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Review

Importance of *Brassica napus as* a medicinal food plant

Soodabeh Saeidnia and Ahmad Reza Gohari*

Medicinal Plants Research Center, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran, Iran.

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***Brassica napus* L. (B. napus L) (Cruciferae), is one of the cultivated medicinal food plants in Middle Asia, North Africa and West Europe. In Iranian traditional medicine, the root parts of this plant were used for the therapeutic properties as diuretic, anti-scurvy, anti-inflammatory of bladder and anti-goat. The usage of rapeseed oil as a food product as well as in the production of non-nutrition products such as greases, lubricant oils and especially bio-fuel may cause the increasing in rapeseed production in the world with FAO estimation of 58.4 million tons in the 2010-2011.The presence of a high quantity of erucic acid in natural rapeseed oil makes it toxic for consuming and the edible rapeseed oil is prepared from plant's hybrid (contained little or no eurcic acid) which used as cooking oil. Unfortunately, the medicinal properties of this plant have not been considered and are going to forget by expert scientists except the seed oil. Alongside the world trend to increase the cultivation of this plant, more evaluations on the pharmacological and biological activities of *B. napus* L. is recommended especially using traditional and folk experiences based documents. In this paper, the important achievements of phytochemistry and pharmacology for this plant are reviewed.**

Key words: *Brassica napus,* canola, eurcic acid, anti-inflammatory, bio-fuel.

INTRODUCTION

Brassica napus L. (Brassica napus L.), belonging to the family Cruciferae, is one of the cultivated medicinal food plants in Middle Asia, North Africa and West Europe. This plant is well-known as "Colza" in Iran, even the seeds of *Brassica compestris, Brassica juncea* and *Brassica nigra* are known as Colza in the world market. Its seeds have been commonly used for various purposes in diverse countries. Rapeseed (*Brassica napus*), also known as "rape", "oilseed rape", "rapa", "rappi" and "rapeseed". Colza is a bright yellow flowering member of the cabbage family and its name derives from the Latin origin for turnip as "*rapa"* or "*rapum"*. In the old documents, turnip and rape had been distinguished by the adjectives round and long (-rooted), respectively (Ahmadi, 1991; Mozaffarian, 1996). Rapeseed is the valuable product of the crop and now the third most important source of edible oil in the world after soybean and palm oil (El-Beltagi and Mohamed, 2010). The plant is also grown up to 50-200 cm and is ploughed back in the soil or used as bedding.

Processing of rapeseed for oil production provides rapeseed animal meal as a by-product. The by-product is a high-protein animal feed, competitive with Soya been and mostly employed for cattle feeding, but not for chickens and pigs. The meal has a very low content of the glucosinolates responsible for metabolism disruption in cattle and pigs (Evans, 1997; Ghahreman, 1993; Zargari, 2001).Colza fruits are siliqua shape (5 to 10 cm) without hears. Each sliqua contains 15 to 40 seeds and opens from down part to release the seeds. In order to raise a crop of winter rapeseed, almost 100 to 150 pounds per acre of nitrogen and 25 pounds per acre of phosphorus have been applied. The seeds are planted into good moisture. In mid-April the crop will elongate and flower. Ground moisture at this time is most important to initiate and fill seed pods. Plants will grow to 4 to 6 feet by April 30 (Ghahreman, 1993; Zargari, 2001).

MEDICINAL AND FOOD PLANT MATERIALS

The seed oil of *B. napus* is usually used for medicinal or food purposes. In Iranian traditional medicine, the root parts of Colza were used for the therapeutic purposes as diuretic, anti-scurvy, anti-inflammatory of bladder and anti-goat (Zargari, 2001). Also, the seeds were

*Corresponding author. E-mail: goharii_a@sina.tums.ac.ir. Fax: +98-21-66461178.

documented to use for treatment of hepatic and kidney colic. Colza seeds are also used in the Eastern folk medicine as bronchial cathartic (Evans, 1997; Zargari, 2001).

Chemical constituents

The problems in the rapeseed *B. napus* L. var. *oleifera* breeding led to the change of fatty acid composition in seed oil. It is found that the combination of biotechnology approaches and classic methods of breeding resulted in optimization and further improvement of rapeseed oil composition (Sakhno, 2010). The usage of rapeseed oil as a food product as well as in the production of non-nutrition products such as greases, lubricant oils and especially diesel fuel may increase the rapeseed production in the world (Fulton, 2004). In the literature, the mean content of rapeseed oil is reported to be 43.3-46.1%. Among the tested rapeseed cultivars, in both years of the study the highest content of oil was recorded for rapeseed of the Bosman cultivar to be 41.4 to 46.1%. The content of saturated fatty acids in rapeseed oil has been reported varied (3.47-5.2%). The least variation in this respect has been observed during the two years in the seeds of the Liciassic cultivar. Furthermore, the presence of unsaturated acids with multiple bonds in molecules is the cause of their susceptibility to oxidation, which makes them less stable, especially during the storage (Bojanowska, 2006).

In a report, seeds of five different rapeseed cultivars were investigated for their fatty acid composition, glucosinolate profile, amino acids, total tocopherols and phenolic content, as selection criteria for developing genotypes with modified seed quality traits in *B. napus* L (El-Beltagi and Mohamed, 2010). Their results indicated a significant variability in fatty acids among all cultivars. The oleic acid (C18:1) ranged from 56.31 to 58.67%, linoleic acid (C18:2) from 10.52 to 13.74%, α-linolenic acid (C18:3) from 8.83 to 10.32% and erucic acid (22:1) from 0.15 to 0.91%. They reported small variations in the glucosinolate profile, and progoitrin and gluconapin as the major glucosinolate found. In addition, total phenolic contents varied from 28.0 to 35.4 µg/g dried weight.

Canola oil is made from selective bred plants that contain less than 2% erucic acid. *B. napus* and *B. rapa* are two examples of these cultivars, which contain lower erucic acid and glucosinolates, and they are very different from high erucic acid rapeseed oil in chemical, physical and nutritional properties (Dewick, 2003). The results of one report showed that the average moisture, ash, oil, protein and glucosinolate contents were measured as 5.92-6.58%, 3.23-4.95, 40.38-45.56, 21.43-27.01 and 21.43-50.63 µmol/g, respectively. In addition, fatty acids analysis showed the rage of C_{16} to C_{22}. The unsaturated fatty acids were more than saturated fatty acids. The maximum and minimum erucic acid level was found as 73 and 0.25%, respectively (Haq et al., 2009). Since *B. napus* oil can be easily contaminated with protein bodies and/or myrosin cells, it must be purified step by step using floatation technique in order to remove non-specifically trapped proteins. Genomic analysis led to the identification of sequences coding for major seed oil body proteins, including nineteen oleosins, five steroleosins and nine caleosins (Jolivet et al., 2009). In another report, three cultivars of *Brassica* (Westar, *Brassica napus*; Tobin, *B. rapa*; Cutlass, *B. juncea*) were grown in four locations and successive years. Harvested seed was extracted with hexane, ground and analyzed for mineral content. The average contents were reported (mg kg^{-1}) as Ca, 0.64; P, 1.12; Mg, 0.56%; Cu, 6.2; Zn, 46; Fe, 188; and Mn, 55. Locations affected all mineral levels. Year-to-year variability was of minor consequence (Bell et al., 1999).

The contents of soluble and insoluble condensed tannins have been reported in several varieties of rapeseed hulls, using the proanthocyanidin assay, ranged from 1913 to 6213 mg per 100 g of oil-free hulls (Naczk et al., 2000). The authors mentioned that the insoluble tannins were predominated and comprised from 70 to 95.8% of total tannins. The amounts of constituted tannins were reported as 4.7−14.1% of insoluble tannins. However, sinapoyl esters and proanthocyanidins (condensed tannins) are considered undesirable compounds in human nutrition, because they can cause a dark color together with a bitter taste in rapeseed meal. For this reason, they are currently limiting the use of canola seeds and other oilseed crops of the genus *Brassica* including *B. rapa*, *B. juncea* or *B. carinata* (Auger et al., 2010; Cartea et al., 2011; Zum Felde et al., 2007). It is reported that the seeds of winter rapeseed varieties contain high amounts of phenolic compounds. The most significant phenolic compounds are sinapic acid derivatives, together with minor phenolic compounds including *p*-hydroxybenzoic, vanillic, gentisic, protocatechuic, syringic, *p*-coumaric, ferulic, caffeic and chlorogenic acids. In leaves of oilseed rape, four hydroxycinnamic acids (caffeic, *p*-coumaric, ferulic and sinapic acid) were identified in the water-soluble phenolic fraction of the leaves (Szydlowska-Czerniak et al., 2010; Khattab et al., 2010).Literature review showed that the concentration of glucosinolates in the leaves of this plant increased by applying a salicylic acid soil drench. Developing leaves retained enhanced levels of glucosinolates longer than mature leaves. 2-Phenylethylglucosinolate showed the greatest increase in concentration, with only minor increases in other glucosinolates in developing leaves (Kiddle et al., 1994).

NATURAL HABITAT AND THE LAND UNDER CULTIVATION

World production is growing rapidly, with FAO reporting that 36 million tons of rapeseed was produced in the 2003-2004, and estimates of 58.4 million tons in the 2010-2011 (USDA, 2011). Colza is the native species growing in Asia, North and South America, and also Europe. China followed by India and Canada are the most important countries due to the most lands under cultivation. In Iran, Colza is cultivated in Mazandaran and Golestan provinces next to the Caspian Sea (Shariati and Ghazi-Shahnizadeh, 2000; USDA, 2011).

PHARMACOLOGICAL ACTIVITIES OF RAPESEED OIL

It has been reported that rapeseed oil diet contained 326 mg more plant sterols than the olive oil diet. Their results showed that rapeseed oil decrease cholesterol absorption by 11%, and increased excretion of cholesterol, bile acids, and their sum as sterols by 9, 32, and 51% compared to olive oil. The serum cholesterol level decreased by 7%, but a serum marker for cholesterol synthesis (lathosterol) as well as plant sterols remained unchanged (Ellegard et al., 2005).

Literature review showed that rapeseed oil, pure erucic acid and a control diet of sunflower seed oil during 24-26 weeks were studied in the rats. In spite of focal myocardial fibrotic lesions due to rapeseed oil, no changes were found with respect to the intrinsic myocardial contractility *in vitro* and *in vivo*. After inotropic intervention, the rapeseed oil fed animals showed less contractile reserve capacity. Neither rapeseed oil nor erucic acid feeding led to electrocardiographic changes in comparison with the control sunflower seed oil group. Their results confirmed that the rapeseed oil and erucic acid are not responsible for loss of contractile reserve capacity.

Furthermore, erucic acid may interfere with the peripheral vascular system and also fat rich diet might result in reduced myocardial function (de Wildt and Speijers, 1984). A relationship between erucic acid and myocardial changes in male rats has been reported by Hulan et al. (1976). The results of that study revealed that the myocardial lesions associated with feeding 20% rapeseed oil diets are not directly related to the contents of erucic acid. They suggested that an imbalance in the triglyceride of the oil may cause these lesions in rats. Kickler et al, (1996) reported that the physical properties of platelets may also be affected by erucic acid (Kickler et al, 1996). Their studies revealed that platelet counts and properties are influenced by monounsaturated fatty acids, in addition to the well-known effects of polyunsaturated fatty acids. It means that the ingestion of erucic acid affects platelet biology.

In another study, a diet containing 10% rapeseed (canola) oil or soybean oil was used as the only dietary fat in rats. The intake of rapeseed oil for 13 weeks increased systolic blood pressure, plasma levels of Na^+ and lipids, and decreased the level of K^+ compared to those in the soybean oil group. High density of neutrophils and low density of platelets were observed compared to the soybean oil group. They suggested that an increase in body fluid *via* activation of Na^+ pump or Na^+, K^+-ATPase and/or a blunt endothelium-dependent vasodilation by increased superoxide might be related to increase of blood pressure and hence, these would promote the peripheral vascular lesions and atherosclerotic vascular injury (Naito et al., 2000).

The effect of four fatty acids linolenic acid, linoleic acid, erucic acid and oleic acid were evaluated on the growth of the plant pathogenic fungi, *Rhizoctonia solani*, *Pythium ultimum, Pyrenophora avenae* and *Crinipellis perniciosa* (Walters et al., 2004). Erucic acid has been reported no effective on fungal growth at any concentration, while the antifungal activity have been exhibited by linolenic, linoleic and oleic acids. The effects of soil amendment with rapeseed meal from *Brassica napus* (high glucosinolate and low glucosinolate concentrations) on the biological control activity of *Trichoderma harzianum* towards *Sclerotinia sclerotiorum* and *Aphanomyces euteiches* have been examined (Dandurand et al., 2000) and resulted in no control root rot using Stonewall (low glucosinolate concentrations) meal alone, while combination of Stonewall meal with *T. harzianum* reduced the biocontrol efficacy of *T. harzianum*.

Other usages of rapeseed oil

The presence of a high quantity of erucic acid in natural rapeseed oil makes it toxic for consumption by humans (Reddy and Hayes 2007). The edible rapeseed oil was prepared from plant’s hybrid that contained little or no eurcic acid and used as cooking oil throughout the world. Edible rapeseed oil was termed as canola oil by the Western Canadian Oilseed Crushers Association in the year 1979. In addition, rapeseed oil can be used to produce bio diesel fuel. It is reported that, rape cake as a source of bio-methane greatly improves the energy balance of the system but is of little benefit to emissions (Thamsiriroj and Murphy, 2010). The by product that is left behind after the extraction of oil from the rapeseed, serves as a nutritious animal feed. This animal feed that is full of proteins is great for cattle (Patterson et al., 1999a). Rapeseed oil was also used as effective lubricating oil in case of oil lamps. It was also used in the production of soaps and plastics (Johnson, 1999). It has been found that the plant protects and enriches the soil so that it is grown during the winter time, as a cover crop in many countries. Canola in the rotation allows farmers to better manage their weeds. Because canola is a broadleaf crop, and because there are different herbicide tolerant varieties of canola, farmers have more options for weed control than in cereal crops such as wheat and barley (DPI, 2011). The use of *B. napus* to remove heavy metals from soil (phytoremediation) is expanding due to its cost-effectiveness compared to conventional methods. Roots of this plant are more effective in the uptake of Cu, Cd, Pb and Zn (Turan and Esringü, 2007).

CONCLUSION

The seed oil of *B. napus* is usually used for culinary purposes. In Iranian traditional medicine, the root parts of this plant were used for the therapeutic purposes as diuretic, anti-scurvy, anti-inflammatory of bladder and anti-goat. The medicinal properties of this plant have not been considered and are going to forget by researchers, although there is a world trend to elevate the cultivation of this plant for other usages such as greases, lubricant oils and bio-fuel. Therefore, the evaluation and more investigation on pharmacological and biological activities of *B. napus* are recommended especially using traditional and folk experiences based documents.

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