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Exploring the versatile potential of garden cress seeds: Therapeutic applications and industrial utilization: A comprehensive review

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Abstract

The seeds of *Lepidium sativum*, commonly known as Garden Cress is an iron rich underutilized edible crop. Garden cress seeds have a variety of therapeutic properties, including antioxidants properties, anti-anemic properties, anti-diabetic properties, anti-inflammatory properties, hepatoprotective properties, antibacterial properties and chemoprotective properties. It may also be used in food supplementation to develop functional foods. Garden cress seeds have been utilized as medicine since ancient times. It is also used to treat conditions such as asthma, diarrhea, and numerous skin problems such as scurvy. However, it can also help to increase the milk supply in lactating mothers. Garden cress seeds have a high calcium, iron, folic acid, vitamin A, and vitamin C content. While, the seeds serve as a significant energy source due to high content of protein and fat. Also, these seeds are in use within the pharmaceutical, cosmetic industry and aroma therapy due to the presence of fatty acids, antioxidants and bioactive compounds in abundance. The current review is planned to give an overview about the functional, pharmacological properties and industrial uses of garden cress seeds to enhance the scope of this underutilized crop for human consumption.

Keywords: Underutilized crops, garden cress seed, therapeutic properties, anti-inflammatory, industrial utilization

1. Introduction

Underutilized crops are plant species which have been used for years and centuries as domesticated crops, usually as food and fodder due to fiber content as well as therapeutic properties. But their importance reduced over a period of time because of unawareness of people. These crops are often referred by several terms such as ‘forgotten’, ‘abandoned’, ‘local’, ‘minor’, ‘traditional’, ‘underdeveloped’, ‘niche’, ‘orphan’ and ‘specialty’ crops (Malhotra and Sontakke, 2023; Raj *et al.*, 2020) [36, 49]. Out of these, garden cress seeds (*Lepidium sativum* L) are also considered as the most underrated and underutilized crop (Azene *et al.*, 2022) [10]. It belongs to the plant order *Brassicales* and plant family *Crucifera* (Ramadan and Oraby, 2020) [50]. In actual, garden cress is a spring crop and to be grown in Meditarian climate (November- February) for highest yield. But its natural versatility leads to production of crop in all seasons and in any kind of soil condition (Shaban and Nassef, 2023; Gupta and Chaudhary, 2020) [52, 23]. However, it is used as a garnish or culinary vegetable in Asian countries due to its peppery and sour taste (Jain and Grover, 2018) [29]. While, it is often regarded as an important nutritious medicinal plant in India since Vedic era because of its health promoting properties (Ramadan and Oraby, 2020) [50].

Garden cress seed has unique names in different regions: cress, garden cress and pepper cress (English); mastuerzo, lepidio (Spain); berro de sierra (Argentina); escobilla (Costa Rica); morritort, morrisà (Catalan); masturco, herba do esforzo (Portuguese and Galician); Chandrashoor, Chandrasur (India); Halim (Bengali and Urdu); Holan (Punjabi) and Alian (Kashmiri) (Abu-Rumman, 2018) [2].

In present times, these “little-used” crops are attracting many scientists for research and development. In ancient times, these seeds were added in the food of lactating women to induce milk secretion (Jain and Grover, 2020) [30]. In Asian countries, Garden cress seed is used as a garnish or culinary vegetable due to its peppery, tangy flavor and aroma (Ramadan and Oraby, 2020) [50]. These seeds are good sources of minerals whereas high mineral content favors its usage in the development of many functional foods and drinks. Calcium, phosphorus and magnesium are found in abundance in these seeds.

High content of alpha-linolenic acid in garden cress seeds make it more prone for auto-oxidation (Ali, 2021) [16]. While, the iron content (279.68 ppm) (Mahdy *et al.*, 2023) [21] present in seed powder, helps to cure mild anemic state, especially in school going kids. The Garden cress seeds are rich in iron and are easily absorbed, hence these helps to increase the blood hemoglobin level (Khomane *et al.*, 2021) [33]. Considering its health promoting properties and nutrient dense nature, it is often regarded as an important nutritional and medicinal plant in India since Vedic era. Garden cress seeds are anti-asthmatic, anti-diabetic, diuretic, hypotensive, anti-carcinogenic, antibacterial and helps in treating inflammatory bowel disease (Naik *et al.*, 2020) [56]. Alkaloids, carbohydrates, proteins, amino acids, and flavonoids account for the majority of its phytochemical components (Sharma, 2020) [54].

On the other hand, some side effects apart from its nutritive nature are also associated with these nutritious seeds. It is an abortifacient in nature and triggers spontaneous abortion due to ability to induce uterine contraction in pregnant women. Therefore, advisable to avoid consumption during pregnancy without any prescription (Malhotra and Sontakke, 2023) [36]. However, it also interferes with the iodine absorption in thyroids due to the presence of goitrogens and thus leads to hypothyroidism. Large doses of garden cress seeds or Garden cress oil may lead to digestive problems such as indigestion in some people. So, it should be consumed in limited amount for appropriate effects (Singh and Paswan, 2017) [59].

2. Morphology of garden cress seeds

Garden cress seeds are tiny, reddish brown, and have a smooth exterior. Whereas, oval in shape with a tip and a triangle on one end, these seed measures 1-2 mm in width and 3-4 mm in length (Prajapati and Dave, 2018) [46]. These have two types of leaves where at the bottom of the stem there are long ones while on the opposite side at the top of its stalk, there are small, bright green colored, feathery leaves. Leaves have rapid growth and harvesting season begins in the same month as sowing. Yields are as high as 6 tons per hectare. The pH of the soil must be 6.0-7.5 to yield a healthy crop. Whether grown indoor or outdoor, garden cress seeds can be harvested all over the year and are cut when the sprouts are 2-4 inches long (Polash *et al.*, 2020, Al-Snafi, 2019; Agarwal and Sharma, 2013) [45, 7, 5]. The leaves, sometimes, divide pinnately and can be up to 5-6 cm long with lobes that range in size from 0.7-1.2 to 0.3-0.6 cm. The upper leaves typically have one leaf per node, 2-3 cm long, oblanceolate, sessile, and composed of two or more distinct leaflets placed alternately. Green colour can be seen on the stems and leaves whereas racemes are axillary, terminal, and 7 to 15 cm long. They have pedicels with 3 to 5 mm length and white or pale pink blooms. Pods are spherical, somewhat emarginated, obovate or broadly elliptical, and thickly winged above (Aqafarini *et al.*, 2019; Shabbir *et al.*, 2018) [9, 53].

3. Nutritional profile of garden cress seeds

Garden cress seeds are high in macro and micronutrients and belong to the nuts and oilseeds food category. It contains 30-

34% carbs, 25-39% proteins, and 23-25% fat. The seed includes vitamins and minerals such as calcium, iron, magnesium, thiamine, riboflavin, and niacin in the amounts of 377mg, 100mg, 430mg, 0.59mg, 0.61mg, and 14.3mg per 100 g, respectively (El-Salam *et al.*, 2019). The high iron content in seeds can help to treat anemia. The seeds are high in important fatty acids such as arachidic acid and linoleic acid (Jain & Grover, 2018) [29]. The seeds also have considerable amount of vitamin E (258.74 mg/100 g) owing to anti-ageing property. However, they may be used as a component in health foods since they have a high potassium content (1635.62 mg/100 g) and a low sodium content (36.25 mg/100 g). They are also high in potassium (1635.6 mg/100 g), thus they can be included in high potassium diets for athletes who engage in intense physical activity or who suffer from high blood pressure (Singh *et al.*, 2022) [58]. Garden cress seeds also contain anti-nutritional factors (ANF) such as phytate and oxalate in quantities of 1037 mg/100 g and 33 mg/100 g, respectively (Naik *et al.*, 2020) [56]. These ANF interfere with the absorption of other nutrients, although their concentration may be lowered by utilizing different processing processes such as germination or sprouting and soaking (Rahate *et al.*, 2021) [48].

4. Therapeutic properties

Functional foods may have a more intricate purpose in the human body than simply supplying nutrients and providing gastronomic pleasure. They have favourable impacts on the human body adhering to frequent consumption within a dietary regimen. They also contain high concentration of bioactive compounds that prevent oxidative damage of human cells, reducing the risk of developing chronic diseases and cancer (Galanakis, 2021) [20]. Garden cress seeds are used to cure a variety of illnesses. Garden cress seeds are a functional food component with nutritional, phytochemical, antibacterial, toxicological, and therapeutic properties. It is commonly used to treat respiratory diseases like asthma, bronchitis, and cough (Hanan *et al.*, 2019) [24]. Following are some of the garden cress seeds based functional foods and their health benefits (Azene *et al.*, 2022) [10].

Garden cress seeds have a laxative effect and are used to treat inflammation, muscular discomfort, and rheumatism. It also has anti-diabetic, laxative, cholesterol-lowering, fracture healing, pain-relieving, procoagulant and diuretic qualities, as well as hepatoprotective, anti-diarrheal, antioxidant, blood-purifying, hunger stimulant, antispasmodic, and anticancer characteristics (Kanabur *et al.*, 2022; Lahiri and Rani, 2020) [32, 34].

Hepatoprotective effect

The ability of garden cress seeds, also referred to as *Lepidium sativum*, to support liver health and shield the liver from harm has drawn attention to their hepatoprotective properties. The bioactive substances found in garden cress seeds and their effects on liver function have been the subject of numerous investigations (Jagdale *et al.*, 2021) [28]. Here is a summary of garden cress seeds' hepatoprotective qualities:

Table 1: Effect of garden cress seeds on Human Health

Garden cress seeds based value added products	Health benefits	References
Raw whole seed (Powder form of garden cress seed extracted in various solvents)	Hepato-protective effects, fracture healing effect, antihypertensive and diuretic effect. treating breast cancer, hypoglycemic effect, antidiarrheal activity	Azene <i>et al.</i> , 2022 ^[10] ; Yadav <i>et al.</i> , 2018 ^[35]
Bruised garden cress seed mixed with lime juice	Reduce inflammation and rheumatic pain	Mali <i>et al.</i> , 2022 ^[37]
Garden cress seed powder mixed with coconut kernel and molasses	Treatment of anemia	Sharma. 2020 ^[54]
Mixed with little millet in the production of flakes	Enhances the iron, protein and trans-fat free flakes Production of iron and calcium rich corn extruded snacks	Kanabur <i>et al.</i> , 2022 ^[32]
Corn flour, moth bean and garden cress seed flour	Production of iron and calcium rich Indian traditional foods	Vishvakarma <i>et al.</i> , 2022 ^[63]
Garden cress seed mixed with green gram, ghee, wheat flour and jiggery	Production of iron rich healthy drinks for malnourished people and building muscle	Goyal <i>et al.</i> , 2022 ^[22]
Boiled garden cress seed mixed with sugar, skimmed milk, fat, sodium salt of carboxymethyl cellulose	Production of high protein, fiber iron, potassium, calcium and antioxidant content of food products	Espinoza <i>et al.</i> 2020 ^[17]
Garden cress seed powder mixed with water, salt, lemon, pieces of injera and garlic in Ethiopia	treatment of stomachache, prevent infection, abdominal pain and toothache	Mintah <i>et al.</i> 2019 ^[38]
Garden cress seed oil blended with sunflower, rice bran, sesame	Production of omega three rich blended products and biscuits used in modulation of lipid metabolism	Afzal <i>et al.</i> , 2022 ^[4] ; Lahiri and Rani. 2020 ^[34]

- 1. Antioxidant activity:** Garden cress seeds are a good source of antioxidants, such as vitamin E, flavonoids, and other phenolic substances. These antioxidants are essential in preventing the damaging effects of free radicals, which can lead to oxidative stress and destroy liver cells. Garden cress seeds aid in preventing liver damage and advancing general liver function by lowering oxidative stress (Hanan *et al.*, 2019) ^[24].
- 2. Anti-Inflammatory Effects:** Liver illnesses are frequently accompanied by chronic inflammation. The seeds of garden cress include anti-inflammatory substances that can lessen liver inflammation. The protection of liver cells and the reduction of tissue damage are both benefits of this anti-inflammatory effect (Vazifeh *et al.*, 2022) ^[62].
- 3. Support for Detoxification:** The liver is a key organ in the process of detoxifying various compounds and metabolizing drugs. By boosting the activity of enzymes involved in detoxification pathways, garden cress seeds are considered to enhance the liver's detoxification processes. To Maintain proper liver function and limiting the build-up of toxins require this detoxification assistance (Singh *et al.*, 2015) ^[60].
- 4. Liver Regeneration:** According to certain research, garden cress seeds may aid in the regeneration of liver tissue. It is believed that certain bioactive substances found in the seeds encourage the development of new liver cells, assisting in the repair of damaged liver tissue (Mohamed *et al.*, 2023) ^[40].
- 5. Lipid Metabolism Regulation:** Fatty liver disease and other liver illnesses can be exacerbated by dysregulation of lipid metabolism. Researchers have looked into the ability of garden cress seeds to control lipid metabolism, which could help stop the buildup of fat in the liver and the onset of linked disorders (Ibrahim *et al.*, 2020) ^[26].

Anti-diabetic activity

2.1 The ability of garden cress seeds (*Lepidium sativum*) to control blood sugar levels and lessen the signs and symptoms of diabetes has sparked interest in its anti-diabetic properties. Numerous research has looked into the bioactive substances found in these seeds and how they affect insulin sensitivity and glucose metabolism (Doghmane *et al.*, 2021) ^[13]. An

overview of garden cress seeds' anti-diabetic qualities is shown below

- 1. Blood glucose regulation:** Garden cress seeds consists of bioactive substances that may help to control blood sugar levels. These substances may have an impact on insulin signalling pathways and enzymes involved in glucose metabolism (Doghmane *et al.*, 2021) ^[13].
- 2. Increased Insulin Sensitivity:** According to some research, specific elements found in garden cress seeds may improve insulin sensitivity. The body's capacity to react appropriately to insulin, a hormone that controls the uptake of glucose by cells, depends on insulin sensitivity. The risk of insulin resistance, a characteristic of type 2 diabetes, can be decreased with improved insulin sensitivity (Mohamed *et al.*, 2023) ^[40].
- 3. Inhibition of Gluconeogenesis:** The liver manufactures glucose from non-carbohydrate sources through the process of gluconeogenesis. The ability to prevent excessive gluconeogenesis, which can be a factor in high blood sugar levels in diabetes, garden cress seeds have been investigated (Bhatia *et al.*, 2022) ^[11].
- 4. Modulation of Gut Health:** Newer research suggests that gut health and diabetes are related. Dietary fibre from garden cress seeds can improve the composition of the gut microbiota. The potential impact of a healthy gut microbiota on metabolic health, particularly blood sugar management, is becoming more widely acknowledged (Mulla *et al.*, 2021) ^[42].
- 5. Dietary fibre and the glycemic index (GI):** The glycemic index (GI) gauges how rapidly a food raises blood sugar levels. People with diabetes are frequently advised to eat foods having a lower GI. However, due to their fibre content, which slows down the absorption of glucose and prevents abrupt rises in blood sugar after meals, garden cress seeds have a relatively low glycemic index (Mulla *et al.*, 2021) ^[42].

Anti-inflammatory, antipyretic and analgesic activities

Garden cress seeds (*Lepidium sativum*) have a wide range of medicinal possibilities, including analgesic, antipyretic, and anti-inflammatory properties. The complex mixture of bioactive substances found in the seeds, including alkaloids, tannins, flavonoids, sterols, glucosinolates, and triterpenes, is

thought to be responsible for these qualities (Al-Snafi, 2019).

- 1. Anti-Inflammatory Activity:** Garden cress seeds have bioactive substances, including flavonoids and alkaloids, which have anti-inflammatory benefits. Flavonoids play a role in the anti-inflammatory action of the seeds by modulating pro-inflammatory pathways and lowering the generation of inflammatory mediators. Alkaloids, on the other hand, have the ability to obstruct inflammatory signalling pathways, helping to reduce inflammation. This interaction of bioactive substances can lessen inflammation-related disorders and enhance general health (Mohamed *et al.*, 2023) ^[40].
- 2. Antipyretic Activity:** The antipyretic action of these seeds is influenced by the tannins and flavonoids that are present in them. Tannins are well known for being astringent and lowering fever. Through the constriction of blood vessels and a decrease in excessive heat generation, these substances can aid in lowering body temperature. Due to their ability to act as antioxidants, flavonoids can also help lower fever by preventing the oxidative stress brought on by an elevated body temperature (Sharma and Agarwal, 2011) ^[55].
- 3. Analgesic Activity:** Garden cress seeds have analgesic (pain-relieving) properties because they contain sterols, triterpenes, and alkaloids. By altering neurotransmitter pathways, sterols and triterpenes are known to obstruct the perception and transmission of pain. Saponins are an example of an alkaloid that may bind to pain receptors and alter pain signals. These combined effects provide the seeds the ability to treat a variety of pains, from minor discomfort to more serious pain disorders (Al-Snafi, 2019) ^[8].

Anti-anemic effect

Garden cress seeds (*Lepidium sativum*), due to their extraordinary iron and folic acid content, have drawn interest as a potential natural treatment for anaemia. A lack of red blood cells or haemoglobin in the blood is what is known as anaemia, and it is a disorder that frequently causes weakness, exhaustion, and other health problems. Garden cress seeds have a robust nutritional composition that makes them an excellent dietary complement for preventing anaemia (Chaudhary and Gupta, 2021) ^[12].

Treating Anemia: Garden cress seeds stand out as one of the greatest plant-based sources of dietary iron, a critical mineral necessary for the synthesis of haemoglobin, the protein in charge of transporting oxygen in the blood. Garden cress seeds are an iron-rich food that can help restore iron stores and promote the development of healthy red blood cells. Iron deficiency is one of the main causes of anaemia. These seeds are also a notable source of folic acid (vitamin B9), a nutrient that is crucial for treating anaemia. Folic acid is essential for DNA synthesis, the production of red blood cells, and the prevention of several anaemias, including megaloblastic anaemia (Chaudhary and Gupta, 2021) ^[12].

Raising Haemoglobin Levels: The iron and folic acid found in garden cress seeds help to raise haemoglobin levels in the blood. The movement of oxygen from the lungs to different tissues and organs depends on haemoglobin. Anemia results from the body's inability to synthesize haemoglobin when iron and folic acid levels are inadequate. Garden cress seeds can

boost the synthesis of haemoglobin and eliminate anemia-related symptoms by restoring the body's iron and folic acid levels over time (Singh and Paswan, 2017) ^[59].

Enhancing Iron Absorption: The effect of vitamin C in improving iron absorption is important when treating anemia. When combined with foods or supplements high in vitamin C, garden cress seeds are even more helpful at battling anemia. Non-heme iron, such as that found in plant-based sources like garden cress seeds, is more easily absorbed when vitamin C is present. Incorporating garden cress seeds with vitamin C-rich foods like citrus fruits, berries, and vegetables will maximize the absorption of iron and help to increase hemoglobin levels (Haridas *et al.*, 2022) ^[25].

Helps to control high blood pressure

Lepidium sativum (garden cress, seeds) have been recognized for their ability to help lower blood pressure. This is explained by the fact that they have been shown to have anti-hypertensive characteristics and diuretic effects, which together help lower high blood pressure levels. It is believed that the seeds' anti-hypertensive properties come from bioactive substances that can help widen blood vessels, encourage vasodilation, and therefore enhance blood flow. Garden cress seeds' diuretic properties also encourage greater urine production, which helps the body rid itself of extra fluid and sodium. Reducing fluid retention may lessen the stress on blood vessel walls, which would help regulate blood pressure even more (Sharma, 2020) ^[54]. Although garden cress seeds appear promising in this respect, it's crucial to incorporate in diet while taking into account any existing medical conditions and with the prescription of professionals. The addition of garden cress seeds fits with a comprehensive strategy for controlling high blood pressure and gives individual health needs top priority (Singh *et al.*, 2022).

Protects against cancer

A growing amount of research has suggested that garden cress seeds (*Lepidium sativum*) have anticancer properties and may be useful in the fight against cancer. These seeds have the ability to protect cells from the damaging effects of free radicals, which can cause DNA damage and the start of malignant growth. These are particularly high in antioxidants, such as vitamins A and E (Singh *et al.*, 2022) ^[58]. The antioxidants in the seeds work to combat free radicals and lessen oxidative stress, which is a major contributor to the development of cancer. Garden cress seeds also contain a bioactive substance that has the capacity to suppress the activity of particular enzymes involved in the development of tumours (Ibrahim *et al.*, 2023) ^[27]. This method, which focuses on vital pathways involved in uncontrolled cancer growth, shows promise in slowing the spread of the disease. Despite the encouraging body of research, it's important to recognize that using garden cress seeds to prevent and treat cancer requires extensive scientific research, including clinical studies, in order to fully comprehend their potential advantages and develop protocols that are both safe and effective. (Faid, 2019) ^[19].

Heart disease prevention

Garden cress seeds (*Lepidium sativum*) are capable of offering protection from heart disease due to their high vitamin C and K content (Lahiri and Rani, 2020) ^[34]. These nutrients are

essential for strengthening cardiovascular health. Vitamin C, which is well known for its antioxidant abilities, helps to make collagen, which is necessary for preserving the structural integrity of blood vessels and also supports the immune system. Garden cress seeds help maintain the flexibility of arteries by encouraging the creation of collagen, protecting them from the potential harm caused by high cholesterol levels. Another essential component of these seeds, vitamin K, also promotes heart health by limiting the buildup of calcium in the arteries and heart valves (Salama *et al.*, 2019) ^[51]. The prevention of arterial calcification, a process that can lead to artery hardening and narrowing, is made possible by this preventive activity (Singh *et al.*, 2021) ^[57]. Despite the fact that the vitamins found in garden cress seeds show promise for preventing heart disease, a holistic approach to heart health—one that includes a balanced diet, consistent exercise, and medical supervision—remains essential for overall cardiovascular well-being. To be sure that garden cress seeds are a good fit for their particular needs and heart disease prevention strategies, anyone interested in including these seeds into their heart-healthy diet should speak with healthcare professionals (Mohamed *et al.*, 2019) ^[39].

Utilization of Garden Cress Seeds in various industrial sectors

Uses in food industry

Coatings that decrease the fat concentration in fried foods are another alternative for addressing both health concerns and consumer acceptability. Mucilage of garden cress seed extract (*Lepidium sativum*) was converted into an edible coating with or without ascorbic acid (AA) to coat fresh-cut potato strips during cold storage (5 °C and 95% RH for 12 days) and subsequent frying. Colour, weight loss, and texture of potato strips coated with MSE solutions with or without AA revealed that coatings effectively delayed browning, decreased weight loss, and preserved texture during cold storage. As a consequence, the edible coating of garden cress mucilage might be a potential application for increasing the shelf-life and lowering the oil absorption of fresh-cut potato strips (Ali *et al.*, 2021) ^[6]. The mucilages of seeds are used as substitute for gum Arabica and tragacanth (Al-Snafi, 2019) ^[8]. Garden cress leaves that have been stimulated are used for garnishing the salad. Used in the development of blended garden cress seeds products such as faloodaare, garden cress soup and citrus khus cooler (Shabbir *et al.*, 2018) ^[39].

Application in Non-Food Industry

Uses in aroma therapy

Seeds are rich in fatty acids and vitamins and are recommended in rheumatism, inflammation and muscular pain (Nasef and Khateib, 2021) ^[43]. It is also used by soldiers for warmth and stomach discomfort during night. It also heals skin disorders, sunburns and amoebic infections. Seed's oil is also used to treat dysentery and diarrhea. The oil derived from roasted seeds in til oil is used as analgesic medicinal oil in gout, rheumatism, glandular swelling etc.

Uses in cosmetic industry

Surfactants have been shown to have long-term effects on the human body due to their slow accumulation in the brain, liver, heart, and subcutaneous. However, these compounds have a broad impact on the human body, aside from the skin. The situation is further aggravated by the inability of the majority

of treatment plants in our country to eliminate surfactants qualitatively, resulting in their gradual deposition in the environment (Tkachuk and Okulovych, 2021) ^[61].

Tocopherol (a natural antioxidant), carotenoid, oleic acid, and alpha-linolenic acid are all found in GC seed oil, and it has the ability to neutralize many types of radicals, therefore utilized in cosmetic industry (El-Saadany *et al.*, 2022) ^[14]. Garden cress (*Lepidium sativum* L.) is a well-known sensitive test plant which is used in bio testing for determining the toxicity of various substrates present in cosmetics (eg. shampoo).

Uses in pharmaceutical industry

Use as film forming agent: The influence of glycerol concentration (25, 35, and 50 percent w/w) on cress seed gum edible film synthesis was examined. The edible films' water vapour permeability increased as the glycerol content in the film formulation increased, resulting in enhanced flexibility, considerably lower film tensile strength, and higher elongation at break (Fahami and Fathi, 2018) ^[18].

Use as an encapsulating agent: Cress seeds quickly absorb water, generating a sticky mucilage. The mucilaginous content of these seeds ranges from 6.5 to 15%. This mucilage is composed of hydrocolloids, which have a wide range of applications in the food sector. Mannose (38.9%) and arabinose (19.4%) are the two sugars found in cress seed mucilage. The inclusion of cress seed mucilage as the encapsulating wall material considerably increased vitamin A heat stability ^[10]. Furthermore, using electrostatic interactions between the mucilage and sodium caseinate as a structural material, the mucilage was employed to encapsulate curcumin (Moniri *et al.*, 2020; Fahami and Fathi, 2018) ^[41, 18].

Utilization as natural superdisintegrants: It is frequently utilized as a disintegrating agent and as a herbal medicine in the pharmaceutical sector. Seeds include increased mucilage, as well as the dimeric imidazole alkaloids lepidine B, C, D, E, and F, as well as two novel monomeric imidazole alkaloids semilepidinose A and B. Mucilage may be extracted from seeds in a number of ways (Mali *et al.* 2022; Nerkar and Gattan, 2012) ^[37, 44].

Use as a gelling agent: Cress seed mucilage has a gel-like consistency. The mechanical qualities (gel strength, adhesiveness) and rheological properties of cress seed mucilage at different minimum Carbopol concentrations were investigated in this study. It also has additive effects. The combination of Carbopol and cress seed mucilage led to longer and more effective venlafaxine administration through buccal route (Mali *et al.* 2022; Nerkar and Gattan, 2012) ^[37, 44].

Uses in other industries

Biomonitoring of Pollution: Garden cress is commonly used as a test plant for conducting biomonitoring of pollutants in urban soil on a large scale due to its simplicity, sensitivity, and low cost. Peroxidase is an essential antioxidant enzyme that increases when plants are polluted. It was recently demonstrated that increased peroxidase activity was highly linked with high phenolic content and antioxidant activity during garden cress germination. Anionic peroxidase (GCP2) play a key role in the lignification process, removing

phenol and p-chlorophenol from contaminated soil/wastewater, and resisting the adverse effects of heavy metals (Abdel-Aty *et al.*, 2021) ^[1].

Use of garden cress seed oil in improving productive traits of laying hens: Phenolics, polyphenols, flavonoids, antioxidants, and PUFA are abundant in GC seeds. These active compounds stimulate growth genes, metabolic processes, white blood cell proliferation, cytokine synthesis, and improve final product quality by regulating cholesterol content and boosting PUFA in the bird's body. Supplementation with GC seed oil in the layer diet has a positive influence on the feed conversion ratio, egg mass, and egg production of the birds. Thus, garden cress (*Lepidium sativum*) seeds are essential economic plant seeds that have recently captured global attention due to their nutritional and therapeutic attributes, leading to novel sources of feed additives that can supplement diverse poultry diets (El-Saadany *et al.*, 2022) ^[14].

Conclusion

The concentrations of bioactive chemicals, as well as the antioxidant potential of *L. sativum* demonstrate that seeds are an excellent source of amino acids, minerals, and fatty acids. The presence of bioactive phytochemicals (phenolics, alkaloids, flavonoids, cardiogenic glycosides, saponins, tocopherols, phytosterols, tannins, and triterpenes) in *L. sativum* seeds may be responsible for its nutritional, ethnopharmacological, and therapeutic recognition. *L. sativum* seed extracts help with pain, asthma, nociception, inflammation, blood coagulation, oxidative stress, anuresis, and other conditions. As stated earlier, these seeds are highly rich in iron and calcium, thus persons suffering from malnutrition, calcium insufficiency, and iron deficiency anemia can benefit the most from this product. Furthermore, those who are well now may suffer from any health or nutrition-related condition in the future. It is thus preferable to take these types of supplements on a regular basis in order to maintain a healthy lifestyle and avoid these problems in the future. There are several additional benefits of consuming GCS supplemented products for moms for 24 hours milk production, low glycemic index seeds for sugar patients, maintaining optimum haemoglobin levels and decreasing body fat faster. Therefore, the functional and therapeutic properties of *L. sativum* may be exploited through the incorporation of seeds into a variety of food compositions and health drink formulations. Moreover, Garden cress seeds provide a wide range of possibilities for additional research into their preventative effects against a variety of diseases, utilization as a functional component in novel food products, nutraceutical formulations and in cosmetic industry.

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