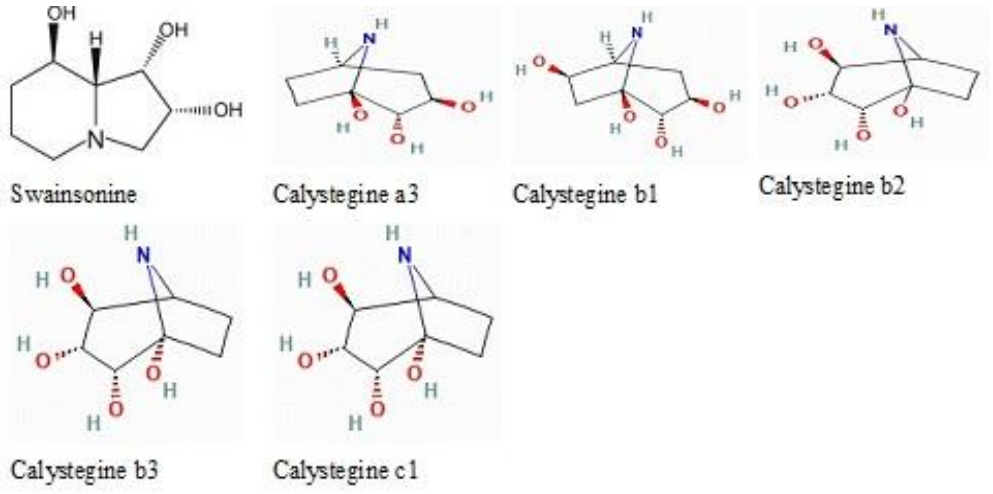

Figure 1: Major bioactive constituents of Ipomoea carnea. (A) Swainsonine, (B) Calystegine a3, (C) Calystegine b1, (D) Calystegine b2, (E) Calystegine b3 and (F) Calystegine c1. Source: Pubchem: www.pubchem.ncbi.nlm.nih.gov

The National Institute of Standard and Technology (NIST) database 2005 was used for the GC-MS analysis of the methanol extract of the leaf powder to determine the chemicals contained. By comparing the molecular weight and retention period, the spectra of unknown compounds were compared to those of recognised compounds kept in the NIST collection. Leaf powder included 22 bioactive phytochemical substances that were discovered. The majority of the substances are phenolic compounds, derivatives of flavonoids, carbohydrates, glycosides, saponins, and phytosterols based on factors such peak area percentage, molecular formula, and molecular weight. It has been discovered that these various active phytochemicals have a variety of properties that may aid in the prevention of various diseases. 2018 [Kar et al.]. A gas chromatography–mass spectrometry study on the hexane extract of I. carnea showed the presence of a panel of 13 compounds including hexadecanoic acid, stearic acid, 1,2-diethyl phthalate, n-octadecanol, octacosane, hexatriacontane, tetraacontane and 3-diethylamino-1-propanol [Haraguchi et al., 2003].

Medicinal/pharmacological action of Ipomoea carnea Over the last few decades, a number of researches demonstrated several researchers have been found to be antiinflammaotry, antioxidant, antidiabetic, Anti-hepatotoxic, oxidative stress, liver protective etc [Khalid et al., 2011, Adsul et al., 2012, Abdul et al., 2012, Gupta et al., 2013, Khan et al., 2015, Ambiga et al., 2015, Gupta et al., 2012]. Other pharmacological activities are discussed below under.

REPORTED PHARMACOLOGICAL ACTIVITIES

Anti-microbial activity

I. carnea has been studied for its ability to fight bacteria and fungi. In one study [Adsul et al., 2012], it was found that the acetone extract of I. carnea is effective against Ptroteus vulgaris and Salmonella typhimurium bacteria, while the ethanol extract works against Pseudomonas aeruginosa. Another compound called dibutyl phthalate, found in I. carnea, has anti-bacterial properties and can fight certain types of gram negative bacteria like Klebseilla pneumonia, Proteus mirabilis, and P. aeruginosa [Khatiwora et al., 2012]. Some resin glycosides from I. carnea have been shown to enhance the effectiveness of antibiotics such as tetracycline, kanamycin, and chloramphenicol, which are commonly used to treat bacterial infections [Corona-Castañeda et al., 2012]. These resin glycosides may work together with other compounds in I. carnea to fight bacteria.

In traditional medicine, I. carnea has been used for treating skin diseases, but there is limited scientific research on this topic. However, a study by Mogle et al. [2013] demonstrated that the leaf extracts of I. carnea have antifungal properties and can inhibit the growth of fungi such as Aspergillus niger, Penicillium digitatum, Botrytis cinera, Rhizopus arrhizus, Aspergillus flavus, Chaetomium brasiliense, and Rhizoctonia solani. Among these fungi, the extract showed the strongest effect against Aspergillus niger. The main anti-fungal components in the leaves of I. carnea were found to be two cumarate isomers: (E)-octadecyl p-coumarate and (Z)-octadecyl p-coumarate [Nidiry et al., 2011].

Anti-oxidant activity

A class of compounds known as antioxidants can stop the oxidation of other molecules by squelching reactive free radicals. As a result, they may have positive health benefits on the prevention of degenerative diseases. According to [Khatiwora et al., 2010], the leaves, stem, and flowers of I. carnea contain significant amounts of antioxidants such polyphenols and flavonoids. According to Adsul et al. (2012), I. carnea contains high levels of polyphenols and flavonoids that have been shown to have potent DPPH radical scavenging action. Particularly, this plant's blossom has higher concentrations of phytoconstituents that fight free radicals.

Anti-cancer activity

Hexane, chloroform, and ethyl acetate all had cytotoxic effects on the I. carnea fraction, with LC50 values of 141.4 g/mL, 211.28 g/mL, and 307.28 g/mL, respectively [Sharma et al.,

2013]. Isolated from I. carnea, the natural alkaloid swinsonine has been shown to have anti-cancer effects on a number of rat cancer models and human carcinoma. The apoptosis that is induced by swansonine in the human lung cancer cell line A549 prevents cell proliferation. The I. carnea alkaloid swainsonine was found to induce apoptosis in A549 cells by upregulating Bax, downregulating Bcl-2, promoting Bax translocation to mitochondria, triggering the mitochondria-mediated apoptotic pathway, releasing cytochrome C, and activating caspase-9 and caspase-3 [Li et al., 2012].

Anti-convulsant activity

The anti-convulsant activity of both polar and nonpolar extract was evaluated in mice and rats using the pentylenetetrazole and maximal electroshock (MES)-induced seizure models by Rout et al.[30] The result of MESinduced convulsion showed that the polar extract significantly reduced extensor phase and stupor phase at a dose ranging from 200 mg/kg to 400 mg/kg. Indeed, the anti-convulsant activity was comparable to that of standard drug, Phenytoin. The polar extract also delayed the onset of time and increased the duration of pentylenetetrazole-induced convulsion. Thus extracts caused a significant dose-dependent increase in onset of convulsion compared with the control in pentylenetetrazole and MES-induced seizures [Rout et al., 2013].

Immunomodulatory effect

Only ten years ago, a study by Hueza et al. brought I. carnea's immunomodulatory function into sharper focus [Hueza et al., 2003]. They claimed that a small dose of I. carnea's aqueous fraction caused macrophages to phagocytose and produce hydrogen peroxide. Swainsonine, an alkaloid found in I. carnea, also exhibits immunomodulatory properties. Swainsonine typically functions by preventing glycoprotein metabolism. If rats were exposed to swinsonine when they were young, during breastfeeding, swinsonine modifies immunological function in adult rats [Hueza et al., 2011].

Anti-diabetic effect

The anti-hyperglycemic effect of aqueous extract of I. carnea leaves in streptozotocin-induced diabetes in rats was studied [Khalid et al., 2011]. A significant effect was observed by the extracts at 500 mg/kg dosage that was comparable to Glibenclamide (10 mg/kg). The phytoconstituents probably explains such anti-diabetic or hypoglycemic effect. The polyhydroxylated nortropane alkaloids calystegines are found in I. carnea and other Convolvulaceae plants.[34] Calystegines B1 and C1 are potent competitive inhibitors of

bovine, human and rat βglucosidase activities. Calystegine B2 is a strong competitive inhibitor of the α-galactosidase activity in the livers of bovine, human and rat, while calystegines A3 and B2 are selective inhibitors of rat liver β-glucosidase [Asano et al., 1997].

Liver protective

Aqueous extract of I. carnea leaves was reported to restore the liver structure and functioning suggesting indicators (activity and/or expression) in a dose-dependent manner in a rat model of hepatotoxicity caused by carbon tetrachloride. The anti-oxidant properties of I. carnea are partially responsible for the hepatoprotective effect. The lipid peroxidation in liver tissue was said to be reduced by leaf aqueous extract, and the activity of anti-oxidant enzymes such superoxide dismutase and catalase were said to be restored to normal levels. According to histological findings [Gupta et al., 2012], hepatocellular necrosis had also improved and the infiltration of inflammatory cells had decreased.

Anti-inflammatory effect

In formalin (0.1%)-induced rat paw edoema model, the anti-inflammatory efficacy of methanolic and petroleum ether extracts of I. fistulosa, a subspecies of I. carnea, leaves was reported. The extract appears to have anti-inflammatory effect at different acute phases of inflammation, according to a time-dependent evaluation of that activity. The presence of -sitosterol in I. fistulosa or I. carnea may be responsible for this anti-inflammatory effect [Ruchi et al., 2009]. The ability of I. carnea leaf extracts to reduce inflammation was tested using a carrageenan (0.1%)-induced rat paw edoema model. This study's findings are comparable to those of the previous study, but more notably, the anti-inflammatory impact is developed in the early stages of inflammation [Khalid et al., 2011].

Anxiolytic activity

I. carnea seems to belong to the class of central depressants known as sedative-hypnotics. The elevated plus maze, open field test, and hole-board test model were used to examine the anxiolytic effect of the aqueous and methanolic extract of I. carnea leaves in mice [Bidkar et al., 2012]. The elevated plus maze is a typical behavioural paradigm because it may be used to research anxiety in animals in pharmacological, physiological, and behavioural approaches [Fabian et al., 2009]. Both the open field test and the hole-board test typically show emotional and/or anxious reactions to stress and indicate exploratory behaviour [Rodriguez et al., 1987; Takeda et al., 1998]. The potential of the aqueous and methanolic extract of I. carnea leaves to lessen anxiety is supported by each of these behavioural paradigms [Bidkar

et al., 2012]. Many nortropane alkaloids, notably calystegines B1, B2, C3, and the indolizidine alkaloid swainsonine, are present in I. carnea, and these alkaloids are assumed to have anxiolytic characteristics [de Balogh et al., 1999; Haraguchi et al., 2003].

Sedative activity

The sedative effect of the petroleum ether, alcohol and aqueous extracts of I. carnea leaf was evaluated in mice and rats using phenobarbitone-induced sleeping time and head dip test.[30] Study reported that the duration of sleeping time in phenobarbitone-induced experimental models was increased in a dose-dependent manner with a significant decrease in locomotor activity at high dose, and in case of head dip test, exploratory behavioral potential was found to be decreased due to high dose of alcoholic and aqueous extract [Rout et al., 2013].

Wound healing activity

The flavonoids (Kaempferol and Kaempferol-3-O-â-D-glucoside) extracted from I. carnea flowers demonstrated considerable wound healing activity in the study using the incision and excision wound model [Ambiga et al., 2007]. Both the inflammatory and proliferative phases of wound healing are strongly influenced by these two flavonoids, according to macroscopic, biochemical, and histological aspects [Stadelmann et al., 1998]. Less macrophage, which are the predominant inflammatory cell type cells at the wound site, are one of the histological aspects of healing that signified the improvement of the inflammatory phase in another study [Rodero et al., 2010]. Interestingly, the improvement of the proliferative phase of wound healing was confirmed by a combination of macroscopic features and biochemical features, including an increase in granulation tissue and hydroxyproline concentration, respectively [Midwood et al., 2004]. Depending on the flavonoid kinds and wound types, different biochemical, histological, and macroscopic characteristics are present to different degrees.

Toxicity effects of Ipomoea carnea

General toxicity A number of studies reported the toxicological effects of I. carnea, mainly in goats and sheeps. Chronic ingestion of I. carnea has been reported to cause general weakness, loss of body weight, loss of hair, locomotor disturbance, loss of reflexes, intero-hepato-nephropathy, muscle tremors, ataxia, posterior paresis, paralysis and even death [Idris et al., 1973, Damir et al., 1987]. In Wister rats, some of the biochemical changes, like leukocytosis, anemia, an increase in serum aspartate Amino Transferase activity and decrease of albumin level have been noticed after I. carnea treatment [Amna et al., 2011]. The dihydroxynortropane alkaloids are thought to be responsible for these toxic effects of I.

carnea [Asano et al., 2001]. Also, it is suspected that the calystegines might act as coadjuvants of swainsonine in I. carnea toxicosis [Hueza et al., 2005].

Lysosomal storage disease induction

Lysosomal malfunction causes a category of uncommon inherited metabolic illnesses known as lysosomal storage disease [Winchester et al., 2000]. A small number of lysosomal storage diseases are caused by environmental causes, such as ingesting poisonous plants like locoweeds (Astragalus and Oxytropis spp.) [Van Kampen et al., 1969]. The majority of these diseases are hereditary abnormalities. According to a report by de Balogh et al. (1999), I. carnea causes lysosomal storage disease in goats. Ataxic, with head tremors and nystagmus, the affected animals were discovered. Lysosomal storage disorder is hypothesised to be caused by the glycosidase inhibitor phytoconstituents of I. carnea, notably swainsonine and calystegines.

Teratological property

Oral administration of the plant extract from days 6 to 20 of gestation was used to assess the effects of prenatal administration of I. carnea on pregnant rats and their progeny. According to the findings of that investigation, the thyroid, pancreas, liver, and kidneys of kids had organ-specific I. carnea toxicosis, which was characterised by cytoplasmic vacuolization. I. carnea treatment resulted in pups losing weight, having their thymus atrophy, and having their spleens grow larger [Hueza et al., 2003]. It has been demonstrated that feeding the offspring an aqueous extract of I. carnea did not result in severe developmental changes that resulted in behavioural changes [Schwarz et al., 2003]. In contrast, a different study by Schwarz et al. [Schwarz et al., 2007] demonstrated that giving I. carnea aqueous extract to animals causes a considerable reduction in 3,4-dihydroxyphenylacetic acid levels and an uptick in vanilmandelic acid levels in the striatum, cortex, and hypothalamus in a diffuse way. This demonstrated the pups' increased norepinephrine activity and decreased dopamine activity [Schwarz et al., 2007].

CONCLUSION

Phytomedicine has become popular again. It refers to using plants as medicine. Modern medicine is interested in traditional medicine, especially phytomedicine, alongside chemical medicine. In fact, many chemical medicines are derived from plants. Phytotherapy, which is using plant-based treatments, is believed to be an important approach in the future because it's safe and effective. I. carnea is a medicinal plant that has been used for thousands of years,

but there haven't been many scientific studies on it until recently. Scientists have started to show interest in it. However, most of the research on I. carnea has been done in labs and on animals. To develop it as a drug for humans, more studies need to be done, including pre-clinical and clinical trials. This review focuses on the basic research of I. carnea and its active components using animal models that mimic specific diseases like diabetes, immune deficiency, and cancer. Lab experiments using animal cells can help identify the specific effects of I. carnea on different organs and evaluate its safety. It's important to evaluate the effects of I. carnea on normal and diseased human cells to establish its potential as a treatment. Before I. carnea or its active components can be used clinically, they need to be evaluated for safety. It's hopeful that active compounds in I. carnea can be identified and used in clinical trials for drug development. More scientific studies, both clinical and basic, can establish I. carnea as an important plant in modern phytotherapy research.

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