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Biological Activities of *Spinacia oleracea* L.

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Abstract:

As the evolution process of microbes continues to attempt to render our antibiotics obsolete, cancer plagues the unfortunate of our population, and the well being of citizens decline, the scientific community has come up with the super food which has the effect of all 3 of the ailments listed above. The Spinacia oleracea L. (Spinach) has been reported to have antimicrobial activities, antioxidant activities and anticancer activities along with its other perks such as antiproliferative, central nervous system depressant, antihistaminic, and protection against gamma radiation. This literature review aims to highlight the biological activities that can be beneficial for anyone by compiling and analysing its findings.

Keywords **—Antimicrobial activity, anti-oxidantion, anticancer, *Spinacia oleracea* L.,**

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I. INTRODUCTION

Spinacia oleracea L. or Spinach is a leafy green vegetable plant which can be grown in the spring and autumn, yielding a lot in a short time (1). It belongs to the family Chenopodiaceae and is native to Central Asia and Persia (Iran) (2). Spinach produces Leaves annually while it's seeds are produced biennially (1). It can also be divided into two subspecies: ssp. *Glabra*and ssp. *Spinosa*(3). Several types of vitamins and minerals can also be found inside Spinach such as Vitamin a (Lutein), Vitamin c, Vitamin e, Vitamin k, magnesium, manganese, folate, and iron (4). Aside from having a great nutritional value, Spinach is also linked to various biological activities, eg: being a virus inhibitor, anthelmintic, antioxidant, hepatoprotective, and reducing the risks for several forms of cancer. The aim of this review is to highlight the biological activities of *S. oleracea L.* regarding its nutritional value, antioxidants, and anticancer properties (5, 6). This review aims to highlight the biological activities of *S. oleracea* L. and points out the benefit of *S. oleracea* regarding medical purposes.

II OVERVIEW OF*Spinacia oleracea L.*

S. oleracea is a consumable angiosperm plant from the family of Amaranthaceae. Standing at heights of up to 30 cm, it has the resilience to survive over winters within temperate regions (7, 8). The larger leaves are usually around the base of the plants and get smaller the more you move up the spinach's stem (7). The locations of the leaves along the spinach's stem are alternated on each side of the stem while its leaves have an ovate, triangular shape. The leaves can grow up to 30 centimeters long and can grow as broad as 15 centimeters(7). Its flowers are low profiled yellowish white buds at the size of 3-4 mm and mature into small clusters of seeds spanning from 5-10 mm (1). Being high in Magnesium, Iron, Folate, Manganese, and vitamins C, K, and A, Spinach is high in nutritional value (9-12). These biochemical resources are what makes it of great pharmacological and medical importance (13). The natural compounds inside leafy green vegetables are also good for reducing risks for diabetes, cancer and hepatotoxicity, as well as protecting against oxidative stress, eye disorders, iron deficiencies (14-18).

S. oleracea has been used since ancient times as a source for food since it contains many useful nutrients and minerals essential to maintaining good human vitality (19). Spinach can also be very useful in modern times as a great food source for developing countries especially in times where the world population is still increasing quickly, the increasing demand of food may be a big challenge (19). Spinach can supply many countries with the nutrients that it needs and combat malnutrition (20, 21). Leafy green vegetables can act as great sources of energy being producers themselves (21). They can supply nutrients and micronutrients essential for good vitality. For example, antioxidant activity (22). Some of the vegetables are also reported to be able to relieve more than one ailment while passively recuperating the human well being and health in other areas (19-21). Some of the diseases that these fruits and vegetables can prevent include cardiovascular diseases for example heart attack, high blood pressure, and stroke (23-25). These chemicals inside Fruits and vegetables carry out their functions of protecting us by combining with minerals and vitamins.Phytochemicals which help a human thrive originates from a fruit or vegetable's feature for preventing itself from getting the disease. This can cause the fruit to have a specific color, smell, or flavour. Phytochemicals are non-nutrient compounds inside Vegetables, fruits, grains and have been linked to the reduction of major degenerative diseases in humans (4). So, the capacities of local vegetables need to be evaluated concerning its nutrients and its phytochemicals which will greatly assist nutritionists, food processors, dieticians, and consumers about what they should be eating. Plants which have medical attributes are being used locally to cure infections caused by viruses, bacteria, parasites and fungi (4, 26-29). Many people living in Nigeria have been relying on their own traditional means of treating their diseases ever since ancient times (30-32). Plants have been the starting point of many modern medicines whether it would be in its extract form, or its pure form.

III ANTIMICROBIAL ACTIVITIES

S. oleracea leaf extracts were examined by the random amplification of polymorphic (bacterial) DNA (RAPD) and scanning electron microscopy (SEM) to determine the effects on Gram-negative and Gram-positive bacteria models (33). The best conditions for extraction were 45 °C, 44 per cent ultrasound power, and a 23-minute extraction time (33). The leaf extract of Spinach was antimicrobial to both bacteria, with minimum inhibitory concentrations (MICs) from 60 mg/ml to 100 mg/ml (33). Analysis by SEM revealed that the treated bacterias were damaged, and decreasing in number. Analysis by RAPD of DNA showed that treatments dwindled both the number and size of amplicons. Upon these findings, Spinach leaf extract was concluded to exert bactericidal activity by promoting DNA mutations and destroying cell walls (33). In comparison to controls, extract preparation under ideal circumstances improved antibacterial activity and increased the area of inhibition zones of growth for the treated bacteria (non-treated bacteria). Bacteria cells treated with Spinach (*S. oleracea*) leaf extract were revealed by SEM image to be reduced in the number of viable bacteria cells. Additionally, *E. coli* and *S. aureus* strains treated with spinach extract can be gauged by using DNA polymorphism detected by RAPD as a Biomarker (34, 35). Previously in two separate studies, extracts from Rhazyastricta leaves, and Conocarpus erectus had demonstrated similar results (36, 37). This indicated that ultrasonicated spinach extracts can both treat and combat bacteria that include both Gram-positive and Gram-negative organisms like *E. coli* and *S. aureus* (36, 37). Iqbal et al. researched antimicrobial properties of n-hexane, sonicated n-hexane, aqueous, and ethanolic extracts of Spoiled and fresh Spinach and discovered through agar disc diffusion testing that both the spoiled and fresh *S. oleracea* extracts exhibit activity against several mammalian pathogens (38). *E. coli, Salmonella typhimurium, S. aureus, Pasteurella multocida, Klebsiella pneumoniae, Staphylococcus epidermidis, Micrococcus luteus, Proteous vulgaris,* and *Lactobacillus bulgaricus* were the most frequently encountered mammalian bacterial strains tested for antimicrobial activity (38). All pathogens tested, except *S. typhimurium*, were inhibited by aqueous extracts of spoiled and fresh spinach (38). Adapa and the team determined the minimum concentration of ethanolic and aqueous extracts of spinach in opposition to *Lactobacillus* and *Streptococcus mutans*. They reported that the MIC of the ethanolic extract of spinach was 25 µg/ml for *Lactobacillus* and 12.5 µg/ml for *S. mutans*. In addition, the ethanolic extract showed more significant bacteriostatic activity toward *S. mutans(39)*. Furthermore, *in vitro* antimicrobial activity was demonstrated by the extracts from cooked and uncooked leaves of *S. oleracea* were tested against *S. aureus.* The zone of inhibition between cooked and uncooked *S. oleracea* leaves was similar at 75 and 100 mg/ml (40).

IV ANTIOXIDANT ACTIVITY

The antioxidant activity of *S. oleracea* green leaves exhibited antioxidant capacity performing via several assays including reducing power assay and superoxide anion scavenging activity (40-43). The DPPH radical scavenging activity of uncooked and cooked leaves is given in milligrammes per gramme (mg/g) and is calculated using the equation in 2.7. Cooked and uncooked leaf methanol extracts demonstrate antioxidant activity (40). Since a hydrogen atom, or an electron was transferred, the reduction of DPPH was witnessed. Because of their ability to donate hydrogen, phenol compounds are also excellent antioxidants (44). Antioxidants are found in plants in flavonoids, phenol acids, and tocopherols (45). The decrease of a chemical reaction by the addition of DPPH was utilized to determine the reaction's radical nature. Due to its high absorption capacity, the DPPH radical has a dark violet colour while acting as solute and degrades to colourless (Clear solution) or light yellow when neutralised (40). These activities are beneficial for disease treatment and drug extraction from spinach leaves.

V ANTICANCER ACTIVITY

Research showed that phenolic compounds can hinder the growth of cancerous tumours and have a range of other therapeutic properties, including antifungal, antiviral, anti-inflammatory, antispasmodic, and anti-diarrheic (14, 46, 47). Because of its high levels of phenolic acids, flavonoids, and pigments such as chlorophyll and lutein, it is thought that Soleracea is high in antioxidants, such as tocopherols (48). Many bioactive compounds are found in spinach, like MGDG, DGDG, and SQDG, all located in the chloroplast membrane. It has been demonstrated that MGDG and SQDG have an inhibitory effect on mammalian DNA polymerases, but DGDG does not (49). The tumour growth, angiogenesis, and blood vessel development inhibitors found in these glycoglycerolipids were shown to target cancer cells, endothelial cells, and tumour growth via the inhibition of replicative DNA polymerase activities. Glycolipids from subspecies of spinach were influential in developing cancer-fighting foods in research done by Kuriyama et al (49).

Anather study, which studied spinach ethanol extract (SE), the three hydrophobic column chromatography fractions, and DNA polymerase activity, demonstrated that these three compounds inhibited calf DNA polymerase (pol) (50). Glycoglycerolipids in spinach completely hindered the activity of pol α at a concentration of 43.0µg/ml (50). Fat-soluble glycoglycerolipids were less potent at this concentration and had no additional effect on pol α activity. Water-soluble glycoglycerolipids were not observed to affect pol α. However, the extract from spinach does not affect pol α (50). This is because the extract contains a pol-inhibitory glycolipid, a glycolipid that acts as a pol inhibitor (50). Following these experiments, it was found that the spinach glycoglycerolipids fraction could hamper mammalian pol activity, human cultured cancer cell growth, and in vivo solid tumour proliferation when administered orally. This fraction may contribute to helping stave off cancer and might also be a preventative food with anticancer properties.

CONCLUSIONS

Spinach (*S. oleracea L.*) is a goosefoot-family leafy green vegetable. Numerous pharmacological activities of *S. oleracea* have been reported, including antioxidantion, anti-bacterial activity, and anticancer. This plant has been reported to contain various secondary metabolites. Thus, *S. oleracea*warrants additional phytochemical, pharmacological, and clinical studies to develop an effective natural remedy capable of providing therapeutically effective lead compounds or extracts.

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