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Biological Activities of Oregano Oils

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Abstract:

Herbs and spices store a variety of phytochemicals with powerful biological and pharmacological features. Oregano essential oils are generally known for their antimicrobial activity also the anti fungal characteristic moreover antiviral properties. The compounds from the oregano oils were widely studies the biological properties which exhibit the pharmacological activities such as antihyperglycemic, anti-inflamatory,antibacterial, and antiproliferative activities.

Keywords **—Biological activities, essential oils, oregano, *Origanum vulgare* L.**

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I. INTRODUCTION

*Spinacia oleracea L.*Oregano(*Origanum vulgare* L.) is the noun that used to mention a range of plants that have a similar terms such scent and flavor(1). Oregano contains at least 61 species and 17 genera belonging to six different botanical families. Verbenaceae and Lamiaceae are the most noticeable families in the reason of their economic importance. Within the Lamiaceae family are the plants member to the genera *Origanum* and *Hedeoma*; while the genera *Lippia* and *Lantana* included to be the Verbenaceae family(2). The additional families are Rubiaceae, Apiaceae and Asteraceae. *Hedeoma patens*, *Lippiagraveolens*, *Lippiapalmeri*, *Lippia alba*, *Origanumdictamnus*, *Origanumhirtum*, *Origanumonites*, *Origanum vulgare* are some specimens of oregano species generating Eos. EOs have high impact on the pharmaceutical, food and cosmetic industries (3). Furthermore, there is evidence establishing that essential oils of oregano (EOO) might have a positive effects on human health(4). Therefore, the present document will evaluate recent investigations according to the elements of essential oils of different oregano species and their biological abilities, such as antioxidant, anti-inflammatory, anti-diabetic and antiproliferative properties(5, 6).

II. BACTERICIDAL ACTIVITY OF OREGANO OILS

The study of Lu and the team investigated the antimicrobial activity of oregano against multidrug-resistant bacteria(7). In this work, oregano oil has been tested in a wide range of MDR isolates in Gram-negative and Gram-positive bacteria. Seven Gram-negative strains have been included in this study which was four strains of *A. baumannii* (AF0004, AF0005, IQ0012, and IQ0013) and three strains of *P. aeruginosa* (AF0001, IQ0042, and IQ0046)(8, 9). Additionally, four Gram-positive MRSA strains (AF0003, IQ0064, IQ0103, and IQ0211) have been used. Also, they reported the MIC of oregano oil against two luminescent strains of PA01 and MRSA USA300, with a MIC ranging from 0.08 mg/ml to 0.64 mg/ml and indicated that oregano oil can eradicate bacterial biofilm at similar MIC values(8, 9). Moreover, Lu and the team have performed antibacterial activity of oregano oil in animal studies on third-degree burn wounds which the result showed that oregano oil can drastically reduce bacterial bioluminescence with no skin histological toxicity or genotoxicity after applying oregano oil at 10 mg/ml on the skin for three consecutive days(7, 10).

Supporting evidence by the work of Sarakaya et al. stated that Essential oils repressed the growth of *Listeria monocytogenes*, *Salmonella typhimurium*, and *Escherichia coli*.

Another work from Kosakowsky et al. has stated that antibacterial activities of Greek Oregano (*O. vulgare* L. subsp. hirtum (Link) Ietswaart) were more potent than common Oregano (*O. vulgare* L. subsp. vulgare), which showed by the lower MIC values of oregano species used in this study compared with common oregano(6).

III. ANTIOXIDANT ACTIVITY OF OREGANO OILS

Oxidative stress befalls when the pro-oxidant-antioxidant balance is shifted favouring the former, resulting in potential damage. It is frequently caused by the attack of reactive species such as hydrogen peroxide (H_2O_2), superoxide anion ($O2^{\bullet-}$), hydroxyl ($HO^{\bullet}$), peroxyl ($RO_2^{\bullet}$), and alkoxyl ($RO^{\bullet}$) radicals on the constituents of living organisms. Oxidative stress can increase cell proliferation and adaptation via risen defence system activation, DNA damage, senescence, and cell death(11). As a result, various studies have established a positive relationship between oxidative stress and the pathogenesis of various diseases, including Alzheimer's disease, Parkinson's disease, chronic inflammation, arthritis, certain types of cancer, diabetes, and atherosclerosis. Numerous phytochemicals have been investigated for their potential to act as scavengers of reactive species and their ability to neutralise oxidative stress(12). EOs are one of the targeted phytochemicals due to their anti-oxidative capacity, which is critical due to their ability to prevent oxidative damage. EOs from different oregano species have been examined to find their antioxidantactivities, and carvacrol, thymol, which were discovered in other plants and tested for their antioxidantactivities, can also be found in different oregano species. Despite this, it does not mean that their antioxidant capacities will be neutralised and their bodies protected from oxidative damage, as the differing concentrations of EOO can modify the biological activity(13). When the progeny of *O. vulgare* subsp. hirtum were supplemented with the seeds of *O. vulgare* subsp. hirtum, oxidative stress markers were reduced in their piglets, which causes severe DNA damage(5). Certain antioxidants have been shown to act as both a pro-oxidant and antioxidantactivities depending on the dose(14). More precisely, carvacrol and thymol, terpenes found in oregano, can potentially increase oxidative stress in Caco-2 cells, as these terpenes may increase the level of reactive oxygen species and decrease the content of glutathione(15, 16).

IV. ANTI-INFLAMATORY ACTIVITY OF OREGANO OILS

Tissue damage, infections, and chemical or physical agents cause the body to naturally release inflammatory agents, which helps the body respond to these problems. In the early stages of inflammation, inflammatory mediators are produced. The following are mediators that increase inflammation: cytokines, prostaglandins, enzymes, nitric oxide (NO) and reactive oxygen species (ROS), to name a few(17, 18). Inflammation may be uncontrolled if it is not brought under control, and pro-inflammatory mediators are produced in more significant amounts than would be needed to avoid pathological processes like arthritis, atherosclerosis, and cancer, to name a few. Inhibiting the mediators is a vital part of treating inflammatory diseases, thus inhibiting the mediators from treating inflammatory diseases.

Recent studies showed, for example, that the level of ROS and NON produced by RAW 264.7 macrophage cells stimulated by lipopolysaccharides was significantly decreased by terpene from three Mexican oregano species, *L. graveolens*, *L. palmeri* and *H. patens*, among other things (LPS)(19-21). In addition, EOs of O. majorana (10 µg/mL) had a suppressive effect on tumour necrosis factor-alpha (TNF-α), interleukin-1β (IL-1β) and IL-6 production in LPS-activated THP-1 human macrophage cells (22). Just recently, Han and Parker demonstrated that essential oils obtained from O. vulgarewere capable of significantly inhibiting levels of the inflammatory biomarkers monocyte chemoattractant protein-1 (MCP-1), the vascular cell adhesion molecule-1 (VCAM-1) and the intracellular cell adhesion molecule-1 (ICAM-1)

on activated-primary human neonatal fibroblasts. These findings imply that the EOOs may have anti-inflammatory properties(23, 24).

V. OREGANO OILS AND ITS EFFECTS ON CARDIOVASCULAR DISEASES

Cardiovascular diseases (CVD) are the leading cause of death in several countries and are growing globally. CVD is a chronic inflammatory disease accelerated by many factors, including smoking, diabetes, and inflammation. Atherosclerosis is the primary cause of CVD, as specific pro-inflammatory cytokines such as IL-1 and TNF- are involved in the process of leukocyte adhesion(25). The research on the anti-CVD effects of essential oils has concentrated on individual components such as carvacrol, thymol, eugenol, and -terpinene from various sources. Interestingly, these studies have demonstrated that certain EOs can help reduce total plasma cholesterol and triglyceride levels, both of which contribute to the development of atherosclerosis.On the other hand, research utilising essential oil extracts from herbs such as oregano is limited(26, 27). While most studies have concentrated on the potential beneficial effects of individual EOs or combinations of them, it is worth noting that some efforts have been made to investigate the bioactive properties of EOs from various oregano species. Several of the most well-known studies to date have reported on the anti-inflammatory properties of various species of oregano(28). There was a study used oxidised LDLs to activate THP-1 macrophages, which were then treated with EOO from O. vulgare, the main components of which were sabinene hydrate, thymol, and carvacrol. The authors observed a decrease in the production of pro-inflammatory cytokines TNF-, IL-1, and IL-6, but an increase in the production of anti-inflammatory cytokine IL-10. These findings are significant because they suggest that oregano essential oils could be used in innovative treatments for chronic inflammatory diseases like atherosclerosis. Due to a dearth of studies, the mechanism of action of EOO on their effect on cardiovascular health is unknown. However, some studiessuggest that EOs such as carvacrol may have antihypertensive properties by acting as hypotensive agents via vasodilation caused by the inhibition of Ca^{2+} influx through Cav and TRP channels(27, 29). TRP canals are in this respect a superfamily of receptors that are proposed to participate in the development of heart hypertrophy, cardiac insufficiency, cardiac arrhythmias, vascular remodelling and lung hypertension. Most people will suffer from some form of hypertension during their lifetime, which is considered a serious risk factor for morbidity and mortality. Among the numerous factors contributing to the pathophysiology of hypertension are changed in cellular cations such as sodium (Na^{+}), calcium (Ca^{2+}), potassium (K^{+}), and magnesium (Mg^{2+}), all of which have been shown to elevate systolic blood pressure. While EOs have demonstrated modulatory properties on various ion channels, research on oregano EOs is limited(30, 31).

VI. OREGANO OILS AND ITS EFFECTSON METABOLIC SYNDROMES

Obesity and metabolic syndrome are major health problems that are prevalent worldwide. Obesity is the fundamental and causative component in metabolic syndromes due to an energy imbalance leading to insulin resistance and type 2 diabetes. Metabolic syndrome is characterised by diabetes and raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood glucose. Even though proper diet and exercise effectively prevent metabolic syndrome, patients are also prescribed drugs to control the medical complications of the syndrome, including elevated fasting plasma glucose, insulin resistance, and type 2 diabetes. Among the most common drugs used are metformin, a well-known AMPK activator, and the inhibitors of α-glucosidase and α-amylase, the main enzymes that mediate carbohydrate metabolism. Nevertheless, side effects like abdominal discomfort are sometimes caused by natural compounds, so researchers seek new, non-toxic alternatives. Research has been done on the anti-diabetic properties of numerous phytochemicals, including polyphenols and EOs. Research has primarily focused on the hypoglycemic effect of polyphenols, but the

possibility of inhibitory activity has often been overlooked.

Nonetheless, a few studies have suggested that numerous plant-derived EOs may help improve metabolic syndrome factors. Many herbs continue to be used in folk medicine in some developing countries as primary health care for people with diabetes. Moreover, some species of oregano are being studied as hypoglycemic therapeutic agents.

Some studies in plants belonging to the Lamiaceae family suggest that the mode of action of EOs varies depending on the EOO's main components.

VII. CYTOTOXIC ACTIVITY OF OREGANO OILS

Essential oil constituents could exert antiproliferative effect. Different mechanisms such antioxidant, antimutagenic, antiproliferative, among others are responsible for their chemopreventive properties(32). The antiproliferative effects of EOs have been demonstrated in diverse cancer cell models through several pathways(33). The antiproliferative activity of EOs of *Origanum* species at 100 µg/mL concentration, EOs derived from *O. dictamnus* showed the most interesting biological activity with an inhibition on colon carcinoma cell line (LoVo) of 58.39% after 24 h(34). Additionally, the IC50 value for this essential oil was 84.76 µg/mL after 24 h and 72.26 µg/mL after 48 h of treatment. In the same study, it was reported that the EOs from *O. dictamnus* and *O. libanoticum* had an antiproliferative activity of 49.83% and 48.50% in the hepatocarcinoma cell line (HepG2) at 100 µg/mL concentration. In addition, EOs from *O. vulgare* inhibit cell proliferation in human breast adenocarcinoma (MCF-7), and human colon adenocarcinoma (HT-29) cells at 50 mg/mL (60.8% and 48.9%, respectively).However, an increase in the EOO concentration did not increase the cell growth inhibition. The authors implied that the effect could be attributed to the main components (terpinen-4-ol, thymol, γ-terpinene and carvacrol)(35). Besides, EOs of *O. hirtum* significantly reduced the proliferation of human lung adenocarcinoma epithelial (A549) cell line, after 24 h incubation, compared with untreated control cells(36). Furthermore, it was suggested that the EOO modifies the onset of mitosis, possibly prior to the G2 phase and prophase.Many evidences have shown that EOO had antitumor effect. EOO have shown antitumor activity both in in vivo and in vitro assays. An in vivo study reported that low doses of EOO in a three-month period exerted preventive action by decreasing the sizes of tumors by 1.5 times in diseased animals. It was suggested that the EOO could possible affect the development and progression of the tumor process via the activation of regulator cell molecules. The in vitro antitumor activity of EOs of *O. onites*, was analyzed against rat adipose tissue endothelial cells and c-H-ras transformed rat embryonic fibroblasts (5RP7) cells. EOO at 125, 250 and 500 µg/mL resulted in significant inhibition of cell viability(37). In addition, EOO induced apoptosis of 5RP7 cells and blocked in vitro tube formation which accounts for its angiogenic activity(38, 39).Besides, EOO have shown activity against genotoxic agents, which are capable of altering DNA and thereby causing cancer or mutation. The effects of AFB1 (5 µM), a cancer promotor, on human peripheral lymphocytes, were decreased after treatment with EOs of *O. rotundifolium* (1.5 µL and 2.0 µL). This activity could be attributed in part to the EO composition and its antioxidant capacity. Similarly, the combined treatment of prallethrin and EOs from *O. majorana* in bone marrow cells of rats, resulted in the reduction of the chromosomal aberration (54.54%), thus, EOO demonstrated to have genotoxic effect. The effects could be attributed to the scavenge ability of EOO and its contribution in hindering lipid peroxidation(39-41).

CONCLUSIONS

To conclude, this review aims to educate readers about the therapeutic applications of essential oils derived from multiple oregano species. Numerous studies cited in this manuscript may be considered by those interested in discovering new components or natural drugs that can be used to treat or prevent various serious diseases affecting the world, such as diabetes and cancer. Despite the numerous benefits of oregano essential oils, it has been reported that they can have adverse effects. As a result, pre-

clinical studies are required to ensure the safety of these compounds when used in humans. Similarly, administration strategies for such compounds should be investigated in order to maximise their effect.

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