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Biological and phytochemicals review of Omani medicinal plant *Dodonaea viscosa*

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ABSTRACT

An infusion of the plant of *Dodonaea viscosa* (*D. viscosa*) was used by the Omanis and other nations to cure a variety of ailments for many years. The plant was considered as a laxative, spasmolytic, antiviral, anti-inflammatory, antimicrobial and hypotensive agents. *D. viscosa* is a species of plant belonging to the Sapindaceae family. Other species of this family have been similarly used to treat a wide variety of illnesses. Very little is known of the active constituents of any of these plants, particularly *D. viscosa*, a native Omani plant. The biochemical evaluation of the selected plant extracts showed that the selected plant contains oils and fats, heterocyclic nitrogen compounds, tricyclic flavonoids, steroidal compounds, cyclic and acyclic phenolics, pentacyclic saponins, tannins, mucilage, carbohydrates, reducing sugar, cardiac glycosides, and different trace elements. The previous in-vivo and in vitro different pharmacological studies of the plant extracts showed that the selected plant has significant antidiabetic, antimicrobial, insecticidal, antioxidant, cytotoxic, antifertility, anti-inflammatory, analgesic, anti-ulcer, antispasmodic, anti-diarrheal and detoxification effects. According to the literature, the selected plant showed potential biological activities, and it is available throughout Oman; however, only limited research work conducted and published on the selected plant in the scientific journal. Therefore, our present intention is to review the biological and bioactive constituents of the locally grown potential medicinal plant of *Dodonaea viscosa* which is used as a folk medicine. In conclusion, the isolated compounds from the selected plant or plant extracts could be used as medicine to treat illness.

Contents

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1. Introduction

1.1. Plant description

The effort to find naturally occurring bioactive substances began in primitive times. The man used natural sources such as plants for curing human diseases without any scientific knowledge. Following the discovery of penicillin, a fungal product, many antibiotics have been isolated from microorganisms, and a number of these have been used clinically to control human infectious diseases (Fleming, 1929; Gottlieb, 1973; Wishnow and Steinfield, 1976). Recently plants have been extensively screened for antineoplastic agents, and many potentially useful drugs for cancer treatment have been discussed (Kupchan, 1976). Although many useful drugs are now available for the treatment of various diseases, new potential drugs are required to control neoplastic growth, viral diseases, and resistant microorganisms. In addition, new drugs which could ameliorate the harmful side effects of those presently used are desirable. Although the medicinal use of marine organisms and plants were described a very long time ago in the Orient, the extensive search for biologically active substances from both sources was started only very recently (Baslow, 1969). An early study of toxic principles of some marine animals revealed unique and interesting substances. It has been proposed that because of differences between the environments of marine and terrestrial organisms, the former may produce structurally very different compounds, some of which might be useful as new drugs for human disease control.

Dodonaea viscosa (*D. viscosa*) is a flowering medicinal plant available in a specific area of Oman. The plant is originated from Australia and native to western America. The plant is widely distributed in the particular regions of Australia, Africa, Mexico, New Zealand, India, Northern Mariana Islands, Virgin Islands, Florida, Arizona, South America and elsewhere. Now, it is available in most of the countries. The specific plant originates from Australia, but, it is available throughout the tropical and subtropical countries (AL-Oraimi and Hossain, 2016). Sapindaceae family contains about 1000 species (Mehmood et al., 2013). Most of them are flowering and woody plants and used medicine to treat different diseases including cardiac diseases. It has several species including *D. viscosa*. It has several local and common names. The common name of the plant is hop bush. In India, it is known as virāli. In Australia, it is known as broadleaf hopbush, native hop bush, sticky hopbush, candlewood, soapwood, switchsorrel, wedge leaf hop bush, giant hop bush, narrow leaf hop bush and native hop. In Oman, it is known as Shahs, and its Arabic name is Zaitoon Alramal (Mehmood et al., 2013). Almost all parts and all species belong to this family are used as a traditional medicine to cure various ailments including cardiac diseases (AL-Oraimi and Hossain, 2016). One of the species is *D. viscosa* which is available in almost all the countries including Oman. The locally grown selected species showed significant in-vitro and in-vivo various biological activities, and it is traditionally used by different ethnic communities to treat various diseases. A few species including *D. viscosa* belongs to the mentioned family are available in Oman. Recently, most of the species of the selected family also used traditionally to treat different chronic diseases. The leaves, fruits, stems and flower pictures are presented in Fig. 1.

1.2. Synonyms of D. Viscosa

According to the literature the selected plant originates from Australia, but, it is available throughout the tropical and subtropical countries including Oman (AL-Oraimi and Hossain, 2016). This plant species as belonging to the Sapindaceae family. More than 1000 plant species are available belongs to this family and most of all they are flowering and woody plants and used as folk medicine to treat different diseases including cardiac diseases. There are about 20 synonyms are available globally; however, the most common subspecies are as follows:

1. *D. viscosa* subsp. *angustifolia*
2. *D. viscosa* subsp. *angustissima*
3. *D. viscosa* subsp. *burmanniana*
4. *D. viscosa* subsp. *cuneata*
5. *D. viscosa* subsp. *mucronata*
6. *D. viscosa* subsp. *spatulata*
7. *D. viscosa* (L.) Jacq. subsp. *viscosa*

1.3. Taxonomic classification of D. Viscosa

Kingdom: Plantae; **Subkingdom**: Tracheobionta; **Superdivision**: Spermatophyta; **Division**: Magnoliophyta; **Class**: Angiosperms; **Clade**: Eudicots; **Subclass**: Rosids; **Order:** Sapindales; **Family**: Sapindaceae; **Genus**: *Dodonaea*; **Species**: ***D. viscos;*** **Binomial name**: ***Dodonaea viscosa*** (https://en.wikipedia.org/wiki/Dodonaea_viscosa, visited July 28, 2018).

1.4. Distribution of D. Viscosa

D. viscosa is a flowering and woody plant belongs to the family Sapindaceae (AL-Oraimi and Hossain, 2016). Initially, the plant originates from Australia; however, now it spread all the tropical and subtropical countries. In specific areas such as Australia, Africa, Mexico, New Zealand, India, Northern Mariana Islands, Virgin Islands, Florida, Arizona, South America and elsewhere are widely distributed of the selected plant. The plant is a multi-stemmed shrub or single-stemmed small tree up to 7 m tall. The selected plant leaves are various in shapes and sizes and generally obovate, but some of them are lanceolate. The leaf size is about 4 to 7.5 cm long and 1 to 1.5 cm broad with deep green color. The leaves are arranged alternately and secrete a white gummy substance. Usually, the flowers are yellow, but sometimes yellow turns to red. The flower produced in panicles is about 2.5 cm in length. The plant flowers are a particular gender either male or female. The plant cannot bare both male and female. However, there is an exception; sometimes the plant bears both sexes. The fruit is about 1.5 cm with capsule shape. It is red, and during the ripening, it

Fig. 1. The picture of leaves, fruits, stems and flowers.

turns to brown color. The bark is pale and roughness with thin and exfoliating in long thin strips. The plant is producing seeds, and the seeds need to pretreatment by hot water. The pretreatment method used only female plants with their winged fruits to treat aesthetic value. Most of the subspecies are wild plant and found in different parts of Oman. The specific location of this plant is AL-Jabal Al-Akhdar, Northern Oman, AL-Hamra and Salalah (Hussain et al., 2013). The plant has potential activity against different diseases; therefore, the people of Oman are planning to cultivate the selected plant commercially soon.

1.5. Traditional use

The selected plant is used as folk medicine most of plant producing countries to treat different diseases. The specific part of this plant is used to treat specific diseases. The treatment of different diseases is based on the chemical ingredients and geographical distribution (Rojas et al., 1996). In New Zealand, the leaves are used to treat the wound, and the African people used the plant leaves to treat GI system, skin diseases and rheumatism (Rojas et al., 1992). However, in Oman the leaves of the selected plant as a medication to treat many ailments such as itching and rash, swelling, rheumatoid arthritis, bone disorders, GI disorder and the muscle relaxant (AL-Oraimi and Hossain, 2016). Roots are used to treat ulcer and headache (AL-Oraimi and Hossain, 2016). However, the mixtures of leaves and roots as paste are used to treat dental pain, headache, indigestion, diarrhea, and constipation (Meenu et al., 2011). Australian people have used the plant to treat the wound, bleeding, bone fractures and snake bites. Indian also used to treat for different ailments like bone fractures, snake bites, wound healing, headache, indigestion, and diarrhea (Rajamanickam et al., 2010).

1.6. Plant collection

The selected plant samples were available in almost all the tropical and sub-tropical countries. However, in Oman, the selected plant species are available especially Jabal Al-Akhdar, Northern Oman, AL-Hamra and Salalah (Hussain et al., 2013). Almost all parts of this plant are medicinally important. Therefore, the researchers collected suitable parts of the selected plants for their studies. Soon after the collection of samples, the plant samples were stored in polyethylene bags.

1.7. Preparation of extract

The researchers are extracting the plant constituents from the plant samples by using different extraction methods. They are also used different polarity solvent for the extraction. The mother solvent from all extracts was evaporated by using a rotary evaporator. All prepared extracts from the selected plant either hot or cold extractions were used to determine in vitro and in-vivo biochemical, pharmacological and toxicological studies.

2. Biochemical studies

The previously reported phytochemical studies showed that the plant contains different nitrogenous cyclic compounds, various types of flavonoids, volatile oils, immune modulator ingredients, saponins, primary and secondary cyclic and acyclic phenols, tannins, gum, cardiac glycosides, carbohydrate and sugar (Venkatesh et al., 2008; Shafek et al., 2015; Ramya et al., 2011; Jeya et al., 2014; Jawahar et al., 2004; Kumar et al., 2013a). Various groups of chemical compounds were isolated from the selected plant parts which were reported earlier by the researchers (Sachdev and Kulshreshtha, 1983, 1984, 1982; Mata et al., 1991; Wabo et al., 2012; Lai-Bin et al., 2012; Akhtar et al., 2012a, 2012b; Abdel-Mogib et al., 2010; Khan et al., 1988; Dominguez et al., 1980; Dreyer, 1978; Zeza et al., 1985). Not all groups of compounds were isolated from one part of this plant. They were isolated from different parts of the selected plant. According to the record, more than seventy chemical compounds isolated and characterized from the selected plant. The identified compounds are mainly flavonoids, alkaloids, terpenoids, saponins, tannins, glycosides, cardiac glycosides, steroids, proteins, carbohydrates, fats, oils, amino acids etc sugar (Venkatesh et al., 2008; Shafek et al., 2015; Ramya et al., 2011; Jeya et al., 2014; Jawahar et al., 2004; Kumar et al., 2013b). Previous studies showed that the total isolated compounds from the whole plant of the selected species are various molecular weight compounds e.g., flavonoids (9), isoprenylated flavonol (10), chalcone (5), triterpenoid saponin (2), volatile oil (14), mineral and trace element (6) and others (15) (Fig. 2). Still, the scientists are working on the specific plant, and they are adding the name of isolated compounds in the chemical list. All isolated individuals from this plant showed significantly different biological activities. The isolated plant individuals differ from one region to another due to the geographical distribution. We are also trying to isolate some more individuals with potential biological activity from the leaves of this plant which is locally grown. Some of the individuals were isolated and reported from the locally grown plant species presented in Table 1. In addition, we also intend to isolate biologically active compounds and add their names to the existing list.

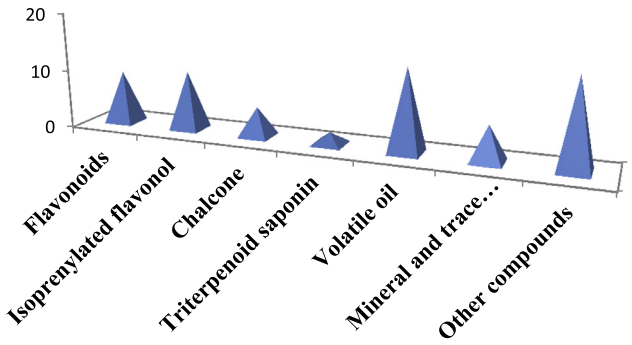


Fig. 2. Brief list of chemical compounds isolated from the plant.

3. Pharmacological activities

D. viscosa is a wild plant and used traditionally in various countries to treat different diseases. Different parts of this plant are used to treat certain specific diseases. Due to the traditional use, there is a considerable number of scientific work was done on different parts of the selected plant. Some of them worked on the biological activities of the plant extracts and isolated the plant individuals. Some of them isolated the biologically active compounds and evaluated their bioactivity by various model. The earlier reports showed that all parts and their extracts of the selected plant give potential pharmacological activity (AL-Oraimi and Hossain, 2016; Khaloud and Hossain, 2016). The potential activity of the plant extracts could be due to the chemical ingredients (Sachdev and Kulshreshtha, 1983, 1984, 1982; Mata et al., 1991; Wabo et al., 2012; Lai-Bin et al., 2012; Akhtar et al., 2012a, 2012b; Abdel-Mogib et al., 2010; Khan et al., 1988; Dominguez et al., 1980; Dreyer, 1978; Zeza et al., 1985). The various polarity plant extracts have different significant activity on anti-diabetics, antioxidant, insecticidal, antifungal, cytotoxic, antifertility, wound healing, and cardiotonic activities (Mehmood et al., 2013; Khurram et al., 2011; Diaz et al., 2015; Kumar et al., 2013a; Shanthi et al., 2015; Khalil et al., 2006).

3.1. Antidiabetic activity

The antidiabetic activity of the selected plant extracts and their individuals was determined by in vitro and in vivo model (Akhtar et al., 2011; Muthukumran et al., 2011). Most of the previous reports showed that various polarity crude extracts showed different antidiabetic activity. Their studies also showed that the maximum antidiabetic activity was found in the highest polar crude extracts. That means, the highest polar crude extract contains the polar compounds which are responsible for the antidiabetic activity. Therefore, the general conclusion is that the antidiabetic activity was increased with the increase of the polarity of crude extracts. Unfortunately, we are not able to evaluate and compare the antidiabetic activity of the locally grown *D. viscosa* due to the lack of facilities.

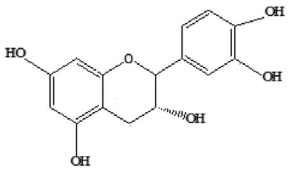
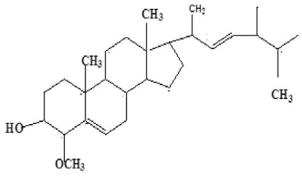
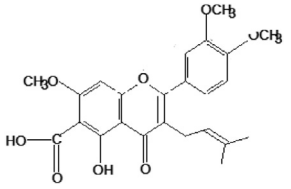
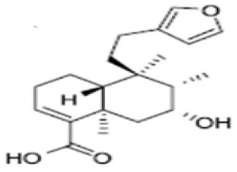
3.2. Antioxidant activity

All polarity crude extracts of *D. viscosa* was determined their antioxidant activity by different in vitro model (Mothana et al., 2010). The previous results showed that all polarity extracts showed antioxidant activity against all in vitro models. Most of the reports, they mentioned that the maximum antioxidant activity was obtained in the methanol extract. However, our experimental results showed that maximum activity was obtained in the hexane and chloroform extracts (Khaloud et al., 2016). So that, our experimental results differ entirely from their results. The different results may be due to the sample harvesting, drying, and different extraction procedure. Firstly, the coarse powder samples were extracted with methanol and methanol extract was fractionation by the different polarity of solvents. However, they extracted from coarse powder samples starting from nonpolar and gradually increased the polarity. In addition, the geographical distributions, sample process, drying plant materials are also not the same.

3.3. Antimicrobial activity

The growth inhibition of the selected plant extracts against different microbes was determined by different methods including disc diffusion method (Jeya et al., 2014; Naidoo et al., 2012). All plant parts extracts showed notable activity against different iso-

Table 1
Some of the individuals were isolated and report from the locally grown *D. viscosa*.

Plant parts	Name of the compound	Structure of the compound	Reference
Leaves	3,3′,4′,5,7-Pentahydroxy flavane		Asila and Hossain (2018)
Leaves	4-Methoxylstigmasterol		Asila and Hossain (2018)
Leaves	5-Hydroxy-7,3′4′-trimethoxy-6-acetoxy-3-prenylflavone		Khaloud and Hossain (2016)
Leaves	Dodonic acid		Khaloud and Hossain (2016)

lated human pathogenic bacterial strains (Gram positive and Gram harmful bacterial strains). Various previous results mentioned that the 80% methanol and 20% chloroform extracts showed the maximum activity against the human pathogenic bacterial strains. Several authors also mentioned that the highest inhibition was in the chloroform extract against different microbes (Khaloud and Hossain, 2016). That means the growth inhibition results are not constant for the extracts. However, locally grown of the selected plant also showed the critical growth of inhibition against the clinically isolated bacterial strains which was collected from a local hospital. However, the maximum activity was found in chloroform extract of the Omani species. The chloroform extract contains the maximum number of active individual with the high percentage which is directly involved in the growth of inhibition. Our experimental results slightly differ from other due to the harvesting, drying, weather condition, and extraction procedure. Also, the bacterial strains and time of incubation are also the major factors for the inhibition of growth. The highest inhibition extract was used for the separation of chemical individuals are in progress.

3.4. Cytotoxic activity

The cytotoxic activity of plant extracts was determined by various in vitro and in vivo methods (Shafek et al., 2015). Their experimental results showed that 80% ethanol extract showed potent activity on breast cancer cell line. Still, nobody worked of the locally grown selected plant on cytotoxic activity. In our research group is planning to do the cytotoxic activity of the selected plant extract within a short time.

3.5. Antifertility activity

The in-vivo animal model determined the antifertility activity of the selected plant extracts. Most of the previous studies showed that methanol extract give the maximum antifertility activity compares to other extracts (Kumar et al., 2013b). The dose within the permissible limit then the plant extract accelerate fertility activity but high dose it can cause miscarriage (Shafek et al., 2015). However, still, it is undermined on the Omani species.

3.6. Wound healing activity

The healing activity was determined by in vitro and animal models. The researchers showed that highly polar extract from the plant showed significant healing activity. They also mentioned that the polar extracts contain flavonoids and it can heal very fast compare to other fewer polarity extracts (Habbu et al., 2007; Khalil et al., 2006). Nobody work on the Omani species of the selected plant in regards to wound healing activity.

4. Total phenol content

The vast number of research was previously conducted by the researchers to determine the total phenols content by the FCR method (AL-Oraimi and Hossain, 2016; Khaloud and Hossain, 2016). However, the results for total phenols are different in the leaves, roots, and stems. In addition, the results are also different in various polarities of extracts. Some research mentioned that the highest amount of total phenols obtained from high polar extract and some mentioned that the high amount is obtained from the medium polar extract.

5. Total flavonoids content

The total flavonoids content of the plant crude extracts was determined by the $AlCl_3$ method with modification (AL-Oraimi and Hossain, 2016; Khaloud and Hossain, 2016). However, the results reported previously for total flavonoids are also differ from one part to another part. It also differs from polarity extract to extract. Some research mentioned that the highest amount of total flavonoids obtained from the universal polar solvent and some

mentioned the high amount is obtained from polar solvent. Our experiment results on Omani species contain the highest amount of total flavonoids in water extract (most polar solvent).

6. Conclusion

D. viscosa is a wild plant is available in Oman. Most of the subspecies including *D. viscosa* belong to this family are available in the Arabian Countries. The plant had significant biological and physiological activities and used as a folk medicine in the Gulf countries. In the Arabian countries including Oman, the selected plant used to treat several diseases including cardiac problem. Recently, the plant is commercially cultivated all over the world due to its medicinal importance. About seventy over chemical individuals are present in the plant. The previously published reports showed that the isolated individuals gave the significant different pharmacological activities. The extracts of the selected Omani species also showed the significant pharmacological activity. The highest activity extract was used for the isolation of chemical individuals and isolated some of the biological or pharmacologically active individuals who are commercially used as medicine to treat diseases. In our future plan to selected right extract for the discovery of the new medicine with the potential chemical individual. In this context, the current review of the selected plant could be encouraging other scientists to research discovery of new pharmaceutical, agrochemical, and cosmetics drugs.

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