A REVIEW ON PHARMACOLOGICAL EFFECTS OF POTENTIAL MEDICINAL PLANT *NASTURTIUM OFFICINALE* (WATERCRESS)

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Abstract:
Various parts of many plants and herbs have been used by ancient traditional and alternative medical systems to treat many diseases. In addition, modern medicine uses many drugs based on seeds, spices, plants, herbs, or active components. Traditionally, nasturtium provided medicine and food security. These plants have become more attractive and exciting due to their polyphenol content and antioxidant activities. The present study aimed to provide an overview of the studies investigating Watercress in a regular diet based on clinical trials to show whether this plant-based food, with its promising properties, has an essential role to use for human health could play. This article provides a comprehensive account of the traditional uses, phytochemical investigation, and therapeutic potential of nasturtium.
***Index Terms: Nasturtium officinale*; Pharmacological activities; Watercress; Antidiabetic**

1. INTRODUCTION:

Herbs are the main ingredient of the traditional Ayurvedic Unani; Homeopathic and natural remedies are superior to synthetic drugs because they are always associated with natural and biological entities such as proteins, lipids and carbohydrates. Plants can synthesize various chemical compounds to perform important biological functions and defend against attacks from predators such as insects, fungi, and herbivorous mammals.

The use of plants as medicine predates written human history. Medicinal plants have been of great value in discovering medicines well-known to man, and people have used them for various purposes since the dawn of human history **(Farnsworth, 2008).** The healing methods of traditional folk medicine derived from plants have become a guide for scientists to research new medicine to promote and maintain animal and human health **(Achterberg, 2002).**

Nasturtium officinale, known as Watercress, is a perennial dicot herb, a member of the Brassicaceae family. A member of the Brassicaceae, Watercress is related to cruciferous vegetables such as broccoli, cabbage, radish, Brussels sprouts, mustard, and kale **(Voutsina et al., 2016).** Consuming vegetables from the Brassicaceae family is suggested to benefit human health. These are rich sources of sulfur-containing compounds called glucosinolates, which have a pungent aroma and a spicy or bitter taste **(Kristal et al., 2009)** and phenyl ethyl isothiocyanate (PEITC), which has been linked to a reduction in cancer risk and oxidative stress **(Basu and Acharya 2007; Rizzo et al., 2005; Yazdanparast et al., 2008).** Watercress contains vitamins such as A and E, minerals (iron and copper) and is also rich in bioactive compounds, polyphenols, glucosinolates and PEITC **(Bahramikia and Yazdanparast 2008; Jeon, 2017).** Therefore, this food can be collected from its natural habitats and used as a fresh or dried plant **(Klimek-szczykutowicz, 2018).** Its leaves have been used in folk medicine as a diuretic, hypoglycemia, and many chronic diseases **(Yazdanparast et al., 2008).**

The previous pharmacological studies have shown that Nasturtium officinale has hyperlipidaemic, anti-inflammatory, hepatic and renoprotective, antidiabetic, antioxidant, anticancer, antimicrobial, dermatological, antigenotoxic, antiurolithiasis and antigenotoxic effects. The current report will highlight the ingredients and pharmacological effects of Nasturtium officinale. Watercress is a valuable source of vitamins and an excellent detoxifying herb. This plant is relatively high in vitamins B1, B2, and C, as well as provitamin A, folic acid, glucosinolates, iodine, iron, protein, and most notably, calcium and sulfur compounds, which affect its characteristic odour but also enhance nutritional benefits **(Chung et al., 1992; Rose et al., 2000; Palaniswamy et al., 2003).**

Watercress is an essential source of nutraceuticals and an important detoxifying herb. **Palaniswamy et al. (2003)** reported that the watercress plant contains many vitamins B1, B2 and C, provitamin A, folic acid, glucosinolates, iodine, iron, protein and especially calcium and sulfur compounds. They affect its distinctive odour and contribute to its nutritional benefits. The active components of watercress extract can enhance or stimulate the immune response by interacting with various parameters of the immune system. Watercress has long been used to cure various ailments, claiming that it can improve blood circulation and cure renal colic and liver disease as it is a mild stimulant, diuretic, expectorant and digestive aid. Watercress is very popular and growing due to recent notable studies and reports on the cancer-fighting compounds it contains.

2. TAXONOMIC CLASSIFICATION OF WATERCRESS:

Watercress belongs to **Kingdom**: Plantae, **Subkingdom**: Viridiplantae, **Infrakingdom**: Streptophyta, **Superdivision**: Embryophyta, **Division**: Tracheophyta, **Subdivision**: Spermatophytina, **Class**: Magnoliopsida, **Superorder**: Rosanne, **Order**: Brassicales**, Family**: Brassicaceae, **Genus**: Nasturtium, **Species**: Nasturtium officinale **(ITIS)**

3. MATERIALS AND METHODS:

The search was conducted at the following sites: Cochrane, Scopus, MEDLINE (via PubMed), Science Direct, SciELO, and Lilacs. The available information on various in vivo, in vitro and clinical antidiabetic studies of these types was obtained from various electronic sources such as Pubmed, SciFinder, Elsevier, Springer, Scopus, Science Direct, Google Scholar, and Web of Science collected and peer-reviewed journals should also collect information. The results of this review are used to assess the herbalist's level of knowledge about herbal remedies.

The search terms used were; Watercress and nasturtium.

4. PHARMACOLOGICAL PROPERTIES:

The prominent role of food is to meet the body's need for necessary nutrients and satisfy hunger; However, nowadays, foods made from edible plants also play a significant role in preventing and curing various diseases and disorders due to the presence of various bioactive compounds. The species comprised a variety of bioactive compounds along with strong nutraceutical potential and displayed multiple biological activities. In this section, we have discussed various biological uses of the species, including anticancer, hepatoprotective, antidiabetic and hypoglycemic, antioxidant, antimicrobial, gastrointestinal and fracture/bone healing activities.

4.1 Dietary ingredients:

Shahrokhi et al. (2009) mentioned that Watercress is a vital source of vitamins and an excellent detoxifying herb. Its high vitamin C and mineral content make it a particularly effective remedy for chronic diseases.

4.2 Antimicrobial effect:

The antibacterial effect of aqueous and alcoholic extracts of nasturtium has been studied against Escherichia coli, Salmonella typhimurium, Staphylococcus aureus and Listeria monocytogenes. The antibacterial activity of the alcoholic and aqueous extracts of Nasturtium officinale was higher against gram-positive than against gram-negative bacteria. S. aureus and L. monocytogenes were the most susceptible bacteria, with a MIC of 8 g/ml. the lowest MIC (6.25 g/ml) and MBC (12.5 g/ml) of the plant extract was recorded against S. aureus. In comparison, E. coli and S. Typhimurium resist the aqueous and alcoholic extracts **(Derhami et al., 2016).**

The methanolic extract from Nasturtium officinale was tested for its antimicrobial activity against Bacillus cereus, Enterococcus faecalis, Klebsiella pneumonia and Escherichia coli. The MICs of the extract against these microorganisms were 0.6, 0.4, 0.8, and 0.6, while the MBCs were 0.10, 0.8, 0.10, and 0.8 mg/mL, respectively **(Zafar et al., 2017).** In vitro synergism between aqueous and methanolic extracts of Nasturtium officinale was performed against 11 isolates of extended-spectrum lactamase Escherichia coli. The results showed increased antibacterial activity of the antibiotics in combination with plant extracts and 2-phenylethyl isothiocyanate **(Freitas et al., 2013).**

4.3 Antidiabetic Effect:

The hypoglycemic effect of Nasturtium officinale extracts was studied in rats with streptozotocin-induced diabetes. Rats were orally administered various concentrations of Nasturtium officinale extracts (ethyl acetate, methanol and aqueous) for a short (one week) and a prolonged period (two months). Only 800 and 1000 mg/kg of the methanol extract of nasturtium officinale caused a significant reduction in blood sugar levels after one week of treatment. At the end of the two-month treatment, the ethyl acetate extracts significantly reduced blood glucose levels to 100 mg/kg. Long-term treatment with methanol and aqueous

extracts showed no hypoglycemic effects **(Hoseini et al., 2013).** The hypoglycemic and antioxidant activities were studied orally and administered in alloxan-streptozotocin-induced diabetic rats with aqueous, acetonic and alcoholic extracts of Nasturtium officinale. Extracts showed high concentrations of phenols, polyphenols and flavonoids and a very high antioxidant effect.

When administered acutely, the hypoglycemic outcome of the aqueous solution was 76.6% higher than that of insulin. With chronic administration, glucose levels normalized from the third to the eighth week, and antioxidant enzymes and biochemical parameters improved **(Fenton-Navarro et al., 2018).**

4.4 Hypolipidemic Effect:

The effect of Nasturtium officinale hydroalcoholic extract (NOE) on the serum lipid profile was studied in rats on a high-fat diet. Intragastric administration of the extract (500 mg/kg body weight/day) decreased serum TC, TG, and LDL-C by 34.2, 30.1, and 52.9%, respectively, and increased serum HDL-C levels by 27 .0% after ten days of treatment. The extract also reduced serum ALT and AST levels compared to high-fat diet groups **(Bahramikia and Yazdanparast, 2008).**

In the groups of hypercholesterolemic rats administered Nasturtium officinale intragastrically for 30 days, lower blood levels of total cholesterol (TC), triglyceride (TG) and low-density lipoprotein cholesterol (LDL-C) were observed. However, blood high-density lipoprotein cholesterol (HDL-C) levels were increased by 16% **(Yazdanparast et al., 2008).**

4.5 Antioxidant activity:

The anti-radical properties and the content of phenols, flavonoids and anthocyanins of the hydroalcoholic watercress extract were investigated using the DPPH radical scavenger activity test. The hydroalcoholic extract obtained by Soxhlet showed more potent antioxidant activity than the incubated extract and had more phenolic and flavonoid compounds **(Moradi et al., 2017).**

The antioxidant effect of the ethanolic extract of nasturtium leaf stalks was investigated in vitro using the DPPH radical scavenger test. Nasturtium extract at a 10 mg/ml concentration showed a low, reducing power compared to ascorbic acid **(Meriem et al., 2017).**

The ethanolic extract showed potent antioxidant activity in reducing strength, DPPH radicals and superoxide anion radical scavenging activities in rats. The ethanol extracts decreased lipid peroxidation in the liver, brain and kidney **(Ozen, 2009).**

The DPPH free radical scavenger test evaluated the antioxidant activity of various organic solvent watercress extracts. Watercress methanolic extract showed the best antioxidant activity compared to ethyl acetate and hexane extracts **(Haro et al., 2018).** Watercress showed the ability to modulate the enzymes SOD and GPX in blood cells in vitro and in vivo **(Hofmann et al., 2009).**

4.6 Anti-Cancer Effect:

The anticancer effect of hydroalcoholic watercress extract was studied against the growth of cancerous Hela cells and fibroblasts. The extract was applied at concentrations ranging from 0.625 to 2 mg/ml, and cell mortality rates were examined after 24, 48 and 72 hours of incubation. The survival rate of the cancerous Hela cells decreased with time and increasing concentrations of watercress extract. The IC50 values after 24, 48 and 72 h were 373, 349 and 333 g/ml, respectively **(Moradi et al., 2017).**

Proliferation and metastasis (invasion) was studied using in vitro models. HT29 cells were used to study the protective effect of the extract on DNA damage and the cell cycle. The extract also caused an accumulation of cells in the S-phase of the cell cycle, indicating a delay in the S-phase cell cycle. The extract also significantly inhibited the invasion of HT115 cells **(Boyd, 2006).**

The effects of watercress consumption on nicotine metabolism in smokers have been studied. Watercress was a rich source of phenyl ethyl isothiocyanate (PEITC), a potent chemopreventive agent for lung and oesophagal cancer **(Hecht et al., 1999; Hecht et al., 1995).**

4.7 Protective Effects:

Effects of hydroalcoholic watercress extract against oxidative stress and liver damage were studied in bile duct ligation-induced cholestatic rats. Bile duct ligation resulted in significant hepatocyte necrosis; the hydroalcoholic extract significantly attenuated this effect. The extract reduced oxidative stress by preventing hepatic protein oxidation and enhancing glutathione peroxidase (GPx) enzyme activity through antioxidant effects and free radical scavenging **(Sadeghi et al., 2019).**

The effect of Nasturtium officinale hydroalcoholic extract and vitamin E against vancomycin-induced nephrotoxicity was studied in adult rats. Vancomycin significantly increased serum creatinine and urea levels, MDA levels, relative kidney weights and creatinine clearance. Compared to treatment with vancomycin alone, pretreatment with extract (250, 500 mg/kg) and vitamin E (500 mg/kg) alleviated all of these changes. Histological examination of the vancomycin-treated group showed significant renal damage

with desquamation of the tubular epithelial cells, swelling and tubular dilatation. These changes were mitigated with extract and vitamin E **(Karami et al., 2018).**

4.8 Side Effects and Toxicity:

Acute in vivo toxicity was studied in mice. The plant extract challenged mice at various doses during acute oral toxicity, particularly at 80 mg/kg and 100 mg/kg. Some clinical signs were recorded within eight hours of gavage, including intense excitement followed by immobility. Several deaths were observed after 72 hours, with the LD50 ranging from 50 to 500 mg/kg bw(45). The safety of the standardized extract of Nasturtium officinale with phenylethyl glucosinolate 5.0 mg/ml was evaluated in rats using acute and subacute oral dosing. LD50 was in the range of 2-5 g/kg. The results showed that Nasturtium officinale extract was safe in doses up to 5 g/kg in the acute study, and no side effects were observed with sub-acute administration up to 1 g/kg **(Sadeghi et al., 2014).**

However, the acute toxicity of ethanolic extract (0.5, 5, 50, 500, 1000, 2000 and 4000 mg/kg body weight) of nasturtium was investigated in mice. The maximum dose caused no deaths, and the animals were still under normal circumstances. No significant differences exist in the liver, heart and kidneys relative to organ weights in mice at any dose level. Histopathological studies showed that the highest doses caused necrosis and hydropic degeneration of the liver and kidneys and inflammatory manifestations of the heart with myofibrils and irregular heart **(Ginting et al., 2017).**

4.9 Dermatological effects:

The wound-healing potential of watercress oil in thermal and chemical burns was investigated in rabbits. Watercress oil was applied to the experimental chemical and direct heat-induced burns. Animals treated with watercress oil restored normal architecture faster, significantly reducing burn closure time **(Zinadah, 2008).**

4.10 Antiurolithiasis Effects:

The protective effects of the hydrophilic extract of Nasturtium officinale (750 mg/kg and 1.5 g/kg extract) on ethylene glycol-induced kidney stones were studied in rats. The percentage of calcium oxalate crystals in the negative control groups was 75% in the preventively treated low dose (28.6%) and high dose (57.1%) groups compared to the healthy control group (12.5%). Urinary oxalate concentration was higher in the preventive and negative control groups than in the healthy control group ($P<0.05$) **(Mehrabi et al., 2016).**

4.11 Antigenotoxic Effect:

The effect of aqueous extract (two concentrations: 13.2 and 26.4 mg/mL) on cell viability and its potential antigenotoxic properties against induced oxidative damage were evaluated using a comet assay, and peripheral blood cells as in vitro model examined. No differences in cell viability were found between the control group and the treated group at any time. Significant antigenic effects were observed for both concentrations ($p=0.005$ at 30 min; $p<0.001$ at 60 and 90 min), with the percent reduction in harm being similar at the concentrations used (67.1 and 75.2%, respectively) **(Casanova and Carballo, 2011).**

4.12 Anti-inflammatory activity:

The topical anti-inflammatory activity of Nasturtium officinale leaf crude extract (solutions and gel) was studied in mice inducing irritant contact dermatitis induced by croton oil. Irritant contact dermatitis models were induced by a single (1 mg/ear; acute) or repeated (0.4 mg/ear; chronic; total nine days) application of croton oil. Nasturtium officinale extract and gel inhibited croton oil-induced ear edema, reduced inflammatory cell infiltration, and reduced levels of pro-inflammatory cytokines in an acute and chronic model **(Camponogara et al., 2019).**

V. CONCLUSION:

The extensive literature suggests that N. officinale is an essential medicinal resource and an economically important herb. They are widespread as a vegetable and salad. Their potential against certain diseases has also been experimentally proven in recent years. The herb exhibits potent anticancer activity with biologically active compounds such as gluconasturtiin. More than the anticancer agent, it also possesses antidiabetic, anti-tuberculosis, anti-inflammatory, antimicrobial, cardioprotective, etc. Therefore, we can suggest that N. officinale can be considered a source of nutraceuticals and dietary supplements and is a great source of vital nutrients, vitamins and minerals. Various phytochemicals and nutrients make Watercress a healthy diet that maintains the immunity and health of the human body.

Many new forms of therapy can be developed from natural products, usually derived from medicinal plants. The Brassicaceae family can improve a person's health system through its content of dietary fibre, vitamins, and phytochemicals found in the Brassicale order. Consuming leaves of the Brassicaceae family means naturally available food with potential antimicrobial activity. Due to its

extensive use, the N. Officinale (Watercress) plant is now being researched as an outstanding herb to use in the medicinal field. Traditionally, the plant was used to cure several ailments stated in the manuscript.

The compounds in this family exhibit several beneficial effects due to their particular chemical properties and physiological effects. Therefore, this review provides many facts about the nutritional value and pharmacological activities associated with cruciferous vegetables, eventually guiding people toward healthier dietary choices. The present review, therefore, reveals the full therapeutic potential of this plant, N. Officinale (Watercress) and invites other researchers to provide a platform to establish it as a standard drug in the pharmaceutical industry.

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