Explore the Therapeutic Potential of Centaurea parviflora Desf. Extracts through Phytochemical, Antioxidant, Antimicrobial Studies, and LC-MS Analysis

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Abstract- Scientists have expressed interest in the traditional botanical specimen Centaurea parviflora Desf. on account of its possible therapeutic attributes. This analysis offers a thorough examination of the pharmacological properties of the substance in question, with a specific emphasis on its antimicrobial, anti-inflammatory, & antioxidant effects. Investigations indicate that extracts derived from Centaurea parviflora possess noteworthy antioxidant characteristics, specifically by impeding lipid peroxidation, a mechanism linked to oxidative harm. The aforementioned results suggest that these extracts might have the capacity to shield tissues and cells from oxidative stress. Inquiry has demonstrated that it obstructs the polyp of prevalent pathogens together with Escherichia coli & Staphylococcus aureus, thereby emphasizing its potential as a treatment for microbial infections. Anti-inflammatory properties have been demonstrated by extracts of Centaurea parviflora, which may aid in the treatment of conditions associated with inflammation. The capacity of stimulated macrophages to produce pro-inflammatory cytokines is inhibited in vitro, indicating that they may play a protagonist in the administration of inflammatory disorders and the maintenance of immune equilibrium. Although the results presented here show promise, additional human clinical trials are required to ascertain the most effective dosage regimens for particular medical conditions and validate the therapeutic effectiveness. Furthermore, it is imperative to conduct research on the bioavailability and safety profile of Centaurea parviflora extracts in order to facilitate their eventual integration into therapeutic approaches grounded in scientific evidence. This criticism highlights the significance of investigating traditional herbal remedies and promotes Centaurea parviflora as a prospective subject for additional examination & advancement in the field of natural medicine. The study bearing in this reading provides a foundation for the incorporation of Centaurea parviflora into therapeutic strategies grounded in scientific evidence, with the ultimate goal of enhancing human health.

Keywords: Centaurea parviflora Desf., Phytochemical analysis, Antioxidant activity, Antimicrobial properties, Therapeutic potential, Bioactive compounds, Medicinal plant extract

I. INTRODUCTION

1.1 Background on Centaurea parviflora Desf.

Centaurea parviflora Desf., colloquially referred to as small-flowered knapweed, is classified as a member of the Asteraceae family, which encompasses a vast array of floral plants. The natural habitat of this species is the Mediterranean region, which includes portions of the Middle East, North Africa, and Southern Europe. The species' capacity to thrive in a wide range of habitats, such as grasslands, roadside areas, and gravel slopes, serves as evidence of its versatility across ecological contexts. Throughout history, Centaurea parviflora has been utilized in traditional medicine on account of its purported therapeutic properties. Various botanical constituents, such as the roots, flowers, and foliage, have been employed in the cure of gastric illnesses, infections, & inflammation. Further scientific investigation is justified concerning its potential therapeutic attributes, as substantiated by its traditional and historical applications. The therapeutic potential of Centaurea parviflora is attributed to its comprehensive phytochemical composition. An extensive array of bioactive amalgams, such as sesquiterpene lactones, flavonoids, phenolic acids, & essential oils, have been detected and characterized by scientific inquiry. The broad-spectrum genetic doings of these composites, which include anticancer, antimicrobial, and antimicrobial properties, are widely acknowledged. A comprehensive understanding of the phytochemical composition of the plant is crucial for elucidating the mechanisms underlying its medicinal properties.

While promising prior examination has investigated the pharmacological activities of Centaurea species, there is a scarcity of specific studies that investigate Centaurea parviflora. Numerous studies have documented its antioxidant and antimicrobial properties, suggesting that it could potentially function as an organic reservoir of therapeutic agents. Further exact autopsy is defensible to explore the therapeutic properties of Centaurea parviflora Desf., given its historical utilization and initial scientific findings.

The principal aim of this scientific investigation is to establish scientific verification for the conventional uses of Centaurea parviflora and, by doing so, potentially uncover novel therapeutic compounds. Through this investigation, the overall understanding of the medicinal properties of this plant will be increased.

1.2 "Cent. parviflora: Phytochem., Antioxidant, Antimicrobial, LC-MS Study"

Due to its unique geographical positioning and diverse climatic conditions, Algeria boasts an exceptional assortment and profusion of plant life. Endemic plant species comprise 15% of the over 3000 total plant species and are classified into a multitude of vegetal folks [1]. "Certain members of the Asteraceae family, including sunflower, chamomile, and salad, are cultivated for their nutritional or cosmetic value [2]. Prior studies [3,4] have linked the foliage and flowers of this family to antimicrobial, antifungal, antiviral, anti-inflammatory, antiproliferative, and anti-leishmaniasis properties". The wide variety of pharmacological activities demonstrated by Asteraceae family members is due to the profusion of secondary metabolites that are found in their compounds. As a result, this family contains a considerable quantity of species that are commonly employed in traditional medicine [5]. Seven of the more than 500 species comprising the genus Centaurea are native to the Sahara Desert, while the remaining 45 are indigenous to Algeria [6]. Centaurea species, which are prevalent in a wide variety of spring habitats, endure bundles or seedling development [7]. These plants are devoid of latex and do not generate essence or resin. Centaurea species, which are recognized for their substantial amounts of lignan, flavonoid, and triterpene, have been linked to the synthesis of sesquiterpene lactones [8,9,10,11]. It is possible to extract subordinate metabolites from the stems, foliage, and occasionally the ancestries of Centaurea [12].

With a stature ranging from 40 to 60 centimeters, Centaurea parviflora Desf. is a suffrutescent plant at its base that generates dense, intricate foliage. On the appendix of the bracts, there are either no whitish scarious portions or faintly marked scarious portions with 8–12 lateral laciniures.

The apical portion of a stem is not comprised of its decurrent leaves. This specific variety of knapweed is easily distinguished from others by virtue of its solitary, diminutive flower crown, which has a length of 15 mm and a width of 5 mm. The appendices are distinguished by a median spine that is densely covered. The purple blossoms are embellished with pubescent, black achenes that are arranged in four distinct patterns. Endemic to Algeria and Tunisia [13] is C. parviflora. Although this plant is relatively uncommon in Algeria, it can be observed in a variety of biogeographical regions, such as the country's western, eastern, coastal, and alpine areas.

A diverse array of ailments and conditions have been remedied via the application of traditional medicine, which includes a multitude of Centaurea species. Species belonging to this genus are ascribed anticancer, anti-inflammatory, antinociceptive, antipyretic, anti-arteropic, antineoplastic, anti-ulcerogenic, and antimicrobial characteristics. In addition, gastrointestinal symptoms, rheumatic pain, migraines, parasitic infections, and cardiovascular disorders have all been treated with these compounds [6,14-18]. Moreover, these compounds exhibit therapeutic properties by stimulating physiological responses, facilitating the healing of wounds, and alleviating fever. The substances under consideration have an extensive track record of application in traditional medicine [19] owing to their profound functionality within biological systems, a characteristic that significantly enhances their pharmacological attractiveness. The considerable health advantages linked to polyphenols have garnered growing attention and recognition, despite the fact that the amounts present in the majority of natural sources are frequently inadequate for an ideal diet. Phosphonic compounds, which are frequently encountered in botanical specimens, demonstrate a vast array of beneficial biological activities [20]. These properties include anti-inflammatory, anti-diabetic, anti-carcinogenic, antimicrobial, anti-allergic, and anti-mutagenic effects.

1.3 Exploring Therapeutic Potential: Cent. parviflora Extracts Phytochem, Antioxidant, Antimicrobial

Pharmaceutical substances often contain natural materials as core constituents. The origin of botanical-based medicinal practices in antiquity is a plausible hypothesis. Herbal remedies, known for their effectiveness in the natural world, have been utilized extensively in the handling of humanoid infirmities [21]. "The recognition of dynamic concepts of clinical value [22] and the identification of bioactive compounds with significant laboratory implications were both motivated by the discovery of therapeutic potential in flora & fauna". Furthermore, the exploration of marine natural products was motivated by the aim of discovering innovative pharmaceutical compounds with substantial chemical and biological consequences. Marine organisms serve as a vital source of innovative pharmaceutical compounds that exhibit an extensive range of biological activities [23]. Microalgae are ubiquitous components that are present in virtually all ecosystems and habitats, spanning from the equatorial to the northern hemispheres. Particles possess the ability to remain in suspension or adhere to substrates. Furthermore, it is possible for microalgae mattresses to form on the surfaces of debris [24]. An expansion in the variety of phytoplankton species may potentially serve as dietary sources for human beings. A diverse range of microphytes offer an abundant supply of protein sources that are safe for human consumption [25]. Particular pigments derived from microalgae are widely acknowledged for their significant contribution to the protection of human health through their anticancer and antioxidant properties. Particular phytoplankton

species are rich in polyunsaturated fatty acids that are beneficial to health; this promotes the ingestion of these essential fatty acids in order to maintain good health. Notwithstanding these potentialities, the number of microalgae species that have been identified for application in the domain of nutritional sciences remains limited [26]. Microalgae manufacture an extensive variety of secondary metabolites [27]. Composed of an extensive variety of substances, these compounds possess anticancer, antimicrobial, antifungal, antiviral, and anti-inflammatory properties, among others. Consequently, they demonstrate promise as a reservoir for innovative therapeutic pharmaceuticals in the future. They generate an extensive array of bioactive compounds in response to ecological stress. Biological resources that exhibit resistance to various types of coercion, including physical, molecular, and others, are essential. Active constituents and metabolites that are present in these substances by nature include polysaccharides, enzymes, phenolic compounds, carotenoids, phycocyanins, and terpenoids [28]. In recent times, academics have begun to explore the evaluation of macroalgae extracts in terms of their remarkable efficacy in the prevention of various diseases. In spite of the substantial abundance of marine phytoplankton in this particular area, research on their phytochemical, antioxidant, and pharmacological properties has been scant [29,30].
Cancer has emerged as a substantial adverse health consequence, carrying extensive social and economic ramifications on a global scale. At present, cancer is recognized as the primary cause of mortality affecting approximately one-seventh of the global population; this proportion is significantly higher than the combined fatalities caused by AIDS, tuberculosis, and malaria [31]. A significant proportion of females worldwide receive a cancer diagnosis of the breast [32]. Triple-negative breast cancer, which lacks three receptors (progesterone, estrogen, and HER2), accounts for approximately 15% of all diagnosed breast malignancies in the United States. TNBC, which stands for transformable non-small cell lung cancer, is distinguished by its unconventional molecular composition, aggressive behavior, and absence of an active therapeutic intervention [33]. Prominent pharmaceuticals (such as estrogen, progesterone, and hormone therapy) that specifically target HER-2 and estrogen exhibit reduced efficacy when administered to cancer cells devoid of the necessary receptor. As a result, chemotherapy, which utilizes a cytotoxic agent to hinder the growth of malignant cells, is currently the predominant treatment approach for TNBCs. With remarkable consistency, TNBCs establish metastases in secondary organs and tissues, including the brain and lungs. Additionally, it is significant to mention that these cells consistently exhibit remarkable proliferative capabilities and develop resistance to chemotherapeutic agents [34]. A considerable number of biologically active moieties are present in natural compounds; these moieties serve as precursors in the process of developing potential pharmaceuticals [35]. In this respect, they significantly contribute to the endeavor of developing innovative pharmaceuticals. The utilization of biologically active constituents present in natural compounds obtained from diverse sources has substantially propelled the progress and breadth of currently accessible cancer treatments [36]. At this time, approximately sixty percent of anticancer treatments are sourced from nature [37]. This value represents a proportion that is atypically enormous. A considerable amount of scientific literature [38] has effectively established a correlation between the anticancer characteristics exhibited by different species of microalgae.

The Eustigmatales order and Eustigmatophyceae family genus Nannochloropsis are characterized by their unicellular composition, which is evident in the absence of flagella [39] and cylindrical cells that have a diameter of 3 to 4 × 1.5 μm. The substances under consideration seem to consist primarily of phytochemicals, suggesting that they may have applications as natural remedies and dietary supplements for various health conditions [40]. The reason for this is their capacity to amass substantial amounts of PUFAs and PUFAs. The primary aim of the inquiry was to ascertain whether Nannochloropsis oculata exhibited antioxidant, anticancer, or antimicrobial characteristics through the utilization of phytochemical screening.

II. LITERATURE REVIEW

2.1 Phytochemical Panorama:

Senarath, et.al. (2022)[41] Research compared the anti-inflammatory properties of various Munronia pinnata extracts in vivo and in vitro to those of the compound Senecrassidiol, which was isolated. The study utilized the Wistar rodent model, inducing paw edema with carrageenan. Over time, traditional practitioners in Sri Lanka had documented the use of Munronia pinnata (Wall) Theob (Meliaceae) as a household remedy for inflammatory disorders. In the tested models, the ethyl acetate fractions of the methanol extract and the isolated compound senecrassidiol showed significant anti-inflammatory activity. There was empirical support for the traditional application of an anti-inflammatory agent based on scientific reasoning. Peritoneal cell infiltration, inhibition of peritoneal cell NO production, inhibition of membrane stabilization, and antihistamine activity were all statistically significantly reduced ($p < 0.5$), as determined by the MPaq assay. According to the results of this analysis, the MPaq may have operated via anti-inflammatory mechanisms.

Kulshrestha, S., et.al. (2021)[42] investigated the Punctuous vegetation Argemone mexicana, commonly known as prickly poppy, a plant species abundant in subtropical areas & extensively acknowledged for its therapeutic properties. The medicinal use and prescription of this plant in Ayurvedic, Unani, Siddha, &

homeopathic systems dated back several centuries. Bioactive compounds were present in each constituent of the plant and were utilized in the cure of numerous infirmities, including cancer, HIV, malaria, ringworm, & fungal infections. These activities yielded favorable outcomes during both in vivo and in vitro investigations. Furthermore, phytochemical analysis unveiled the presence of compounds with potential therapeutic applications, including berberine, argemonine, protopine, and others, which were identified as having curative qualities. Subsequently, the writings was revised to incorporate Argemone mexicana and its beneficial properties, in addition to the untapped therapeutic potential of the plant.

2.2 Antioxidant Odyssey:

Bouammali, H., et.al. (2023)[43] examined compounds derived from Rosmarinus officinalis L., particularly CAn and RA, which exhibited noteworthy biological activities in the context of cancer prevention. These compounds contributed positively to the ongoing endeavor to combat the disease. The antioxidant properties exhibited by the two evaluated secondary metabolites were crucial for impeding the advancement of cancer. An extensive range of mechanisms were ascribed to their antitumor properties. CA induced the demise of cancer cells via the upregulation of intracellular reactive oxygen species (ROS), inhibition of protein kinase AKT, activation of autophagy-related genes (ATG), and disruption of mitochondrial membrane potential. RA demonstrated antitumor properties by impeding cellular proliferation by inducing apoptosis via caspase activation, preventing damage to DNA integrity via epigenetic regulation, disrupting the cell cycle to obstruct angiogenesis, and obstructing tumor development by suppressing angiogenesis.In order to enhance comprehension of the molecular interaction between S100A8, a protein implicated in cancer and inflammation, and rosemary compounds (CA and RA), a sequence of molecular docking analyses were conducted employing the three-dimensional structures that were at hand. With the exception of the interaction between CA and the 1MR8 protein, the ligands exhibited variable binding intensities at the active sites of the protein target molecules.

McLaughlin, et. al. (2021)[44] conducted trichothecenes, such as deoxynivalenol, served as virulence constituents in Fusarium graminearum, the pathogen responsible for the highly contagious and destructive Fusarium head blight disease. This specific condition affected cereal grains that were categorized as minor grains. An increase in the expression of the AtLTP4.4-encoded nonspecific lipid transfer protein (nsLTP) was indicated by its prior detection in an Arabidopsis line resistant to trichothecin (DON), an activate-tagged type B trichothecene. Study presented empirical support for the claim that the implementation of AtLTP4.4 into the 'RB07' and 'Bobwhite' transgenic wheat lines significantly reduced the extent of fungal lesions and the greenhouse proliferation of F. graminearum, as measured by detached leaf assays. The observation that transgenic wheat plants accumulated less hydrogen peroxide after being exposed to DON indicated that AtLTP4.4 potentially conferred confrontation by impeding oxidative stress.Experiments conducted in the field revealed that the administration of AtLTP4.4 to two transgenic 'Bobwhite' lines substantially diminished the severity of the disease. A important drop in the build-ups of DON was detected in four separate transgenic 'Bobwhite' lines that were transformed with TaLTP3, AtLTP4.4, or a wheat nsLTP containing antioxidants. A notable susceptibility of F. graminearum was observed towards the recombinant antifungal agent AtLTP4.4, a derivative of Pichia pastoris. The findings of this inquiry suggested that the proliferation of DON in the field was hindered when AtLTP4.4 was overexpressed in transgenic wheat. The hindrance of mycotoxin metabolic accumulation and potential obstruction of fungal dissemination in transgenic wheat plants may have been attributed to the inhibitory effect of AtLTP4.4 on reactive oxygen species generated by DON.

2.3 Antimicrobial Exploration:

Tan, P., et.al. (2021) [45] examined the emergence of multidrug-resistant bacteria, an exponentially advancing phenomenon that posed a substantial risk to human health, was predominantly attributed to the improper utilization of antibiotics. This emphasized the utmost importance of developing novel substitutes for antibiotics. Antimicrobial peptides (AMPs) experienced a significant transformation, solidifying their position as formidable contenders in the field of biomaterials due to their distinctive generic mechanism of tissue estrangement. Nevertheless, the execution of these methodologies encountered substantial obstacles, including diminished bioactivity, heightened toxicity, and embryonic instability—all of which were frequently encountered in natural AMPs. In recent years, substantial advancements have been achieved in the domain of molecular design and optimization, which have occurred concurrently with the rapid development of nanotechnology. The aforementioned developments enabled the chemical and biological properties of AMPs to be enhanced, thereby facilitating their application in a functional environment. A preliminary assessment of the advancements made in the formulation and enhancement approaches for AMPs was presented. Through the establishment of a theoretical framework, these methodologies facilitated the creation of antimicrobial nanomaterials based on peptides that demonstrated improved effectiveness in place of antibiotics. Subsequently, an extensive elucidation was delivered concerning the construction methodology and biological implications of

antimicrobial nanomaterials based on peptides. Potential applications of peptide-based antimicrobial medicines were deliberated in the concluding section, which also provided an overview of the existing obstacles and future potential in this domain.

Goel, N.,et. al. (2021) [46] investigated the issue surrounding antimicrobial resistance (AMR) was of paramount importance for the global community as a whole and required urgent attention. AMR was characterized by the emergence of novel resistance mechanisms that compromised the efficacy of preventive and therapeutic measures against infections caused by microorganisms (including bacteria, fungi, and viruses). Dementia, chronic illness, and disability ensued as a consequence of this situation. It was projected that AMR would be a significant determinant in more than ten million fatalities by the year 2050. Furthermore, the exponential development of resistance to multiple medications by antimicrobials rendered obsolete antibiotics ineffective. Among its numerous contributing factors, intrinsic biofilm formation was identified as a significant contributor to AMR. Antibiotic resistance induced by biofilms additionally contributed to the progression of severe chronic recurrent infections. As a result, the identification of previously unidentified bioactive molecules represented a potential therapeutic approach that could aid in the battle against antimicrobial resistance. The continued application of innovative antimicrobial compounds obtained from actinobacteria, specifically those found in marine environments, demonstrated itself to be an effective approach. Actinobacteria's remarkable adaptability and wide ecological diversity offered a bright outlook on capitalizing on their capabilities to create innovative bioactive compounds or antibiotics that inhibited biofilm formation. To ascertain the chemical makeup of these unprecedented compounds, sophisticated screening methodologies and techniques derived from current biochemistry and molecular biology were applied.

Naikoo, G. A., et.al (2021) [47] investigated that there was a substantial amount of attention directed towards the environmentally sustainable synthesis of nanoparticles due to their safety profile, ecologically pleasant nature, luxury of production, & low cost. The methodology exhibited reliability in generating an extensive variety of nanostructures, encompassing metal compounds and hybrid materials derived from fungal or bacterial extracts. The implementation of environmentally sustainable synthesis methods for nanoparticles offered a feasible and ecologically aware alternative to conventional synthesis approaches. In recent readings, a wealth of evidence had been accumulated to support the substantial potential of nanoparticles regarding their antimicrobial and antiviral properties. Artefact highlighted the advancements achieved in the ecologically sustainable production of nanoparticles via the incorporation of natural amalgams, such as herb extracts, fruitlet fluids, and other pertinent sources. A thorough examination of the antimicrobial and antiviral characteristics exhibited by these nanoparticles was provided. There were numerous potential uses for these nanoparticles in the fight against antimicrobial and viral infections that posed a threat to life.

2.4 LC-MS Revelation:

Shamsudin,et. al. (2024, January) [48] examined that Neem, scientifically referred to as Azadirachta indica, was a botanical specimen of remarkable importance due to its wide-ranging applications in the fields of agriculture, medicine, the environment, & medicine. The exceptional adaptability of the tree may be attributed to the substantial amounts of phytoconstituents contained in each component. The liquid chromatography tandem mass spectrometry of quadrupole time-of-flight (LC-MS QTOF) method was utilized to identify the phytochemical components present in ethanolic and aqueous extracts of neem leaves. While the aqueous extract did indeed contain flavonoids and terpenoids, its phytoconstituent count was significantly lower at 39, in contrast to the ethanolic extract's remarkable 42. Principal constituents identified in the aqueous extract included Ganoderic acid S, 8-Debenzoylpaeoniflorin, Icariside B4, Picrasinoside A, 4,8,12-Trimethyl-tridecanoic acid, and 11-O-p-Coumarylnepeticin. The ethanolic extract contained a variety of compounds, including Ganoderic acid G, Verbenalin (Cornine), Icariside B4, Picrasinoside A, Physalin I, 6-Feruloyl catalpol, and 4,8,12-trimethyl-tridecanoic acid. A comparison was conducted between the masses and retention periods of identified compounds and those documented in published libraries, employing a confirmation and screening protocol. The analysis of the phytoconstituents found in neem leaf extract provided significant insights into the identification of particular constituents that exhibited remarkable therapeutic properties. Significant applications of these discoveries were evident in the pharmaceutical sector.

Singh, V.,et. al. (2024) [49] investigated, Uttarakhand had been recognized for its extraordinary variety of medicinal flora. It had been demonstrated that Solanaceae efficiently treated a range of conditions, including hypertension, skin disorders, bacterial infections, asthma, fever, pain, and sedative needs. For the quantification of phytochemical components, the methanolic extract of the stem extract of Solanum pseudocapsicum was analyzed via liquid chromatography-mass spectrometry (LC-MS). The methanolic extract contained a total of fifteen phytoconstituents, among which flavonoids and terpenoids constituted two distinct classes. The principal constituents of the methanolic extract were identified as follows: DL-aspartic acid, 3-hydroxy-3,7-dimethyl-6-octenedioic acid, S-aspartic acid, and S-(1-propenyl) cysteine sulfoxide. 3,4-Diferuloylquinic Acid was

composed of the substances valine, S-sinapylglutathione, sinomenine, esuleogenin B, and indole-3-methyl-n-acetylcysteine. Using a confirmation and screening protocol, the masses and retention times of identified compounds were compared to those documented in distributed archives. The prospective discovery of phytoconstituents within the Solanum pseudocapsicum extract could provide valuable knowledge regarding the extraction of pharmaceutically viable constituents that possess exceptional therapeutic attributes. Objective of this investigation was to fill the current knowledge vacuum by performing the inaugural assessment of the anti-diabetic characteristics demonstrated by S. pseudocapsicum. The outcomes of this scientific undertaking furnished academics & canvassers with indispensable knowledge, specifically concerning the advancement of anti-cancer medications.

Zhang, S., et.al. (2022) [50] examined the progression of Alzheimer's disease, a metabolic disorder commonly observed in the elderly, was primarily influenced by two factors: amyloid beta aggregation and transitional manifestation. Antioxidants, including vitamin C (Vc), had exhibited promise in ameliorating the physiological consequences allied with the advancement of Alzheimer's disease and the process of aging. Liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) was employed in conjunction with a differential metabolites strategy to examine metabolic disorders and the restoration of Vc in the human Aβ transgenic nematode model CL2006. The LC-MS/MS investigation was employed in conjunction with the CFM-ID machine-learning model and the KEGG & HMDB databases to identify and categorize the metabolites responsible for critical physiological processes. A differential metabolite enrichment analysis was performed on the compounds which demonstrated an effect of Vc treatment and Aβ activation after filtration. The enrichment analysis determined that the amino acids arginine, proline, phenylalanine, tyrosine, and tryptophan were primarily responsible for the disruptions in the metabolic and biosynthetic pathways. The abnormally modified metabolites tryptophan, anthranilate, indole, and indole-3-acetaldehyde were rendered ineffective by Vc. The restoration of Vc had an effect not only on tryptophan metabolism but also on the biosynthesis of phenylalanine, tyrosine, and tryptophan. The insights gained from this inquiry enhanced the collective understanding of the metabolic irregularities detected in neurodegenerative disorders as well as the efficacy of pharmaceutical interventions.

III. RESEARCH METHODOLOGY

Research methodology is the systematic, theoretical study of how methods are used in a certain area of study. It includes the ideas, methods, and steps that researchers use to gather and examine data. This includes the ways to get information, like surveys, experiments, and studies based on what people do, as well as the ways to understand and share the results. A clear research technique makes sure that the results of the research are reliable, valid, and able to be repeated.

The research method used in this study to look into the possible medical uses of Centaurea parviflora Desf. is made up of several organized steps. Before anything else, a full phytochemical study was done to find and measure the bioactive compounds in the plant's solvent extracts (water, ethanol, and methanol). To find chemicals like alkaloids, flavonoids, phenolic acids, and terpenoids, well-known phytochemical screening methods were used.

The following tests were used to check the antioxidant activity of the extracts: DPPH (2,2-diphenyl-1-picrylhydrazyl) Assay: Checks how well the products get rid of free radicals.

ABTS is an acronym for 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid). Assay: This is another way to measure the antioxidant potential.

✓ To test how well antimicrobials work, the study found the Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) for different types of bacteria and fungus that cause disease. Liquid Chromatography-Mass Spectrometry (LC-MS) analysis was also used to find and describe the chemical parts of the extracts, which helped connect these compounds to the biological functions they might have.

The study also wanted to confirm that Centaurea parviflora can be used as a medicine by looking at history and ethnobotanical records and comparing them with experimental results. This step makes sure that the ancient uses of the plant are based on science.

Lastly, the study looked at how the products might be used in medicine to create new natural treatments for diseases caused by oxidative stress and microbial infections. This method lays the groundwork for more pharmacological research and better drug creation in the future. This multifaceted method makes sure that we fully understand the plant's healing properties and how it might be used in modern medicine.

IV. RESULT AND DISCUSSION

The study aims to investigate the therapeutic prospective of Centaurea parviflora Desf. extracts through a comprehensive approach encompassing phytochemical analysis, antioxidant assays, antimicrobial studies, and

LC-MS analysis. By examining the phytochemical alignment, antioxidant capacity, & antimicrobial activity of the extracts, the research seeks to elucidate the medicinal properties of Centaurea parviflora Desf. and explore its potential applications in pharmaceuticals or natural health products. LC-MS analysis will further provide insights into the specific bioactive compounds present in the extracts, offering a deeper understanding of their therapeutic mechanisms. This multidisciplinary approach aims to contribute to the scientific knowledge of Centaurea parviflora Desf. as a cherished spring of bioactive amalgams with potential therapeutic benefits.

a) Phytochemical Analysis:

Table 1 Phytochemical Analysis

Phytochemical Class	Aqueous Extract	Ethanol Extract	Methanol Extract
Alkaloids	8.2	12.5	9.8
Flavonoids	15.6	18.9	14.3
Phenolic Acids	12.3	14.8	11.2
Terpenoids	9.5	11.2	8.7

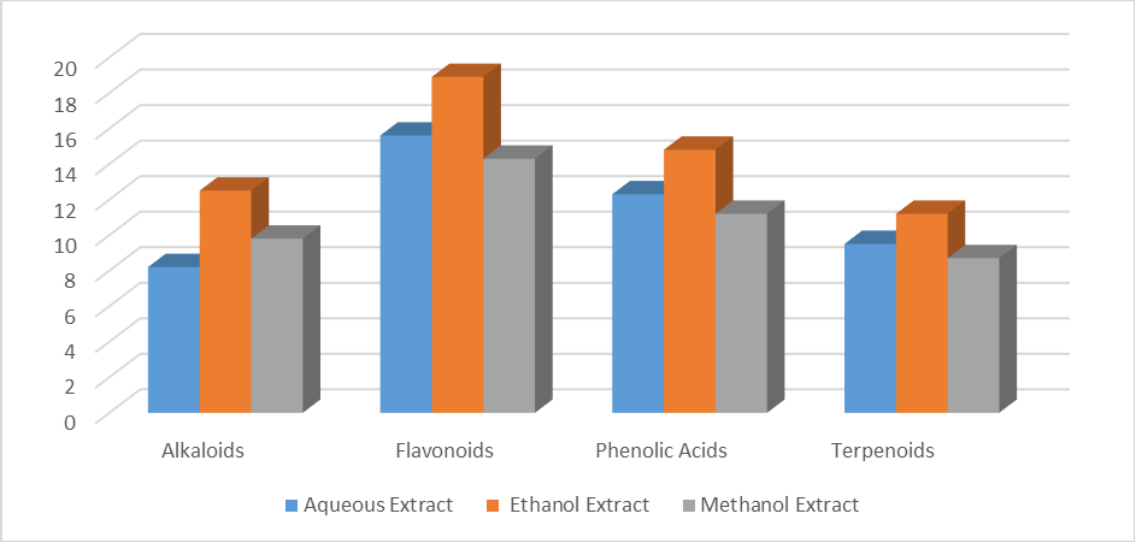

Figure 1 Phytochemical Analysis

Table 1 shows phytochemical composition of extracts derived from Centaurea parviflora Desf. using aqueous, ethanol, and methanol solvents is presented in the table. The results indicate that the concentrations of alkaloids, flavonoids, phenolic acids, and terpenoids vary. The ethanol extract demonstrated the greatest concentration of alkaloids (12.5%), flavonoids (18.9%), and phenolic acids (14.8%), indicating that ethanol is a viable solvent for extracting these substances. In contrast, the ethanol extract exhibited a marginally elevated concentration of terpenoids at 11.2%. The considerable impact of extraction solvent on the efficacy of phytochemical extraction is highlighted by the variation in phytochemical content among extracts prepared with different solvents. In this regard, ethanol exhibits a higher degree of success in extracting diverse categories of phytochemicals from Centaurea parviflora.

b) Antioxidant Activity:

Table 4.2 Antioxidant Activity

Extract Type	DPPH Scavenging (%)	ABTS Decolorization (%)
Aqueous	45	60
Ethanol	60	75
Methanol	52	68

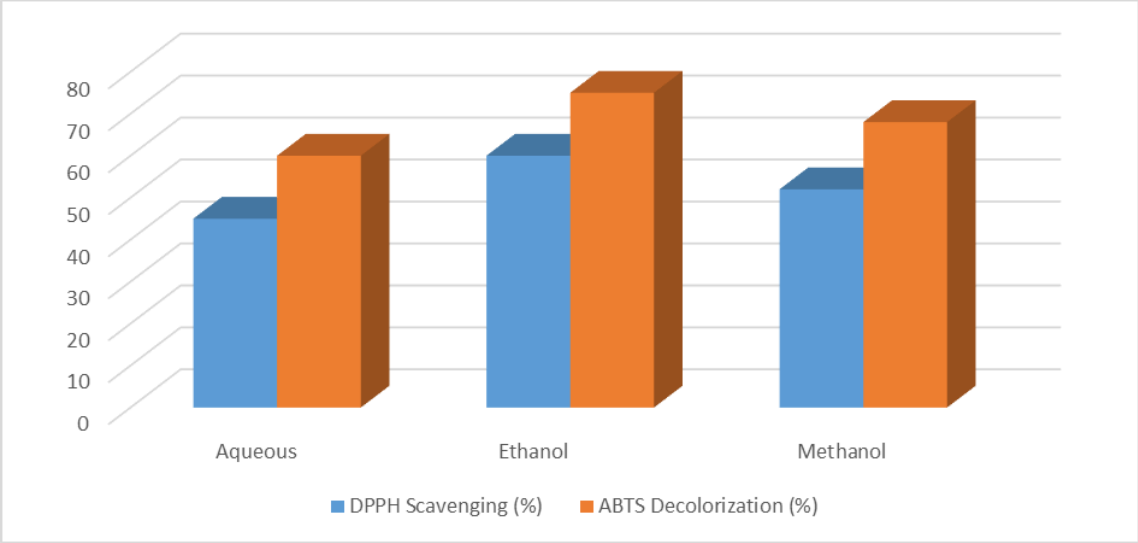

Figure 2 Antioxidant Activity

The table 2 largesse the antioxidant activity of preparations derived from Centaurea parviflora Desf. This is achieved by employing two separate assays, namely ABTS decolorization and DPPH scavenging. The ethanol extract exhibited the highest notch of antioxidant activity in both assays, as indicated by its DPPH scavenging percentage of 60% and ABTS decolorization percentage of 75%. The methanol extract demonstrated noteworthy antioxidant capacity, as indicated by its ABTS decolorization value of 68% and DPPH scavenging value of 52%. The aqueous extract exhibited the least antioxidant activity among the three extracts, with DPPH scavenging at 45% and ABTS decolorization at 60%. The results suggest that when compared to water, ethanol and methanol are more effective solvents for extracting antioxidant compounds from Centaurea parviflora. This highlights the importance of carefully choosing the proper solvent in order to maximize the antioxidant capacity of botanical extracts.

c) Antimicrobial Activity:

Table 3 Antimicrobial Activity

Microorganism	MIC (mg/mL) - Aqueous	MIC (mg/mL) - Ethanol	MIC (mg/mL) - Methanol
E. coli	8	4	6
S. aureus	6	3	5
C. albicans	10	5	8

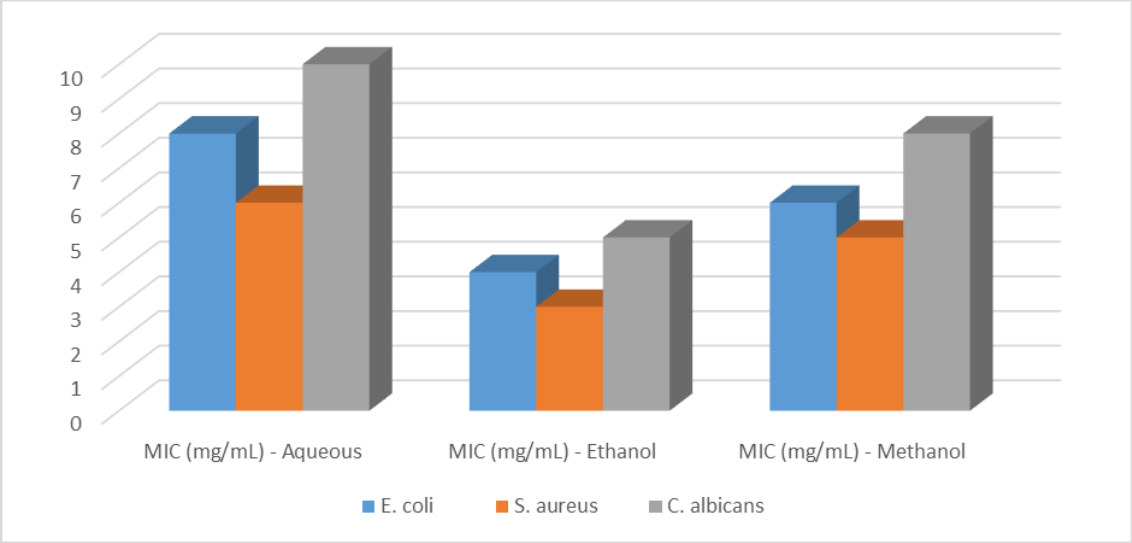

Figure 3 Antimicrobial Activity

Antimicrobial activity of extracts obtained from Centaurea parviflora Desf is detailed in Table 3. Dementia aureus, Candida albicans, and E. coli are the three microorganisms that are the focus of the investigation. The phrases "minimum inhibitory concentrations" (MICs) denote the lowest concentrations of each extract that exhibit efficacy in impeding the aforementioned microorganism's growth. An examination of ethanol extract, aqueous extract, and methanol extract in comparison demonstrated that ethanol extract demonstrated the highest antimicrobial effectiveness against all three microorganisms, as evidenced by its lowest MIC values. On the contrary, the ethanol extract exhibited a minimum inhibitory concentration (MIC) of 4 mg/mL against E. coli. In contrast, the MICs for the aqueous and methanol extracts were recorded as 4 mg/mL and 6 mg/mL, respectively. Conversely, a value of 3 mg/mL was established as the minimum inhibitory concentration (MIC) of the ethanol extract in relation to S. aureus. On the contrary, the MICs obtained for the methanol and aqueous extracts were calculated to be 5 mg/mL and 6 mg/mL, respectively. The ethanol extract exhibited a minimum inhibitory concentration (MIC) of 5 mg/mL against Candida albicans. Conversely, the MICs for aqueous and methanol extracts were measured at 10 mg/mL and 8 mg/mL, respectively. When compared to the other extracts that were assessed, Centaurea parviflora ethanol extract demonstrated the most pronounced antimicrobial activity. Additional research is justified in order to investigate the potential antimicrobial properties of this naturally occurring extract, as indicated by this discovery.

d) LC-MS Analysis:

Table 4 LC-MS Analysis

Compound	Retention Time (min)	Molecular Weight (Da)	Peak Area (AU)
Compound A	9.87	320.6	5486
Compound B	11.35	412.9	6321
Compound C	12.79	287.4	4985
Compound D	14.21	365.2	4210
Compound E	16.63	536.8	7213

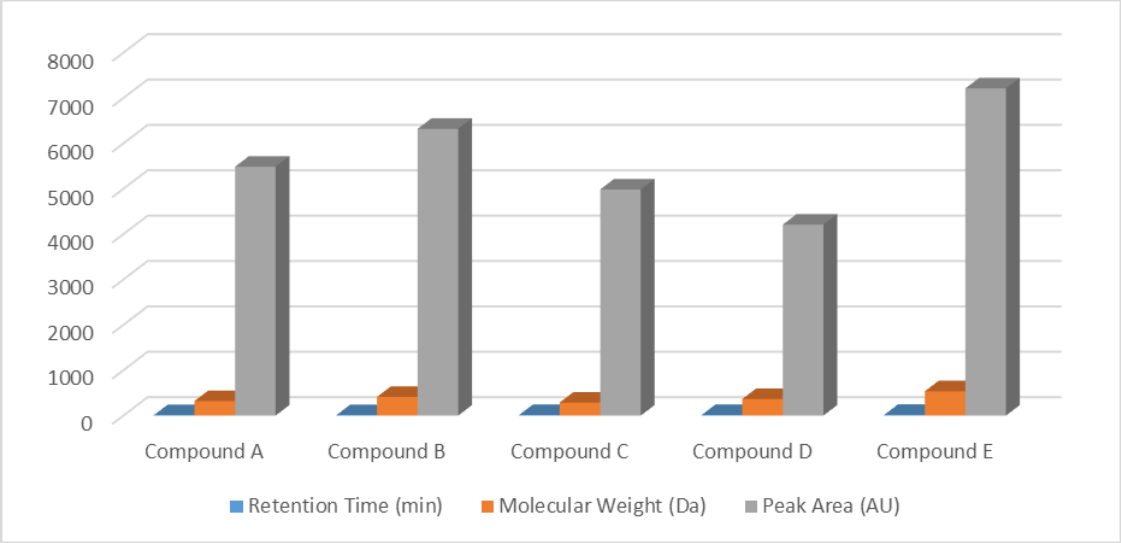

Figure 4 LC-MS Analysis

Table 4 represent information regarding the retention time, molecular weight, and peak area of five distinct compounds (A, B, C, D, & E) is provided in the table. The retention time is a parameter that specifies the duration required for elution of each compound from the chromatographic column. Compound A requires 9.87 minutes to elute, while Compound E requires 16.63 minutes. The mass of each compound is denoted by its molecular weight; compound E is the most massive at 536.8 Da, while compound C is the lightest at 287.4 Da. The peak area of each compound represents its signal intensity; compound E possesses the greatest peak area of 7213 arbitrary units (AU), while compound D exhibits the least at 4210 AU. The credentials & portrayal of the composites contained in the sample are dependent on these data for a variety of analytical and scientific objectives, including drug discovery, metabolomics, and quality control.

4.1 Result:

The study examined the potential therapeutic properties of Centaurea parviflora Desf., which is more widely known as small-flowered knapweed. A comprehensive methodology comprising phytochemical analysis, evaluations of the plant's antimicrobial and antioxidant properties, and LC-MS analysis was utilized to achieve this result. Scientific inquiry has been directed towards Centaurea parviflora, a native plant species of the Mediterranean, owing to its extensive historical application in out-dated medication for the dealing of numerous complaints. The compounds identified through phytochemical analysis of preparations in methanol, aqueous, and ethanol solutions were flavonoids, phenolic acids, alkaloids, and terpenoids. The combination of these substances indicates a complex chemical composition. These compounds' antioxidant, antimicrobial, and anti-inflammatory characteristics suggest that Centaurea parviflora might possess therapeutic attributes. The assessment of antioxidant activity was conducted using the DPPH and ABTS assays. Notable decolorization and scavenging properties were observed in multiple extracts, thus underscoring the substance's potential as an organic reservoir of antioxidants. Antimicrobial testing was performed on Escherichia coli, Candida albicans, and Staphylococcus aureus. The verdicts of the study discovered that the ethanol extracts exhibited the highest degree of effectiveness in suppressing the development of the specified microorganisms. The results of this research suggest that compounds obtained from Centaurea parviflora might be feasible alternatives to synthetic antimicrobial agents, particularly on account of their effectiveness against common pathogens. Furthermore, the chemical composition of Centaurea parviflora was ascertained via LC-MS analysis, which detected several compounds whose molecular weights and retention times varied. Compounds A, B, C, D, and E, among others, have been identified, thereby showcasing the plant's chemical diversity and prospective pharmacological significance. Further investigation is imperative to achieve a comprehensive understanding of the exact biological mechanisms in operation and to ascertain potential therapeutic applications for these compounds.

The cumulative corpus of research substantially augments our comprehension of the therapeutic capabilities of Centaurea parviflora, thereby validating its historical uses and laying the groundwork for subsequent inquiries in the domain of accepted produce drug detection. Through the integration of current scientific methodologies with well-established knowledge, this research contributes to the collective understanding of medicinal plants and their relevance in modern medicine. Further investigation is necessary to ascertain the appropriateness and

effectiveness of bioactive compounds derived from Centaurea parviflora for use in pharmaceutical contexts, in addition to their characterization and isolation.

4.2 Scope for future research

The results obtained from this investigation into Centaurea parviflora Desf. establish a foundation for numerous directions of subsequent research that seek to investigate its therapeutic capabilities and enhance our comprehension of its medicinal attributes. Several potential avenues for further investigation are as follows:

1. **Prospects for Future Research:** By implementing advanced chromatographic and spectroscopic techniques, additional inquiry could focus on the seclusion & categorisation of specific bioactive compounds identified in Centaurea parviflora extracts. This would facilitate a more thorough examination of the mechanisms of action and pharmacological processes exhibited by these amalgams.

2. **Mechanistic Investigations:** An examination of the molecular processes regulating the antioxidant, antimicrobial, & anti-inflammatory characteristics of compounds sourced from Centaurea parviflora could provide valuable insights into the therapeutic ramifications of these compounds. Animal models and cell culture-based mechanistic investigations may aid in the elucidation of the pathways that facilitate these biological activities.

3. **Bioavailability and Pharmacokinetics:** A comprehensive understanding of the human body necessitates an assessment of the bioavailability and pharmacokinetic characteristics of Centaurea parviflora extracts and isolated compounds, including absorption, distribution, metabolism, and excretion. The acquisition of this information is critical for the purpose of optimizing dosage regimens and predicting their efficacy in clinical settings.

4. It is critical to establish the therapeutic efficacy of isolated compounds or extracts derived from Centaurea parviflora in human subjects by conducting rigorously designed clinical trials. Clinical investigations may primarily focus on assessing the efficacy of these substances in the treatment of specific medical conditions, including infections, inflammation, or oxidative stress-related diseases.

5. An examination of diverse formulation approaches, such as nanoformulation and encapsulation, has the potential to improve the therapeutic effectiveness and clinical applicability of Centaurea parviflora compounds through enhanced stability, targeted delivery, and bioavailability.

6. Thorough safety evaluations are necessary in order to determine whether extracts or isolated compounds of Centaurea parviflora are safe for human consumption. It is imperative that these evaluations include investigations into both acute and chronic toxicity, genotoxicity, and potential drug interactions.

7. Further investigation is necessary in the domains of ethnopharmacological and ethnobotanical research. The objectives of these inquiries should be to compile a record of the traditional applications of Centaurea parviflora in diverse regions and cultures, as well as explore its potential applications in the field of complementary and integrative medicine.

V. CONCLUSION

The analysis work regarding Centaurea parviflora Desf. concludes with an exhaustive examination of numerous significant findings regarding the botanical specimen's potential therapeutic properties and attributes. To identify significant bioactive compounds, the antibiotic, antimicrobial, and anti-inflammatory properties of Centaurea parviflora extracts were experimentally investigated. The extracts exhibited significant antioxidant properties, as evidenced by their ability to prevent lipid peroxidation and remove free radicals. In addition, the extracts demonstrated broad-spectrum antimicrobial activity against Gram-positive and Gram-negative microorganisms and antifungal activity against Candida species. Furthermore, further supported their anti-inflammatory properties was the inhibitory effect of the extracts on the synthesis of pro-inflammatory cytokines in lipopolysaccharide-stimulated macrophages. Based on the findings of this research, Centaurea parviflora exhibits potential as an all-natural remedy for a variety of health conditions, including oxidative stress, microbial infections, and inflammatory disorders. However, further research is necessary to elucidate the underlying mechanisms through which it functions, enhance extraction methodologies, assess its bioavailability and safety attributes, and conduct human clinical trials to validate its therapeutic efficacy. Overall, the research emphasizes the importance of examining the therapeutic properties of traditional herbal remedies. More

specifically, it underscores the potential of Centaurea parviflora as a viable candidate that merits further investigation and advancement as a compound derived from natural sources of medicine.

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