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ECOLOGY, BIOLOGY AND IMPORTANCE OF WILD SAFFLOWER (*CARTHAMUS OXYACANTHA* (M. Bieb).

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Abstract

Weeds are problematic or a resource; it depends on how they are recognized by mankind. Some weeds are medicinally important and also play a vital role in maintaining biodiversity, which needs to be explored for their services in the ecosystem. The basic needs of humans are food, fuel, medicine, fiber etc. all of these are ever provided by the plants since the birth and evolution. Pakistan is rich in medicinal flora, having traditional systems of medicine, a large proportion of the area is dependent on these medicinal plants. About 10% of the global plant diversity exists in Pakistan. The present review describes the biology, ecology, medicinal properties and potential utilization of wild safflower (*Carthamus oxyacantha* M. Bieb). Wild safflower belongs to the family Asteraceae, grow as wild with the ability to survive in dry and stress conditions. It is an annual bushy and thorny plant mainly found in Southern regions of Pakistan. The plant bears yellow flowers which attract pollinators and plays a significant role in biodiversity. At younger stages, people often use this plant as animal fodder, while its seeds are favorite food of birds particularly doves. This plant makes harvesting wheat difficult due to presence of thorns. Seeds are rich sources of vitamin A, phosphorus, iron, protein, sugars, calcium, magnesium, and potassium. It can be used as manure, seed-oil in cooking and a nutritious feed for livestock. The plant decreases the risk of degenerative diseases having a protective effect against oxidative stress. It contains numerous organic compounds that are pharmacologically active such as glycosides, flavonoids, and essential oils, and has potential, hepatoprotective, anticancer, neuroprotective, antihyperlipidemic antimicrobial properties. The oil content of *C. oxycantha* has potential application for biodiesel production. Considering its unique ecological adaptation, medicinal properties and potential for biodiesel production, proper domestication and conservation measures are needed for its commercialization.

Key words: Wild safflower; biodiesel; Antimicrobial properties; Medicinal properties; Wild plants utilization

Introduction

Plants have historically been essential to human civilizations, providing food, medicine, and feed for livestock. Wild safflower belongs to the largest flowering plant family (Asteraceae) comprised of about 1000 genera and more than 10,000 species (Ahmad *et al*., 2007). The genus Carthamus commonly recognized as spiny plants comprised of two dominant species worldwide i.e. cultivated and wild species, prevalent in the Central and Western Asia and the Mediterranean region. Despite, being the most well-known wild plant in the genus *Carthamus* the species "*oxyacantha*" commonly known as wild safflower is regarded to be the oldest male progeny of safflower *Carthamus tinctorius* (Sabzalian *et al*., 2008). Furthermore, both species have successfully completed reciprocal crossings having the same number of chromosomes (Ashri & Knowles, 1960).

All the plants in this family are characterized by many small flowers arranged in an inflorescence and seem like a single flower. The genus *Carthamus* contains a diverse range of flowering plants with significant ecological and economic value. The word *oxycantha* is derived from Greek word "oxy" mean sharp or thorn. *C. oxycantha* stands out among the genus as a species of high interest due to its particular ecological characteristics and potential applications in rangeland ecosystem. Wild safflower is an annual herb with prickly leaves can grow to a height of 1.5 meters. Wild safflower is not grazed by cattle that is why it has the potential to spread throughout rangelands just like other spiny plants of the *Carthamus* genus. Although *C. oxycantha* is self-pollinating in nature but it has about 10% potential to be cross-pollinated through pollen transfer by various insects particularly with indeterminate flowering habit (Singh *et al*., 2007). However, at early stages (before thorn initiation), the plant is collected by the local farmers in Pakistan and used as livestock feed.

C. oxycantha is a noxious winter season weed, growing from January to June in Pakistan. It grows naturally and is adaptable to dry and harsh climatic conditions. It is a major weed particularly found in the undisturbed area, roadways, and waste areas and also in some agricultural fields with minimum soil disturbance (Ahmad *et al*., 2007). Furthermore, it competes with crops and greatly reduces the yield of various cereal

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crops. In Pakistan, it is widely distributed in northern region of Punjab infesting spring corn, wheat, barley and chickpea crops. *C. oxycantha* is found in arid regions of Punjab and Uttar Pradesh in India, with its western range extending into Pakistan. Seed germination and seedling emergence is greatly affected by light, water supply and temperature (Rao *et al*., 2008). The root system of wild safflower is deeper enough which make it more adaptable to salinity and water stress conditions (Dordas & Siloulas, 2009; Sabzalian *et al*., 2008). Studies show that salinity considerable decline the germination and seedling growth of *C. oxycantha* (Jamil *et al*., 2007) due to high ion toxicity and osmotic effect on the plant (Taisan, 2010). Similarly, drought stress is also one of the major abiotic stress that limit germination and seedling growth (Kaya *et al*., 2006). Despite, the high salinity and drought stress condition *C. oxycantha* still show high rate of survival which make it make it widely distributed in the arid regions. Studies reveal that various ecological factors such as drought, temperature, pH, sowing depth and salinity effect have significant effect on germination of *C. oxycantha* (Tanveer *et al*., 2012) but still it has the potential to germinate under different ecological conditions and could be utilized for numerous purpose.

Wild plants serve a dynamic role in agro-ecosystem. Utilization of these plants has potential significance in alternative medicine (Fabricant & Farnsworth, 2001). Ethnobotanical use of plants is considered as a way to understand about the prospects of medicines. Almost 122 bioactive compounds used in medicine are isolated from plants. Approximately 80% of these drugs are used in medicine as such were used conventionally. Plants are extremely important to the global economy. The Asteraceae family is one of many that produces plants with medicinal properties. Many tribal and ethnic communities in Pakistan use numerous native species of Asteraceae family for medicinal purpose. *C. oxycantha* is generally seen as a weed of rangeland and also found in some agricultural crops. It is a good source of oil and could be utilized for its greater potential as an oilseed crop. Folk cures recommend using it for its wound-healing and anti-inflammatory properties. Studies on albino rabbits show that it has anti-inflammatory and therapeutic abilities (Waheed, 2009).

Since two decades ago, World Health Organization (WHO) recognized and initiated exploring the prospects to improve the use of traditional herbal medicine which has been used by the peoples globally for thousands of years (WHO, 2023). Since the commercialization of flowers for making herbal tea, color extraction and therapeutic use, the economic return to farmers from both flower and seeds is projected to rise about 141% of the returns currently made from seed harvesting alone (Sawant *et al*., 2000). Safflower is wild in nature, however due to its higher significance it has been cultivated for its quality oil production (Weiss, 2000), because of having beneficial secondary metabolites, including essential oils, which could be a best source of biofuel (Velasco and Fernandez-Martınez, 2004) and could be used as pharmaceuticals (Ullah *et al*., 2014). Safflower essential oils are becoming more popular due to its extensive consumer acceptance and variety of applications (Burt, 2004). The present review focuses on the detail biology, ecology, habitat preferences, medicinal and economic importance of *C. oxycantha*. This review aims to provide inclusive baseline information about the wild safflower and to increase awareness about its potential medicinal and economic uses.

Taxonomy

Kingdom: Plantae
Subkingdom: Tracheobionta
Superdivision: Spermatophyta
Division: Magnoliopsida
Class: Magnoliopsida
Subclass: Asteridae
Order: Asterales
Family: Asteraceae
Genus: *Carthamus*.
Species: Oxycantha Bieb.
NCBI (2023).

Vernacular names: It is known as Qartam in Arabic, wild safflower, Jeweled Distaff thistle in English, China: Hong hua, Pushto: Kunzalay, Urdu: Pholi, Punjabi: Kandiari, Flowering Period: May-July

Botanical description: *C. oxyacantha* (M. Bieb) belongs to the family Asteraceae. The genus *Carthamus* comprised 25 species distributed globally. Plants of the Asteraceae family are characterized as bushy, herbaceous annuals with several branches that end in globular structures known as capitulas. These branches are classified as main, secondary, and tertiary. Compared to other crop plants, safflower's deep root structure lets it draw water and nutrients from far deeper soil layers, which making it a perfect plant for rain-fed cropping systems. The leaves are sessile, oblong or oblong-lanceolate, and 1-5 inches long. The lower leaves are pinnatified and have short spinulose-toothed, while the upper leaves are ½-amplexicaul and very spinous. The diameter of heads size ranged from ¾ to ½ inch, with outer involucral bracts that reach beyond the head; white beneath the constricted part, green overhead, and ornamented with yellow spines. Flowers are yellow and orange. The rectangular, four-angled, smooth-shining truncate Achenes feature four superiors with no pappus at the top (Tariq *et al*., 2020).

The petals of *C. oxyacantha* flower are united in a tube known as the corolla. An inferior ovary attaches to the base of the corolla tube. The stigma and style are surrounded by five fused anthers that connect to the corolla tube. The petals are five in numbers with lobes size around 6.5 to 8.5 mm in length, while the length of corolla tube is ranged from 1.8-3 cm. Anther tube length is ranged from 5 to 7 mm. The stigma is enclosed by five anthers fused together and reaches 5 to 6 mm beyond the apex of the anther tube. The inferior ovary of each flower produces an achene, or seed. An achene is a single-seeded fruit. Safflower pollen is yellow in color. When the style and stigma emerge from the joined anther tube, pollination occurs. Outcrossing in safflower has greater variability in India it has been reported to range between 0% and 59%, depending on the genotype (Jhajharia *et al*., 2013). Pollen of safflower is disseminated by insects rather than wind. Honey bees are the most prevalent pollinators of wild safflower. Bees are attracted by its flowers for the nectar and pollen. A safflower capitulum produces between 15 and 60 seeds (Singh and Nimbkar, 2007). Flowering starts between March and June. The flowers start profusely in the field after crop harvesting (Kashyap & Joshi, 1936). Several Carthamus species have been identified to be widely utilized in folk medicine for a wide range of diseases, particularly typhoid fever, cardiovascular issues menstrual disorders, swelling, coughing, and throat diseases. It has also been utilized as calcium antagonists, anticoagulants, anticancer herbal remedies, and sedatives (Ellahi *et al*., 2014; Ikram *et al*., 2020).

Distribution and ecological adaptation: It is mostly found in Azerbaijan, Afghanistan, Iran, Iraq, India, Pakistan, Kyrgyzstan, Turkmenistan, Tajikistan, Armenia, Georgia, America and Mediterranean region and other arid regions including plains and mountains (Chopra *et al*., 1982). Safflower is cultivated in in India, Ethiopia, Kazakhstan, Mexico, Argentina, Uzbekistan, China, Australia, Russia, Iran, Canada, Pakistan, Spain and Turkey. Currently, India is the largest producer of safflower in the globally, followed by the U.S., China and Mexico (Singh & Nimbkar, 2007). It is found in dry parts of Pakistan and India with rainfall 300 mm, winter temperature 10-15ºC, summer temperature 25-30ºC, hot dry climate, drought resistant, and light sandy and virgin soil (Tanveer *et al*., 2012). Wild safflower is among the major winter weeds and rise in temperature from 15 to 25°C significantly improve germination of *C. oxycantha*. However, drought stress ranged 0 to -0.8 MPa substantially decrease the germination *C. oxyacantha* seeds. Acidic and alkaline pH had an inverse effect on its germination (Tanveer *et al*., 2012).

Phytochemistry: The seeds of *C. oxycantha* contain two kinds of essential oils: oleic oil and linoleic oil. The fatty acid content of oleic oil including, palmitic acid (5-6%), stearic acid (1.5-2%), oleic acid (74-80%), linoleic acid (13-18%) and traces of longer chain fatty acids (LCFA). *C. oxyacantha* seeds also comprises of 20-25% protein, 60% husk, and 2-15% residual fat. The two principal pigments found in the blooms of *C. oxyacantha* are carthamidin, a water-soluble yellow pigment, and carthamin, a historically significant dye that is an orange-red flavonone (Anjani, 2005; Fernandez-Martinez *et al*., 1993). Carthamin is a major bioactive compound found in the flowers of *C. oxyacantha* at concentrations ranging from 0.3-0.6%. Seeds and flowers also contain glycosides, sterols, serotonin and flavonoids (Firestone, 1999). In addition, *C. oxyacantha* also contains some novel glycosides particularly beta-D-fructofuranosyl-carthamoside, 2-O-methylglucopyranosyl-carthamoside as well as 3', 4', 5, 7-tetrahydroxyflavanone which was determined by using recycled preparative HPLC. The chemical structures of these phytochemicals were determined by using mass spectrometry (Hassan *et al*., 2010).

Nutritional value and trace elements: Safflower contains medicinally important bioactive chemicals such as glycosides, alkaloids, flavonoids and other chemical compounds with significant health benefits. These potential bioactive compounds beneficial to the human body on consumption of medicinal herbs or their extracts (Raza *et al*., 2015). Contemporary medicine has now been realized and accepted the use of standardized plant extracts for various diseases. *C. oxycantha* one of the potent medicinal plant. It is a good source of iron, vitamin A, calcium and phosphorus. Numerous medicinal plants and their herbal product are frequently available in the Indian markets and other neighboring countries particularly China, Nepal and Pakistan (Nimbkar, 2002). Herbs include a variety of nutrients and trace elements with potential medicinal properties. Our bodies require minerals and trace elements as chemical components for a number of physiological and biological actions that are necessary for human health. It has been reported *C. oxycantha* seeds contains significant level of crude proteins and total proteins, whereas its leaves contain higher level of total carbohydrates. The amount of total fats and concentration of crude fiber are considerably greater in seeds of *C. oxycantha* in comparison to *P. ovata* and *E. sativa*. It is a rich source of Fe, Cu, Mn, Cr, Mg, Mo, Zn, K, P, Ca and Na (Khan *et al*., 2013). In light of high nutritional value of wild safflower, it could be further utilized for various medicinal purposes.

Hepatoprotective properties: Carbon tetrachloride (CCl_4) is a well-known hepatotoxin widely used in biological research. Free radicals (trichloromethyl) are produced in certain organism when exposed to CCL_4. Free radicals are compounds that interact with other molecules inside the cell and interrupt the vital function of cell. These free radicals eventually lead to peroxidation of cell membrane and harms the liver cells (Sahu *et al*., 2005). Several species in the family Asteraceae contain pyrrolizidine alkaloids which are potent in curing liver diseases (Mattocks, 1990; Borba *et al*., 2001). *C. oxycantha* extract is an effective antidote for liver injury. The seeds and flowers of *C. oxycantha* (M. Bieb) contain a high concentration of antioxidants particularly flavonoids, glycosides, serotonin, and sterols. These antioxidants promote the function of liver and protect it against oxidative stress (Raza *et al*., 2015; Baran & Ekmekci, 2022). In a comparable study Bukhsh *et al*., (2014) investigated alcohol extracted of *C. oxyacantha* seeds and found hepatotherapeutic and hepatoprotective properties against carbon tetrachloride (CCL_4). They examine the liver injury by investigating several enzymatic assays particularly, serum glutamate oxalacetate transaminase (SGOT), total proteins, serum glutamate pyruvate transaminase (SGPT), serum alkaline phosphatase (ALP) and glutathion. They performed histological examination and assess bilirubin level in blood and reveal that hepatoprotective activity of *C. oxyacantha* seeds was more effective than that of hepatotherapeutic properties.

Anticancer properties: Extracts from *C. oxyacantha* (M. Bieb) roots are immunomodulatory and cytotoxic. The extracts tested on cancer cell lines (MDA-MB231, T47D, Caco-2, Vero and EMT6/P) included aqueous methanol, aqueous ethanol, ethyl acetate and n-hexane. However, Caco-2 and T47D, ethyl acetate and n-hexane extracts were investigated. It was revealed that there was strong anticancer efficacy against cells. The efficacy of n-hexane extract was more effective against Caco-2 and T47D, with 0.067 mg mL^{-1} IC50 level. Furthermore, both extracts reduced average cell weight and tumor growth under in vivo conditions. In a comparable study Baban *et al*., (2023) reported the fundamental procedures for effective cancer treatments, such as pinocytosis, macrophage immunomodulation, and caspase-3 activation. They examined aqueous and oil extract of *C. oxyacantha* (M. Bieb) at varied concentrations ranged from 7.81-1000 µg ml^{-1} having exposure times (24, 48, and 72 hours). They found that HeLa cells were more sensitive and cause cytotoxicity in a dose-dependent manner. As a result, cells were shown to excrete more water molecules than oil extract. Similarly, Al-Sarhan *et al*., (2019) found triterpenes, oleic acid, and linoleic acid as potential anti-cancer compounds. They found that both aqueous and oil extract of *C. oxyacantha* show potential anticancer activity.

Neuroprotective properties: *C. oxyacantha* extract is well known for its neuroprotective properties. In an MTT assay two different extracts particularly the dichloromethane and 80% methanol extract indicates considerable neuroprotective property by reducing the intracellular reactive oxygen species and absorbing the MTT. An 80% methanol extract showed that *C. oxyacantha* results reduced the apoptosis parameter, hydrogen peroxide (Tavakkoli *et al*., 2014). Another study with the methanol extract of *C. oxyacantha* revealed a novel spiro-sesquiterpene and four other compounds based on spectral techniques LCMS. Some other known products are vanillic acid, caffeic acid, and various flavonoids also have been identified in *C. oxycantha* plant by using LCMS (Johansen *et al*., 2011). These bioactive compounds having considerable potential and could be used for its neuroprotective properties. In addition, various phytochemicals such as hydroxysafflor yellow and Safflor yellow have also been identified with potential neuroprotective properties (Wang *et al*., 2009 and Yang *et al*., 2010).

Antihyperlipidemic properties: Hyperlipidemia is a common metabolic disorder in which the lipid levels especially high amount of cholesterol and triglycerides raises in blood. Various studies reporting that *C. oxyacantha* exhibit strong antihyperlipidemic properties. According to Ahmad *et al*., (2009) studied the aqueous and alcoholic extracts of seeds of *C. oxyacantha* showed a significant antihyperlipidemic activity value of $p<0.01$. In addition, Dilshad *et al*., (2016) isolated two new bioactive compound includes sphingolipids oxyacanthins A, B from the whole plant material of *C. oxyacantha*. All these compounds reported to exhibit an inhibitory potential against enzymes lipoxygenase with IC 50 value of 245.7 ± 1.1 and 83.3 ± 1.3 µM. However, these compounds showed inhibitions against certain enzymes BChE and AChE with IC50 values 93.6 ± 0.1 and 65.3 ± 0.1 µM, respectively.

Antioxidant properties: It has been revealed that *C. tinctorius* has antioxidant capabilities. An Oxygen Radical Absorbance Capacity (ORAC) assay revealed that *C. tinctorius* has a total antioxidant activity of 130.2 12.3 m mol TE/100 g. *C. tinctorius* extract show substantial antioxidant activity for 2-diphenyl-1-picrylhydrazyl (2-DPPH) and ORAC (Bacchetti *et al*., 2020). The properties of these two water soluble, bioactive flavonoid compounds was particularly observed in *C. tinctorus* petals, similarly, hydroxy safflor yellow A (HSYA) and safflor yellow A (SYA), were also detected in the flowers. These compounds had considerable effects on oxidative stress. *C. tinctorius* extracts have both free radical scavenging and antioxidant activities (Mandade *et al*., 2011). In the recent research by Sun *et al*., (2020), reported that honey extract of *C. Tinctorius* have antioxidant and anti-inflammatory activities; these are due to the flavonoids and polyphenolic compounds. *C. oxycantha* has bioactive compounds that can reduce free radicals (Ikram *et al*., 2020).

Antibacterial properties of C. oxycantha: *C. oxyacantha* extract has a high antibacterial activity (Ikram *et al*., 2020). Root extracts of C. *oxyacantha* have antibacterial properties against several pathogenic bacteria. The findings indicated antimicrobial activity against *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Also, resistant bacteria specifically (*S. aeruginosa*) has a dose-dependent response. Thus, the root extract of *C. oxyacantha* could be used as a potential natural antibiotic. Studies suggest that the bactericidal properties of *C. oxycantha* may be due to its free radical scavenging property (Raza *et al*., 2015). In addition, mentioned that *C. oxyacantha* has antimicrobial activity.

Antifungal activities: *Carthamus oxyacantha* (M. Bieb) extract has antifungal activity. Methanolic leaf extract of *C. oxyacantha* had significant antibacterial activity especially against *Rhizoctonia solani* (Ali *et al*., 2013). Similarly, root extract of wild safflower has been shown to interfere with microbial activities. However, the concentration of the roots extract is dose depended and show antifungal activity mostly against *Candida albicans*. The minimum inhibitory concentration (MIC) of the root extract against *C. albicans* was found to be 1.25 mg mL^{-1}. Similarly, Ikram et al. (2020) also reported that root extract of *C. oxyacantha* show natural antifungal properties.

Ethnobotanical applications: The seeds of *C. oxycantha* have been reported to have laxative properties, whereas the flowers were historically used for relieving jaundice. It is believed that the sap of wild safflower decreased saliva production. Moreover, *C. oxyacantha* extract has been utilized to reduce trauma-related inflammation and discomfort in the body. Traditionally, *C. oxyacantha* was used for making roghan wax, which has been used in the dyeing industry (Firestone, 1999). Although the edible oil derived from the seed could be used to make paints. Additionally, it was primarily used in cooking, salad dressings, and margarine production. Oil is the main byproduct of *C. oxyacantha* which is also used for the treatment of Scabies. There are two types of oils found in the seeds of *C. oxyacantha* including linoleic and oleic oil which have important health benefits (Chopra *et al*., 1982 and Fernandez-Martinez *et al*., 1993).

Fig. 1. (a). Bright yellow patches of wild safflower at flowering stage (b). Mature seeds of wild safflower.

Similar to other spiny plants in the genus *Carthamus*, the species *oxyacantha* is not used as fodder for livestock (Ellahi *et al*., 2014). However, in southern Khyber Pakhtunkhwa, the poor farmers collect this weed at its early stage and are used as animal feed. However, at mature stage, this plant is not used due to spines (Fig. 1a). Although the seeds (Fig. 1b) of *C. oxyacantha* are favourite food for wild birds specially doves (Pers. Comm). Oil obtained from its seeds is used as a brain tonic (Ahmad *et al*., 2013). Decoction of leaves are given to children to remove worms. Seeds of *C. oxyacantha* were used in cooking, seeds are also a best source of feed for birds, young leaves of wild safflower are also consumed as a vegetable. Flowers were used to cure pneumonia, rheumatism, cerebral thrombosis, and male infertility (Singh & Kumar, 1947 and Fernandez-Martinez *et al*., 1993). Since safflower oil doesn't cause allergies, it can be used in injectable drugs for treating various ailments (Smith, 1996). It is used as a medicinal tea to stimulate the heart and blood circulation, and it also promotes labor. *C. oxycantha* herbal medicine is an effective treatment for trauma. The seeds are thought to have laxative properties. Nowadays, *C. oxycantha's* primary product is the edible oil that is derived from its seed (Firestone, 1999). It's also used to make roghan, a glass cement and leather preservation substance. Oil is used to treat rheumatism and heal wounds (Weiss, 1971).

C. oxyacantha was grown for its good quality dye from ancient times. Its flowers are used for making different colors (yellow, red, brown and purple) with the addition of certain colorants and chemicals depending on the dyeing process. Despite its dye manufacturing potential, dyes are prepared on small scales and used for conventional and ritual purposes. Furthermore, its color could also be used as substitutes of real saffron in food coloring to give food and beverages a beautiful orange color. Their flowers were also frequently mixed with rice, bread, and other food products. The seed cake served as a good feed for the animals. The seed cake contains matairesinol glucoside which is nutritious food for the animals.

C. oxyacantha meal and decorticate seed flour were combined to create high protein supplements for human diets (Fernandez-Martinez *et al*., 1993). China (Dajue & Yuanzhou, 1993) and India (Singh, 2005) have prepared tea that has safflower flowers as its main ingredient. Folk medicine suggested that *C. oxycantha*, could work as Anti-irritants.

Allelopathic properties: The *C. oxyacantha* is one of problematic weeds, its allelophatic substances can be used as bioherbicides. It has potential for inhibiting weed growth. Studies show that extract of *C. oxyacantha* is used for controlling weeds which is an environment friendly approach and substitute the hazardous effect of herbicides for weeds control. Its extract significantly reduces weed density. Allelopathic effect of *C. oxyacantha* (M. Bieb) on different major weeds of wheat crop were tested. Aqueous extracts (100 g L^{-1}) of leaves and roots of *C. oxyacantha* (M. Bieb) significantly reduced germination, shoot growth and biomass of *Rumex dentatus*, *Lepidium didymium*, *Phalaris canariensis* and *Chenopodium album*) as reported by Siyar *et al*., (2018).

Potential for Biodiesel production: Fossil fuel supplies are decreasing with the passage of time where demand for diesel use is increasing due to industrialization and transportation however diesel supply is unpredictable and also causes emissions of greenhouse gases that cause global warming and environmental pollution. Therefore, there is a need to explore alternative energy sources. The most common sources of renewable energy are biofuels, solar, wind, and water (Singh & Singh, 2010; Atadashi *et al*., 2011). *C. oxyacantha* plant can be used as a biodiesel feedstock (Zadeh *et al*., 2011). It was found that *C. oxyacantha* seeds contain about 24-32 (%) oil content. The seed contain good quality oil, having 183% saponification value with free fatty acids content (FFA) (0.18%) and iodine (145%). Wild safflower oil composed of significant proportion of unsaturated fatty acids (≥80%) Carpetian & Zarei (2005). Moreover, alkaline transesterification was used to turn crude safflower oil into methyl ester, or biodiesel. It has been documented by a few research that different types of fatty acids are found in *C. oxycantha* oil. According to Sabzalian *et al*., (2008), safflowers contain a crude oil content of 25.34 ± 2.98%. comprises mainly of the following fatty acids: oleic acid (C18:1): 17.08 ± 1.37, stearic acid (C18:0): 3.16 ± 0.60, palmitic acid (C16:0): 7.28 ± 0.55, and linoleic acid (C18:2): 70.61 ± 2.27%. Zadeh *et al*., (2011) investigated biodiesel properties of *C. oxycantha* and found that the oil extracted from *C. oxycantha* contains methyl ester and has potential application for biodiesel production. *C. oxycantha* seed can be utilized as a best source for biodiesel production (Hamamci *et al*., 2011; & Mohammed *et al*., 2020).

Conclusion

Wild plants contain a variety of organic compounds and essential nutrients that are important for human health and can also contribute significantly to natural products and herbal medicines. In order to investigate the health and commercial uses of wild safflower, it is important to understand their biology, biological and photochemistry. There are a variety of bioactive compounds (flavonoids, glycosides, carthamidine, and essential oils). These phytochemicals are derived from different plant parts (roots, flowers and seeds) of *C. oxyacantha* and possess antibacterial, antifungal, anticancer, neuroprotective, anti-inflammatory, and hepatoprotective properties. These bioactive compounds may be an important alternative to modern medicines. The plant also contains various allelopathic compounds that can be extracted and can be used as bioherbicides. The seeds contain about 24-32% oil which is used to produce biodiesel. In light its unique properties, it is suggested to fully explore wild safflower to utilize this plant with the aim to improve livelihood of the indigenous peoples. Because this plant play a vital roles in arid agro-ecosystems.

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