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Review Article

Unveiled the Pharmacological Attributes of *Pupalia lappacea*: An Unexplored Plant

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ABSTRACT

Introduction: *Pupalia lappacea* which is commonly referred to as forest burr found everywhere in the world. In this review article, we will discuss the traditional use and photochemistry of plants. Its traditional uses have been investigated by various scientists whose results came out to be effective against various diseases. *Pupalia lappacea* consists of various phytochemicals named stearic acid, stigmasterol, formic acid, 1-methyl ethyl ester, etc. *In vitro* and *in vivo* studies that have been investigated thus far prove that this plant posse's great therapeutic potential including anti-microbial, antioxidant, anti-inflammatory, anti-diarrheal, anti-nociceptive and anti-pyretic, anti-plasmodium, anti-hypolipidemic, antidiabetic activity which can be further explored for its clinical utility. **Materials and Methods:** This article comprises data from a research article published on various search engines including Google Scholar, PubMed, ScienceDirect, Scopus, etc., Data is also collected via textbooks, reference books, review papers and ancient texts. **Objectives:** This review aims to gather all updated pharmacological investigations that have been done on *Pupalia lappacea* together. In short, the main aim was to provide an updated review of *Pupalia lappacea* to the researchers who further want to explore its potency and efficacy. **Results:** All the documents related to the plant were studied thoroughly and it was concluded that this plant possesses a great therapeutic potential and can be clinically explored.

Keywords: *Pupalia lappacea*, Phytoconstituent, Anti-microbial, Anti-inflammatory, Antioxidant.

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INTRODUCTION

Herbal medicine is an important part of traditional medicine.[1] Herbal products are used in various medical systems including homeopathic, naturopathic, ayurvedic, Unani, Siddha, etc., Because of the toxicity and adverse effects of Western drugs, the utilization of herbal medicine has resulted in a significant surge in the number of herbal drug makers.[2] Herbal medications are currently in high demand in developing countries for basic health care not only due to they are cheap, but also because they are more culturally acceptable, better compatible with the human body and have less adverse effects. The number of people seeking alternative and herbal therapies is increasing at an alarming rate. Herbs are usually thought to be safe because they come from natural sources.[3] Herbal formulations are now widely used as anti-infective, ant-diabetic agents,[4] antifungal agents, fertility agents,[5] anti-aging agents,[6] anti-arrhythmias,[7] sedatives,[8] anti-depressants,[9] anti-anxiety agents, antispasmodics,[10] analgesics, anti-inflammatory agents,[11] Anti-Human Immunodeficiency Virus (HIV),[12] Vasodilatation agents, anti-hepatitis agents,[13] antiviral agents, anti-cirrhosis agents, anti-asthma agents,[14] anti-acne agents, anti-impotence agents, anti-menopausal agents, anti-migraine agents,[15] anti-gallstone agents, anti-chronic fatigue agents, anti-Alzheimer's agents[16] and memory enhancing agents. Due to the potential of plants, there is a need to explore more of them. In this regard, this article gives a brief about *Pupalia lappacea* just.

Descriptive and native places

Pupalia lappacea is a perennial herb from the Amaranthaceae family sometimes also referred to as creeping cock's comb and forest burr.[17] It is mentioned as "Nagdamini" in ancient texts.[18] In Haryana, it is locally called brunt or bar bunt. *Pupalia lappacea* can be seen in the subtropical and tropical regions including, Africa, Asia and across the boundaries of the Indian Ocean. Its presence can be marked at crop field hedges, forests, fruit orchards, mountains and barren areas at an altitude of 300-1050 m. The height of *Pupalia lappacea* is around 1 m, the leave shape varies from oblong, oval to elliptic to sub-circular (Length: 0.2-10 cm, Width: 0.1-0.5), the shape of the base is a wedge, the apex is acuminated in shape, the petiole is glabrescent, (length: 0.2-0.25 cm). The flower consists of lanceolate tepals (0.4 cm-0.5 cm) arranged in thyrse inflorescence with spiciform (L: 5 cm-50 cm, capsules are oval (0.2 cm-0.3 cm).[19]

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Traditional Uses

Since ancient times it has been used as decoction in febrile conditions during diarrhoea and also in conditions of sterility. The biochemical compounds that have been found in *P. lappacea* promote wound healing and anti-inflammatory action in both humans and animals. Stigmasterol present in plants showed anti-inflammatory and hemostatic effects. 20-hydroxyl ecdysone promotes protein formation and mitigation in both humans and animals. Docosanol helps in the treatment of herpes virus wounds in mice. This plant also contains N-benzoyl-L-phenyl alaninol which has shown antimicrobial activity. Considering that compounds found in *P. lappacea* leave have properties that promote the anti-inflammatory, antimicrobial and antioxidant the plant may possess wound-healing properties as affirmed by traditional practitioners. [20,21]

P. lappacea has been used in traditional and Ayurvedic medication for treating various diseases and maintaining good health. The people of Nigeria use decoction of *P. lappacea* in water to treat endometritis, urethra pain cystitis and leucorrhoea. In Tanzania, it is used as a laxative and purgative. Meanwhile, people from the northern region of Kenya use complete plants to treat skin-related diseases in humans and as restorative, tonic and performance enhancers and stimulants.[17]

Moreover, the leave pastes of *P. lappacea* mixed with sesame or Carthamus oil is an efficacious and affordable cure for bone fracture, inflammation and other conditions in both humans and cattle. The plant stem is also used as a toothbrush to treat toothache. Black powder decoction of *P. lappacea* is also consumed to treat piles, fever and malaria and used in enemas.[17] As a remedy, the dried leaves and fruit are powdered and used on wounds.[22] To treat syphilis, the root is cooked with water and the resulting infusion is consumed three times each day. This plant is traditionally used in snake bite-induced tissue necrosis due to inhibiting the necrotic enzymes in South Africa[23] and the concoction of the whole plant is used in the diagnosis of urogenital disease in Ethiopia.[24] The plant contains ecdysterone, saponins, alkaloids, glycosides and steroids that have been studied for their therapeutic benefits. Many of the medicinal benefits of *P. lappacea* mentioned in traditional medicine have been recently proven *in vitro* and *in vivo*. It has the capability of disease treatment and prevention, making it an essential subject of study in the field of medicine. Some traditional uses of *P. lappacea* have been mentioned below in Table 1.

MATERIALS AND METHODS

This article comprises data from research articles published on various search engines including Google Scholar, PubMed, ScienceDirect and Scopus. Data is also collected via textbooks, reference books and ancient texts. The data was searched from 2000 to 2023 using different keywords, for instance, *P. lappacea* and Traditional uses, *P. lappacea* and antimicrobial, antioxidant, anti-inflammatory, antidiarrhea, etc., A total of 63 research articles appeared; however, 48 articles were excluded on evaluation of the title and abstract. Only 15 research articles were available showcasing the pharmacological potential via experimentation data. This review aims to summarize the previously reported phytopharmacological status of this particular plant species.

Phytochemical Constituent

Phytochemicals are the naturally occurring plant constituents present in all medicinal plants and exert pharmacological action.[25] Similarly, *P. lappacea* also contains various phytoconstituents which are investigated by various researchers. In this regard, Farheen *et al.* have investigated the phytoconstituent composition of *P. lappacea* with the help of GC-MS analysis. In their investigation they found out that the ethanolic extract of *P. lappacea* consists of 2-Pentadecyl-4,4,5,5-tetradeutero-1,3-dioxolane which shows antioxidant activity 2-Pentene, 3-Methyl have anesthetic activity, Formic acid, 1-methyl ethyl ester,4-Ethoxy-2-pentanone and eicosane acts as antimicrobial agent, including anti-bacterial, anti-fungal, anti-viral. Propane,1, 1-diethoxy-2-methyl shows an anti-malarial effect and Butane, 1,1-diethoxy-3-methyl shows a spasmolytic effect.[26]

Another investigation made by A. Aladedunye Felix *et al.* in their research on *P. lappacea* with the help of NMR spectroscopy and TLC showed the presence of 8 phytoconstituent known as stearic acid, stigma sterol, β -sitosterol,1-docosanol, N-benzoyl, Phyenylalaninolacetate, Stigmasterol-3-0-Bet a-D-glucopyranoside, βeta-sitosterol-3-0-D–glucopyranoside and 20–hydroxyl ecdysone which shows anti-inflammatory effect.[27,28]

Similarly, Selvan *et al.* investigation reported 38 compounds in the methanol extract of *P. lappacea* aerial part.[29]

Pharmacological activity of *Pupalia lappacea*

In ancient literature, various traditional uses of the *P. lappacea* plant have been mentioned. To prove their efficiency as potent therapeutic agents, many researchers have investigated the pharmacological action of this plant. Below are some pharmacological investigations that have been discussed and summarized in Table 2.

Antimicrobial Activity

The resistance of microbes against conventional antimicrobial drugs is increasing day by day, which has led to a need for alternative drugs. Fortunately, many plant phytoconstituents have shown great antimicrobial activity,[12] and *P. lappacea* is a particularly beneficial plant mentioned in early treatment textbooks. Christian Agyare and his team conducted a study to evaluate the antimicrobial properties of *P. lappacea* extracts. They measured the extracts' Minimum Bactericidal Concentration, Minimum Inhibitory Concentration (MIC), Minimum Fungicidal

Concentration and microbial time-kill kinetics against various strains of bacteria and fungi. Additionally, they tested the extracts' ability to modulate the activity of selected antibiotics and their influence on the Lactate Dehydrogenase release, viability and proliferation of HaCaT keratinocyte cells. The study found that each extract of *P. lappacea* showed wide-spectrum antimicrobial activity, with the *P. lappacea* chloroform extract showing the highest activity. The extracts also showed a concentration and time-dependent rate of microbiocidal activity. Within the dosage used none of them revealed cytotoxic activity against the HaCaT keratinocytes.[30]

An interesting study was conducted by Ositadinma Udegbunam and his colleagues. They investigated the antibacterial properties of the methanol extract of *P. lappacea* and determined its MIC using a macro broth dilution process. The extract was tested against various bacteria in test tubes and the MIC was considered as the minimum concentration of the extract which showed no visible growth of bacteria. The Minimum Bactericidal Concentration (MBC) was also evaluated with the help of freshly prepared drug-free nutrient agar by sub-culturing the test dilution on it. The highest dilution that yielded no bacterial colony was taken as the MBC. The study found that the MIC values of the *P. lappacea* methanol extracts were 3, 4 and 9 mg/mL for *Bacillus subtilis, Staphylococcus aureus* and *Pseudomonas aeruginosa* respectively. Similarly, the corresponding MBC values were 7, 8 and 10 mg/mL respectively.[20]

Antioxidant Activity

Antioxidants are substances that scavenge free radicals and prevent cell damage while boosting our immunity. In an investigation by Adjokè *et al.*, the study was conducted to evaluate the antioxidant properties of *P. lappacea*. The researchers extracted 300g of the dried plant sample with 1L of ethanol and evaluated its antioxidant activity using several methods such as DPPH, Ferric reducing potential, superoxide anion scavenging power and Hydrogen Peroxide (H_2O_2) scavenging activity. The results proved that *P. lappacea* has potent antioxidant properties. At the dose of 100µg/mL, the DPPH assay of *P. lappacea* was found to be 25.52±1.54%. In the FRAP assay, the ethanolic extract of *P. lappacea* exhibited the maximum ferricyanide reduction power (4905±87.79 µmol AAE g-1). Superoxide anion scavenging and H_2O_2 activity of *P. lappacea* extracts were 58.76±3.42% and 32.67±2.45 respectively.[31]

Selvan *et al.* experimented to evaluate the antioxidant activity of *P. lappacea* using various methods such as the DPPH method, polyphenol oxidase activity and superoxide oxide radical scavenging activity. Firstly, they performed an *in vitro* test for the evaluation of antioxidant potency in *P. lappacea* using a DPPH assay. The percentage activity was recorded as 17.28±1.23, 26.55±1.05, 44.65±1.01, 37.85±0.52 and 60.08±0.89 at 100, 200, 300, 400 and 500 µg/mL concentration respectively.[29] Secondly, the researchers performed the superoxide oxide radical scavenging activity in *P. lappacea* ethanol extract. The antioxidant activity was measured at different dosages 100, 200, 300, 400 and 500 µg/mL and the percentage activity is recorded as 18.03±1.42, 32.90±1.53, 41.23±0.52, 53.13±1.25 and 62.25±1.52, respectively. Finally, the researchers used another method to investigate the antioxidant activity of *P. lappacea* ethanol extract. The enzyme activity was measured at different dosages 100, 200, 300, 400 and 500 µg/mL the percentage of activity was recorded as 38.93±1.52, 16.87±1.04, 27.67±1.53, 54.18±1.51 and 68.85±1.64, respectively.[29]

Table 1: Traditional uses of *Pupalia lappacea*.

Sl. No.	Part of plant	Traditional use	References
1	Leaf paste with edible oil	Bone fracture and inflammatory condition	[20]
2	Decoction of plants in water	Urethra pain, endometritis, cystitis and leucorrhoea	[17]
3	Whole plant.	Laxative, purgative, antiemetic	[17]
4	Stem	Toothache	[17]
5	Decoction of black powder of plant	Pile, fever, malaria, enema	[17]
6	Boiled root infusion in water	Syphilis	[17]
7	Leaf paste and fruit juice	Wound healing	[21]
8	Foliage of plant	Poultices	[20]
9	Root	Antidote in snakebite	[17]
10	Plant ash mixed in water	Flatulence	[17]
11	Crushed seeds	Treatment of infected sores and ulcers	[17]
12	Leaves	Cough	[21]

Table 2: Pharmacological Activity of *Pupalia lappacea*.

Sl. No.	Activity	Plant part used	Result	References
1	Antimicrobial activity	Chloroform, petroleum ether, ethanol plant extract.	Shows good antibacterial and antifungal activity.	[30]
		Methanol extract of leave and aerial part.	Shows antibacterial property.	[40]
2	Antioxidant activity	Dried plant ethanolic extract.	Shows maximum activity via the FRAP method.	[41]
		Ethanol extract of plant.	Shows good potency as an antioxidant.	[42]
		Aerial and leave part using chloroform, ethanol, petroleum ether.	All extract shows antioxidant activity.	[43]
3	Anti-inflammatory activity	Methanol extract of plant.	Posses good anti-inflammatory activity.	[44]
		Ethanol extract of plant.	Shows dose-dependent anti-inflammatory activity.	[45]
4	Wound healing activity	Aerial part using chloroform, ethanol, petroleum ether.	All show wound healing potential but are seen more in chloroform extract.	[43]
		Methanol leaf extract.	Showed wound healing activity.	[40]
5	Anti-diarrhea activity	Hydro ethanol extract of plant.	Proved anti-diarrheal efficacy.	[46]
6	Anti-nociceptive and anti-pyretic activity	Aerial part using 80% aqueous ethanol extract.	Shoed antinociceptive and antipyretic activity.	[47]
7	Anti-malarial activity	Dicholoromethane, methanol, aqueous plant extract.	Showed anti-plasmodium activity.	[37]
8	Anti-hypolipidemic activity	Methanol leave extract.	Shows anti-hypolipidemic nature of plant.	[48]
		Ethanol an distilled water extract of plant.	Significant decrease in cholesterol level.	[49]
9	Anti-diabetic activity	Ethanol extract of plant.	Show potency by decreasing glucose level.	[50]

Similarly, Apentang *et al.* also investigated the antioxidant activity in aerial and leaves part of *P. lappacea* by extracting them with three different extracts named chloroform, ethanol and petroleum ether. In their investigation, the researcher used the DPPH assay method to determine the antioxidant activity of *P. lappacea* extract. The petroleum ether, ethanol and chloroform extracts all showed some antioxidant activity, with IC_{50} values of 63.27,17.37 and 9.67 g/mL, respectively.[21]

Anti-Inflammatory

The anti-inflammatory properties of plants help us in the treatment of inflammation and reduce redness and various health ailments.[32] Traditionally *P. lappacea* is considered a good anti-inflammatory agent so to check its efficacy as an anti-inflammatory Selvan *et al.* researched the anti-inflammatory properties of *P. lappacea*. The study involved testing the plant extract using two methods: the heat-induced hemolytic method in Red Blood Cells (RBC) and the egg albumin denaturation method for protein inhibition, both conducted *in vitro*. The methanolic extract showed anti-inflammatory activity by inhibiting the membrane stabilization effect and preventing the hypotonic-induced lysis of the erythrocyte membrane. Stabilizing the lysosomal membrane is crucial in limiting the release of bacterial enzymes and proteases from activated neutrophils. This helps prevent further tissue inflammation and damage. The extract showed maximum inhibitory activity of 68.02% at 800µg/mL, while Diclofenac sodium showed maximum inhibitory activity of 79.93% at 100 µg/mL. Protein denaturation is a common cause of inflammatory and arthritic diseases and the extract showed a concentration-dependent inhibitory effect in the egg albumin method. The extract showed a maximum inhibitory activity of 110.00% at 800 µg/mL, compared to diclofenac sodium's 190.00% at 800 µg/mL. All the enzymes studied showed significant antioxidant activity *in vitro*, as they were compared with the standard drug ascorbic acid.[29]

R. Pandiyan and his colleagues experimented to check the anti-inflammatory potential of *P. lappacea* Leaf Ethanol Extract

(EEPL) on rats. In their investigation, various methods were included such as cotton pellet, carrageenan, histamine, serotonin and croton oil-induced edema. They administered different concentrations of EEPL in rats and compared their result with indomethacin which was taken as a standard drug. Results were analyzed in an instrument named digital plethysmometer which is used for the measurement of paw volume and found that 300 mg/kg of *P. lappacea* extract had the highest inhibitory action in a concentration dependency manner. In each method, percentage inhibition was recorded and it increased in the order of croton oil, cotton pellet, carrageenan, histamine and serotonin respectively.[33]

Wound Healing Activity

Wounds can heal naturally; however, therapies are used to minimize the infection and enhance the healing rate. Nowadays, natural products are highly explored as an alternative approach to antibiotic therapy, in this regard; *Pupalia lappacea* is also investigated for its wound management capacity.

Apenteng *et al*. also investigated the wound-healing potential of *P. lappacea*. They have extracted of aerial part of *P. lappacea* in different solvents (petroleum ether, ethanol and chloroform) by cold maceration. They performed an *in vivo* experiment on rats using an excision wound for continuous 11 days. And the results were checked on the 12th day. The efficacy of the extract was evaluated based on wound closure rate and histopathological examination. The wound closure rate was observed with chloroform (35.65%±2.30 to 67.68%±1.62) and ethanol (33.60%±2.29 to 67.23%±1.90) extract on the 7th to 11th day of the experiment that was significantly higher than the control group. Additionally, increased levels of collagen formation, re-epithelialization and granulation tissue generation were observed in histopathological investigations. Persisting edema and inflammation at the wound in the control and vehicle group, however not observed in the treated group indicate that the vehicle did not exert any pharmacological activity. This concludes the potential of *P. lappacea* as a wound-healing agent.[34]

Similarly, another research was done by Udegbunam *et al*. to prove the wound-healing potential of *P. lappacea* using its methanolic leaf extract. For their experiment, they prepared ointment with extract with different concentrations (10% and 20% w/w). The results were based on wound contraction percentage and rate of epithelialization. On the 7th day of the experiment, the percentage wound contraction rate was seen higher (p>0.05) at 20% w/w (extract concentration). In wound epithelialization regeneration of epithelial takes place by the proliferation of epithelial cells and their movement towards the wound to protect newly formed tissue. In their investigation extract of *P. lappacea* enhanced angiogenesis and collagen formation.[20]

anti-diarrheal Activity

Watery and loose condition of stool is considered diarrhea. In the modern lifestyle, consuming unhealthy food is the major causing agent of diarrhea. Allopathic medicines show no side effects. So, AJ. Akindele et.al. studied the anti-diarrheal activity of *P. lappacea*. In their investigation, crushed leaves were macerated for 48 hr in hydro ethanol (1:1; 50 g/L) and extraction was carried out via exhaustive extraction. After that, acute toxicity studies were done on albino mice which were selected for the experiment. Following that, the anti-diarrheal action of *P. lappacea* on rats is examined using various tests including castor oil-induced diarrhea, normal and castor oil-induced intestinal transit, intestinal fluid accumulation and gastric emptying. As a result, when compared to the control group, *P. lappacea* (100-400 mg/kg) caused a substantial concentration-dependent reduction in normal and castor oil-induced intestinal transit. The *in vivo* anti-diarrheal index was 56.95% generated by the *P. lappacea* extract at the dosage of 400 mg/kg. As an outcome of the intestinal fluid accumulation test *P. lappacea* (400 mg/kg) dramatically decreased the amount of intestinal fluid and considerably accelerated stomachic emptying in the rats.[35]

Anti-Nociceptive and Anti-pyretic Activity

Neeharika *et al*. investigated the anti-nociceptive and anti-pyretic activity of *P. lappacea*. In their investigation, they used 80% aq. ethanol extract of *P. lappacea* aerial part. As test animals, they use Male Swiss Albino mice and Male Wister rats for studying antinociceptive activity and antipyretic activity respectively. *P. lappacea* extract antinociceptive potential was assessed utilizing a hot plate test and acetic acid-induced writhing test. The response time in the hot plate test was significantly prolonged afterwards oral route administration of an ethanol extract of *P. lappacea* at each dosage concentration. When a comparison is made between the concentration of extract 200, 400 and 600mg/kg, the ethanol extract at 600 mg/kg displayed greater antinociceptive efficacy. The ethanol extract (600 MG/KG) considerably enhanced the response time, with a maximal latency duration of 90 minutes. In the acetic acid-induced writhing test, they showed 106.7±3.10 writhing at 200 mg/kg extract with 13.1% inhibition. At 400 mg/kg they showed 82.50±6.47 writhing with 32.4% inhibition and at 600 mg/kg they showed 43.00±4.28 writhing with 64.75% inhibition.[36]

The antipyretic activity was performed by inducing pyrexia using brewer's yeast in rats. Following the subcutaneous route of administration, 15% of brewer's yeast was injected into the rat, which raised the rat's basal body temperature by 1.5°C. The intestinal temperature of rats decreased gradually following oral route administration of the extract at different concentrations (200, 400, 600 mg/kg) and conventional medication paracetamol concentration, 100 mg/kg. After 3 hr, the decline in rectal temperature was quite substantial. The extract produced a

concentration-dependent temperature drop. After 5 hr animals that were administered 600 mg/kg of ethanol extract exhibited the greatest temperature drop.[36]

Anti-Malarial Activity

To prove the traditional claim regarding the anti-malarial activity of *P. lappacea* J. Bero *et al.* investigated the antispasmodic potency of this plant. In their investigation, different extracts were taken for extraction (dichloromethane, methanol and aqueous). They performed their experiment on chloroquine-sensitive (3D7) and resistant (W2) strains of *Plasmodium falciparum*. At the end of the experiment dichloromethane extract of *P. lappacea* showed moderate antiplasmodium activity with IC_{50}=50.29 g/mL.[37]

Anti-hypolipidemic Activity

Oi *et al.* studied the anti-hypolipidemic potency of *P. lappacea* using methanolic leave extract which is extracted using a cold maceration process. The experiment was performed using 30 diet-induced hypolipidemic rats which were further arranged in six different groups. Parameters considered for the experiment are Total Cholesterol (TC), Triglyceride (TG), Low-Density Lipoprotein Cholesterol (LDL-C) and High-Density Lipoprotein Cholesterol (HDLC). The experiment was continued for around 28 days. In their experiment treatment at 10mg/kg3 concentration (group C) shows a mean deviation value is around (100.80±5.07 mg/dL) in Total Cholesterol (TC) and other parameter result includes 18.00±1.58 mg/dL, 62.20±2.86mg/dL and 95.00±3.61mg/dL for LDL, HDL and TAG respectively. A significant decrease in the lipid profile of mice after treatment shows the anti-hypolipidemic nature of *P. lappacea*.[38]

Likewise, another investigation by Farheen et. al has been done on the same activity using ethanolic and distilled water extract of *P. lappacea* by extraction via the maceration process. The experiment was carried out on Wistar albino rats which are both male and female. The investigation remains continued for 21 days. After completion of the experiment TC (Total Cholesterol), TG (Total Triglyceride) and CR (Cholesterol Ratio) values were analysed and it was concluded that there was a significant decrease in the values of respective parameters.[26]

Anti-diabetic Activity

Diabetes is one of the major chronic diseases associated with high glucose levels in the blood. To conquer this problem much research has been done on plants. In this regard, Vivek Kumar *et al.* conducted their research on the ethanolic extract of *P. lappacea* leaves. Extraction was done by a hot percolation process. STZ-induced Albino Webster diabetic rats weighed between 160-200 g were used in the experiment and it continued for around 28 days. On the last day of the experiment, the final result was evaluated and it showed a notable decrease in glucose serum after fasting i.e. 211.61 and 234.68 mg/dL, for the AS002 and AS001 groups respectively. Also, the level of insulin increased around 0.50 mg/dL and 0.57 mg/dL in groups AS001 and AS002 respectively.[39]

CONCLUSION

This review article on *P. lappacea* sheds light on the various aspects of this plant. It provides an overview of its botanical characteristics, phytochemical composition, traditional uses and potential pharmacological applications. The plant's botanical features, including its adaptability to diverse environments and ability to thrive in various soil conditions, contribute to its ecological resilience. As researchers delve into the scientific validation of these traditional uses, there exists a promising opportunity to harness the plant's therapeutic potential for various health conditions. Furthermore, the pharmacological activities of *P. lappacea*, include its anti-inflammatory, antioxidant, antimicrobial, wound healing activity anti-diarrheal activity, anti-malarial activity and anti-hypolipidemic activity. These findings indicate new possibilities for the development of pharmaceutical interventions and nutraceuticals that leverage the plant's bioactive compounds. Moreover, the review discusses the safety profile of *P. lappacea*, adding credibility to its potential as a therapeutic agent. As the scientific community continues to unveil the mysteries of *P. lappacea*, it holds valuable resources in the realms of medicine, ecology and sustainable agriculture.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

***P. lappacea*:** *Pupalia lappacea;* **MBC:** Minimum Bactericidal Concentration; **MIC:** Minimum Inhibitory Concentration; **RBC:** Red Blood Cells; **TC:** Cholesterol; **TG:** Triglyceride; **LDL-C:** Low-Density Lipoprotein Cholesterol; **HDLC:** High-Density Lipoprotein Cholesterol.

SUMMARY

Pupalia lappacea which is commonly referred to as forest burr found everywhere in the world. In this review article, we will discuss the traditional use and photochemistry of plants. Its traditional uses have been investigated by various scientists whose results came out to be effective against various diseases. *Pupalia lappacea* consists of various phytochemicals named stearic acid, stigmasterol, formic acid, 1-methyl ethyl ester, etc., *In vitro* and *in vivo* studies that have been investigated thus far prove that this plant posse's great therapeutic potential including antimicrobial, antioxidant, anti-inflammatory, antidiarrheal, antinociceptive and antipyretic, anti-plasmodium, anti-hypolipidemic, antidiabetic activity which can be further explored for its clinical utility. This article comprises data from a research article published on various search engines including Google Scholar, PubMed, ScienceDirect, Scopus, etc. Data is also collected via textbooks,

reference books, review papers and ancient texts. This review aims to gather all updated pharmacological investigations that have been done on *Pupalia lappacea* together. In short, the main aim was to provide an updated review of *Pupalia lappacea* to the researchers who further want to explore its potency and efficacy. All the documents related to the plant were studied thoroughly and it was concluded that this plant possesses a great therapeutic potential and can be clinically explored.

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