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The Role of Ascorbic Acid on the Antioxidants of Flax (*Linum usitatissimum* L) Grown and the Economic and Pharmacological Importance in Iraq

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ABSTRACT

Various surveys were conducted for many researchers regarding the flax crop in Iraq and countries with similar environmental conditions, its economic and medical importance, and the effect of ascorbic acid on the flax plant. It leads to an increase in the absorption of nutrients, which in turn increases the economic yield, medicinal compounds, and the percentage of oil in the seeds, as well as vitamin C, phenols, flavonoids, and total tannins in the seeds, and increases the plant's tolerance to harsh environmental conditions. Also, the use of this acid increased by spraying it on the vegetative body of the plant because it is one of the antioxidant substances that leads to encouraging vegetative and fruiting growth, and its effect on plant growth is similar to the effect of growth regulators that encourage plant growth and also reduce stress resulting from temperatures and toxins, as well as lead to increased secretion of organic acids From the roots to the soil, which leads to an increase in most nutrients, which are released slowly and absorbed by plants, and its role also in protecting cells from the harmful effect of temperature and light oxidation and stimulating cell division.

Keywords*:* Flax, Medicinal plant, Oils, Antioxidants, Linumu *sitatissimum*, Ascorbic.

INTRODUCTION

Linum *sitatissimum* L. flax is an annual or perennial plant belonging to the Linaceae family. It is cultivated for two purposes, first to produce fiber from the stems and second to produce oil from the seeds. The original home of flax is the temperate regions of the Arab East, Europe, and Asia. It is currently cultivated all over the world for its fiber, seeds, and oil.

Flax has been cultivated for at least 7,000 years in the Middle East and has been included in human and animal diets as well as in industry. Flaxseed is used as a source of oil and as a basic or added ingredient for various paints. Flax oil is also rich in unsaturated fatty acids, and its seeds are an important source of fiber and protein, rich in phenolic compounds responsible for their antioxidant activities, and a major source of antioxidants, including flavonoids. Flaxseeds are oily (40% oil) and are high in omega-3s, which are known to have cholesterol-lowering benefits (Rubilar *et al.*, 2010). The root is characterized as a branched peg in the surface layer of the soil, at a depth that varies from 25-40 cm, depending on the cultivar and soil type. The stem is smooth and green in color, and at maturity, it becomes yellow, flexible, and branches at the top, and its height ranges between 30-120 cm. Two or more branches may develop from one plant. It consists of the original stem directly above the soil surface, and is shorter in the seed varieties. The number of branches is related to the plant density, as the number of stems increases branching the lower the plant density, the branching in the oily varieties is close to the soil surface. The leaves are small, seated, simple, lanceolate, and the oily varieties bear a greater number of leaves compared to the fibrous varieties. The flowers are regular, five-membered hermaphrodites, and their color varies according to the cultivar, from white to blue or purple. The stamens fuse their threads at the base, and the ovary consists of five true lodgings, each containing two ovules. The pollination is usually self and the flowers bloom in the early morning. If cross-pollination occurs, it ranges between 23%. Insects are the most important factor in determining their proportion, and usually, the flowering system is unlimited, as the flowering stage lasts about 3-4 weeks without interruption. The fruit is a box (capsule) with five real housings, and it is flowers and seeds in general. The period of growth of oil flax is longer than the period of growth of oil flax. Linen fibers (Tayfour and Rashid, 1990; Kiryluk and Kostecka, 2020). The seeds are flattened and oval, and they have a smooth, glossy surface covered with a gelatinous substance that turns slimy when heated. It ranges between 5-6% of the weight of the seed or the gum present in the outer layers of the seeds. It also contains many monosaccharides such as xylose, arabinose, lactose (Rhamnose, and Glucose, 2009). Flaxseeds contain tannins, which are one of the types of phenols and are formed as a result of secondary metabolism processes that act as defense substances in the plant against insect infestations and increase the plant’s tolerance to environmental stresses (AlHasanin, 2009). Ripe seeds contain 30-40% oil and retain their viability for 510 years if stored in dry conditions. The longer the storage period, the lower its viability. The color of crude flaxseed oil is dark yellow and has a special smell. Among the most important cultivars cultivated in Iraq to produse seeds and oil are Marrakech 10, Marrakesh 50, Giza 4 and the Indian cultivar that entered Iraq in 1957 and whose seeds contain 46% of oil (Al-Sayed, 1980). In recent years, many studies have focused on the role of ascorbic acid ($C_6H_8O_6$) in improving the growth and production of many crops, as it is one of the organic acids that have an oxidative role in the plant. As it is one of the most antioxidants that have been discovered in most types of plant cells and organelles in the plant cell and has been studied extensively (Borland *et al.*, 2006), the basis for the action of this acid is to reduce and scavenge many types of free radicals of oxygen (ROS) Ascorbic acid interacts with the free molecules of oxygen and hydrogen peroxide and prevents their interference in the structural reactions of the cell and harming it (Pourcel *et al.*, 2007). The aim if this study was the review of the role of ascorbic acid on the antioxidants of flax crop Grown in Iraq in relation to economic and pharmacological importance.

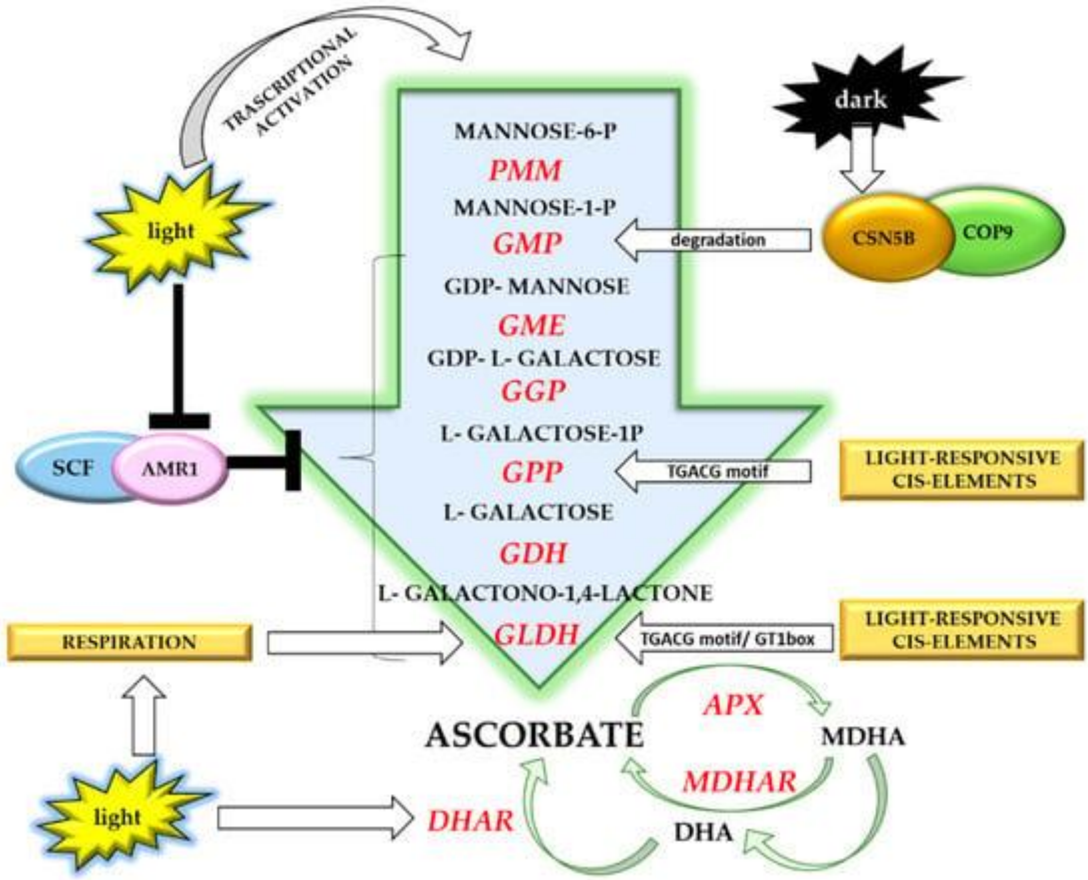

Figure 1. Light-dependent mechanisms involved in vitamin C accumulation (details are provided in the text). Abbreviations: PMM, phosphomannose mutase; GMP, GDP-D-mannose pyrophosphorylase; GME, GDP-D-mannose epimerase; GGP, GDP-L-galactose-phosphorylase; GPP, L-galactose-1-phosphate phosphatase; GDH, L-galactose dehydrogenase; GLDH, L-galactono-1,4-lactone dehydrogenase; APX, ascorbate peroxidase; MDHA, monodehydroascorbate; MDHAR monodehydroascorbate reductase; DHA, dehydroascorbate; DHAR, dehydroascorbate reductase (Paciolla *et al.*, 2019).

Economic importance

Flax as a fiber crop ranks third after cotton and jute in terms of global production, and as an oil crop ranks sixth. Flax oil is used in the manufacture of types of fatty dyes, and it is also used in the manufacture of dyes due to its quick drying, and for this reason 80% of its production is consumed in the world in the manufacture of dyes, in coating and polishing the floors of buildings and in obtaining vegetable wax. Livestock (after grinding) because it contains a high percentage of protein and fattening poultry (Ali and AlAnsari, 1980; Tayfour and Rashid, 1990). It is also used in the manufacture of soft soap (Vaisey-Genser and Morris, 2001). The seed gel is important in fixing ice cream, spices, salads, and a foam stabilizer in eggs. It is also used in preparing Fiberwate in making tea, coffee, and juices. It is also used in the manufacture of sweets and jelly for the texture of the gel that makes the texture thick, and in improving the quality of bread and increasing its storage period, i.e. it is used as an improver in the food industry (Kishk *et al.,* 2011). The cake is used in the manufacture of Cigarettes because it contains phosphorus and calcium, and its stems are used in the manufacture of cartons, and from its waste is the manufacture of pressed boards (Tayfour and Rashid, 1990).

Figure 2. A schematic diagram from the flax field to flax applications (Saleem *et al.*, 2020).

Pharmacological importance

Flaxseeds are distinguished by their presence in mucilage, as the industrial side has increased interest in flaxseed gel due to its nutritional and medicinal importance, as it works to lower blood sugar levels and reduce the risk of coronary heart disease (Oomah and Mazza, 1995). Phenols are important in lowering cholesterol in the blood, stimulating the body's immunity, antifungal, bacterial and viral diseases, and treating high blood pressure (Fuleki and Ricardo, 1997). Bagchi *et al.*, 2000), and increase the effectiveness of estrogen (Yanagida *et al*., 2000). Flax oil contains vitamins (A, B, and D), minerals, amino acids, and is rich in unsaturated fatty acids, which are essential for humans (Lukaszewicz et al. 2004). The seeds contain anti-cancer lignans and fiber, and these substances are useful in reducing cholesterol, reducing weight and diabetes, as well as treating liver diseases (Choo *et al*., 2007). Flaxseed lignans reduce the risk of breast and prostate cancer (Lin et al., 2002; Boccardo *et al*., 2004). Seeds are a major source of antioxidants, including flavonoids (Rubilar *et al.,* 2010). Flavonoids have anti-inflammatory and anti-disease efficacy. The seeds are oily, with a high percentage of Omega 3, 22% protein and 4% minerals. Flaxseeds are an important source of fiber and protein, constituting 30% and 20% of the weight of the seeds, respectively, and are rich in phenolic compounds responsible for their antioxidant activities (Omar et al., 2010). Taking one gram of omega-3 per day reduces the incidence of cardiovascular disease and death by heart attack (Okuyama *et al.*, 2007). The gelatinous substance contained in the seeds is effective in treating chronic constipation and stomach irritation, and flax oil is used externally as an effective antibacterial in case of burns (Wasim, 2011). Thompson and others (2003) mentioned that plant breeders developed flaxseeds with combinations of Alpha-linolenic acid up to 70%. Epidemiological studies indicate that long-term consumption of diets rich in plant polyphenols protects against the development of cancers, cardiovascular diseases, diabetes, osteoporosis, and diseases of the nervous system (Khalloufi *et al.*, 2008). Nutritionists search for food sources rich in polyphenols. Polyphenols are a group of chemicals common in plants. They are structurally characterized by the presence of one or more phenolic units. Polyphenols are the most abundant antioxidants in the human diet. These substances are a component of flaxseed (Rubilar *et al.*, 2010). The tannins present in the seeds act as astringents in the intestines for the treatment of diarrhea in humans and as a treatment for wound bleeding, as they speed up blood clotting and as disinfectants that kill microorganisms and reduce food poisoning resulting from eating alkaloids. They also work to prevent food spoilage and decomposition (Al-Hasanin, 2009).

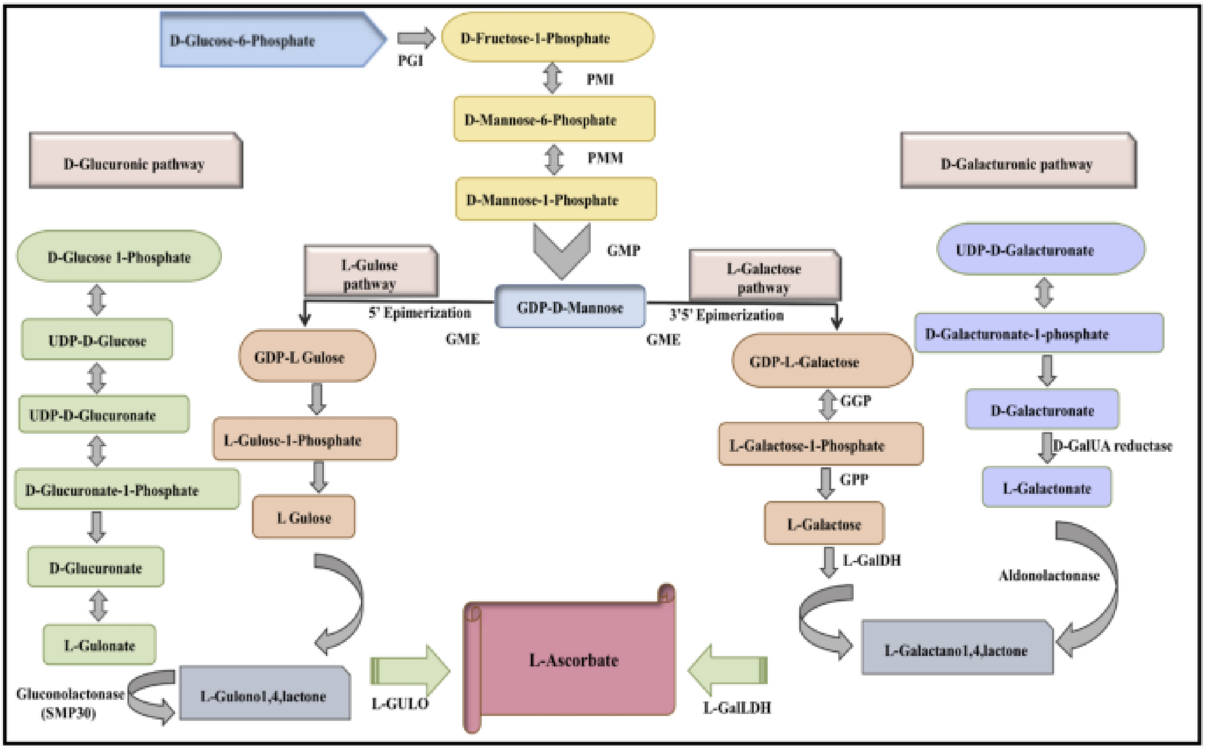

Figure 3. Pictorial representation of four different pathways for L-ascorbate biosynthesis in plants. These are the L-galactose or Smirnoff-wheeler (SW) pathway, L-gulose pathway, D-glucuronic pathway/ MIOX pathway and D-galacturonic pathway (Chaturvedi *et al.*, 2022).

MATERIALS AND METHODS

Before plowing the land, the field is cleaned from the remnants of the previous crop and the weeds to avoid the allelopathic effects of the residues on the subsequent crop (Lahmod, 2012), and then the field is trampled to get rid of the weeds and the soil is moistened before the plowing process. After the soil moisture reached about 50-60%, the plowing process was carried out using the inverter cultivator at a depth of 25-30 cm. The field was left to be exposed to the sun's rays and the soil was completely dry for a week, after which the smoothing process was done with the rotary plow and leveling with the leveling machine (the two modifiers), and then the land was leveled and the field was divided.

RESULTS AND DISCUSSION

The effect of adding ascorbic acid

Ascorbic acid is one of the types of antioxidants that scavenge free oxygen radicals. The cell is like other living things. It is known that ascorbic acid or vitamin (C) works to eliminate the toxicity of electronic ions of oxygen and hydroxyl and works to protect oxidative reactions in the cell (Robinson, 1973). Ascorbic acid is involved in the electron transport system and protects chloroplasts from oxidation (Ahmed *et al.,* 1997). The use of ascorbic acid has recently increased as a spray on shoots for its role in encouraging vegetative growth and increasing economic yield, and it has an effect similar to that of growth regulators (Athar *et al.,* 2008). It also performs several functions in the internal tissues of the plant, including reducing the effect resulting from higher or lower temperatures than the normal range of the plant and toxins, stimulating photosynthesis and respiration, and increasing the effectiveness of most enzymes (Palaniswamy *et al.,* 2003). Between ELAfry and others (2018) when planting flax in Egypt, spraying ascorbic acid is important in increasing the process of photosynthesis, which in turn increases yield and makes flax more tolerant to environmental conditions. Ascorbic acid affects various vital processes, as it activates the process of growth and construction through its work as an enzyme co-enzyme for several enzymes responsible for building carbohydrates and proteins and regulating the work of division and expansion of cells (Blokhina *et al.,* 2003), and it is also possible that spraying with ascorbic may increase chlorophyll in leaves resulting from Increasing the growth and activity of the various organs in the plant, including the roots, and this will increase the absorption of large amounts of nutrients necessary for plant growth, especially nitrogen, which increases the formation of chlorophyll.

Effect of spraying with ascorbic acid on vegetative growth, yield, its components and antioxidants

EL-Gamal, (2005) reported that the highest plant height, number of leaves per plant, number of branches per plant, and weight per plant were recorded when spraying 300 mg L-1 of ascorbic acid.

Emam *et al.*, (2011) when growing flax in Egypt during the growing seasons 2007/2008 and 2008/2009 noticed that spraying flax with ascorbic acid at a concentration of 88 mg L-1 increased the number of capsules per plant, the number of seeds per capsule, and the seed yield per plant, and Weight of 1000 seeds and productivity per unit area compared to plants not treated with ascorbic acid. Also, plants treated with ascorbic acid at a concentration of 88 mg L-1 led to a significant increase in the seed content of vitamin C and total phenols in seeds, the percentage of oil in seeds and oil yield per unit area compared to those that not treated with ascorbic acid. Nassar, (2013) reported in Egypt that when spraying mash plants with ascorbic acid, the treatment exceeded 450 mg L-1 in stem diameter.

El-Bassiouny and Sadak, (2015) when planting flax crops in Egypt for the two agricultural seasons 2011/2012 and 2012/2013 found that spraying plants with ascorbic acid at a concentration of 400 mg L-1 is likely to increase the concentration of antioxidants and plant tolerance to harsh environmental conditions. Compared to those plants that were not sprayed with ascorbic acid in the plant. Nassar *et al.*, (2016) in Egypt, when planted flax plants in the two seasons 2013/2014 and 2014/2015, and treated flax plants with five spray concentrations of ascorbic acid (0, 150, 300, 450, and 600 mg L-1) found that the plants treated with a concentration of 450 mg L-1 were superior In each of the diameter of the main stem at the soil surface level reached 2.57 mm, the height of the plant when flowering reached 107.2 cm, and the height of the effective plant reached 132.2 cm compared to other treatments. The plant reached 17.23 capsules, the number of seeds in the capsule reached 9.13 seeds, the yield per plant of seeds reached 1.309 g, the seed yield per *feddan* amounted to 726.94 kg, the percentage of oil in the seeds amounted to 41.4%, and the productivity of a *feddan* of oil amounted to 300.95 kg compared to other spraying treatments.

El-Shafey and Hassan, (2016) concluded in Egypt when planting flax in two seasons 2012/2013 and 2013/2014, spraying ascorbic acid at concentrations of 0, 50 and 100 mg L-1 significantly outperformed the treatment of spraying 100 mg L-1 in both plant heights. Flowering stage 20.65 and 20.45, the number of main branches 5.7 and 5.8 branches, the biological yield, the amount of fiber produced per *feddan*, the content of leaves of chlorophyll 22.2 and 24.8, the number of capsules per plant 21.85 and 23.4 capsules, the number of seeds per capsule 6.66 and 6.7 seeds, the weight of 1000 seeds 10.04 and 10.74 grams, and the yield One plant of seeds was 1.34 and 1.37 gm, the productivity of a *feddan* of seeds was 475.87 and 506.88 kg of *feddan*, the biological yield was 4.09 and 4.20 tons of *feddan*, and the percentage of oil in the seeds was 39.87 and 39.04% for both seasons, respectively, compared to not spraying ascorbic, where the lowest averages were recorded.

The results of EL-Afry *et al.*, (2018) when growing flax in Egypt for the two seasons 2015/2016 and 2016/2017, when spraying flax with three concentrations of ascorbic acid (0, 200 and 400) mg L-1, showed a significant increase when spraying at a concentration of 400 mg L. -1 in each of the heights reached 102.54 and 109.17 cm and the total leaf content of chlorophyll 29 and 30.47 and a significant increase in the diameter of the main stem and the yield of one plant of seeds 1.321 and 1.567 g for both growing seasons without spraying ascorbic acid Al-Mahmoud *et al*., (2018) when planting flax for the two agricultural seasons 2015/2016 and 2016/2017 in Basra Governorate / Iraq and treating flax with ascorbic at a concentration of 400 mg L-1 and not spraying ascorbic on the plant, noticed an increase in plant height, as it recorded 68.7 cm for the second growing season. Compared to not spraying in both seasons, as well as for yield and its components, spraying was superior in each of the numbers of capsules per plant 46.6 capsules for the second agricultural season, the number of seeds per capsule 8.66 seeds for the second agricultural season, and the weight of 1000 seeds was 7.17 gm for the second agricultural season, and the yield per plant of oil in seeds 1.015 and 0.808 gm for both seasons compared to not spraying ascorbic acid. The percentage of oil in the seeds was significantly superior to the treatment of not spraying ascorbic acid for the second agricultural season over spraying ascorbic acid at a concentration of 400 mg L-1. Also, regarding the percentage of active substances in the seeds, the results showed Significant superiority of the treatment of ascorbic acid spraying at a concentration of 400 mg L-1 in the number of flavonoids in leaves and seeds per plant compared to not spraying ascorbic acid for both seasons. Also, results appeared when planting flax in Iraq for the agricultural season (2019-2020) when flax was sprayed with three concentrations (0-200400) mg per liter, a significant increase when spraying at a concentration of 400 mg liter in both plant height, number of cans per plant, and plant yield of seeds, seed yield per hectare, biological yield, oil yield per hectare, the concentration of antioxidants, phenols in seeds, and antioxidant concentration (Duaa *et al*., 2020).

CONCLUSION

1-According to what was mentioned above, the best added amount of ascorbic acid ranges between 300-400 mg per liter and agrees with this (EL-Gamal, 2005; El-Bassiouny and Sadak, 2015; El-Afry et al., 2018).

2- It is preferable to spray ascorbic acid on the shoots.

3- Encouraging the cultivation of this plant in Iraq because of its nutritional value and important medical benefits.

4- We recommend conducting several studies on this plant to determine the best yield of seeds and oil and its effective components by introducing other variable factors.

5- Conducting more clinical studies on the importance of this plant from a medical point of view.

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