APIACEAE SEEDS AS FUNCTIONAL FOOD

Milica G. Acimović1*, Ljiljana M. Kostadinović1, Sanja J. Popović1 and Nevena S. Dojčinović2

1University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
2University of Novi Sad, Department of Biology and Ecology, Faculty of Sciences, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

Abstract: The aim of this review was to point to a great importance of plants from Apiaceae family as a functional food. Caraway (Carum carvi L.), anise (Pimpinella anisum L.), coriander (Coriandrum sativum L.), dill (Anethum graveolens L.), fennel (Foeniculum vulgare Mill.) and cumin (Cuminum cyminum L.) are plants from the above-mentioned family whose seeds are widely used in folk medicine, pharmaceutical industry, as spices, flavoring agents and as dietary supplements. These plants are rich in essential oil, which is a mixture of volatile compounds that give it a characteristic aroma. Their antioxidant and antimicrobial activities have been proven and because of these activities they have great potential to be used as natural food conservatives. These plants also have hypoglycemic and hypolipidemic activities as well as anticancer properties. They are used as food supplements in everyday nutrition and as natural health products for the prevention and treatment of many disorders such as inflammations, hyperglycemia, hyperlipidemia and others. Apart from this, these plants have real application in foods such as pastries, meat and dairy products, pickles and salads as well as spice blends like curry powder, garam masala and others.

Key words: spices, preservatives, antioxidants, hypoglycemic, hypolipidemic, anticancer properties.

Introduction

Increased health awareness has led many consumers to become more vigilant in maintaining good health. Many consumers have incorporated natural health products and functional foods into their daily nutrition to achieve optimal health and wellness (Nguyen et al., 2014). Spices and herbs have been added to food since the ancient times, not only as flavoring agents, but also as food preservatives. They have also been used in folk medicine (Kabić et al., 2008).

*Corresponding author: e-mail: acimoviebicmilica@gmail.com
Functional foods are complex products and may contain many pharmacologically active phytochemicals and these active ingredients may possess multiple biological activities rather than have only one effect on the human health (Nguyen et al., 2014). Considering the importance of functional food factors for the nutrition of humans and animals, an increasing scientific interest in health related effects occurring as a consequence of their content in the diet has emerged (Milovanović et al., 2009). In animal nutrition, functional foods are usually used as growth promoters and natural antibiotics. Therefore, this paper reviews the medicinal uses and bioactive properties of selected plants from Apiaceae family: coriander (*Coriandrum sativum* L.), dill (*Anethum graveolens* L.), caraway (*Carum carvi* L.), anise (*Pimpinella anisum* L.), fennel (*Foeniculum vulgare* Mill.) and cumin (*Cuminum cyminum* L.).

**Practical use in diet**

Herbs and spices have a long history of both culinary use and providing health benefits. Since the ancient times, the above-mentioned plants from Apiaceae family have been known as flavoring agents in food products due to their pleasant aroma. Apart from this, it is well known that they can act as preservatives. They can also be used for stimulating the excretion of digestive enzymes, relieving an abdominal spasm and eliminating flatulence. Today, this ancient knowledge has been proven by modern scientific methods, and many pharmacopeias recognize these plants as a part of the treatment of digestive disorders.

In addition to having antioxidant and other properties, herbs and spices can be used in recipes to partially or fully replace less desirable ingredients such as salt, sugar and saturated fat in, for example, marinades and dressings, stir-fry dishes, casseroles, soups and Mediterranean-style cuisine. Vegetable dishes and vegetarian options may be more appetizing when prepared with herbs and spices (Tapsell et al., 2006).

Apiaceae plants are usually included into nutrition through drinks, mainly alcoholic beverages, and through food. For example, Turkish raki and Greek Ouzo are aniseed spirits used as aperitifs (Anli and Bayram, 2010). In Scandinavian countries, Aquavit is a very popular alcoholic caraway-flavored beverage (Aylott, 2003). Absinthe is a world-known alcoholic beverage which, among other medicinal herbs, contains fennel and anise (Lachenmeier et al., 2010).

When food flavoring is in question, spices can be added to pastries, meat and dairy products, pickles and salads. Apiaceae seeds are used in products such as bread, cookies and biscuits, and as ingredients in herb mixes which do not adversely affect the sensory quality of the product but provide a specific aroma. These herb mixtures, as well as products with them, exhibited antioxidant activity (Mišan et al., 2009; Psodorov et al., 2007).
In meat industry, Apiaceae are favorable spices. Numerous meat products are recognized as products with added spices. For instance, mortadella sausage contains coriander (Charles, 2013), while traditional Petrovačka sausage contains caraway seeds (Hromiš et al., 2014). In dairy industry, caraway and dill essential oils could be successfully used as safe and natural anti-pathogen sources in the production of cheese and yoghurt (Mohamed et al., 2013).

The microbiological quality of food constituents is one of the essential bases of its ability to satisfy the safety requirements of the consumer. Food exposed to fungal deterioration can have a decrease in its sensory, nutritive and medical characteristics. In spite of the improvements in food conservation techniques, the nature of food conservatives is an important question for public health. Fennel essential oil could be regarded as a very promising preservative in food industry. It is able to prevent the mycelia growth responsible for food deterioration (Cetin et al., 2010; Barkat and Bouguerra, 2012).

Dill, with respect to the characteristic aroma, is used to flavor pickled vegetables, especially cucumber. Spice blends such as curry powder, which contains coriander and cumin, or garam masala containing caraway, are often used in preparation of many dishes, especially in Asian cuisine. The oil and the extract from Apiaceae seed can be added to fatty oil, as in case of dill or coriander for sunflower oil stabilization (Mousavi et al., 2013; Ramadan, 2013).

**Active compounds from Apiaceae plants**

Plants from Apiaceae family are rich in fatty oil, proteins, crude, carbohydrates and essential oil. Nowadays, these plants are usually grown in order to obtain a controlled quality of raw materials and are rarely collected from nature. Many plants from Apiaceae family can be grown in Serbia and they have a high potential for seed yield, as well as for essential oil content and good quality of oil (Aćimović, 2013; Aćimović et al., 2015a). A range of bioactive compounds in Apiaceae have been studied and it has been concluded that essential oil has better potential than others. Linalool is the dominant compound in coriander seed essential oil (Aćimović et al., 2011b), while in the essential oil from aerial plant, trans-2-decenal, decanal and dec-9-en-1-ol are identified as major constituents (Padalia et al., 2011). Different chemical profiles of seed and herb have also been determined in dill. Dominant compounds in dill seed essential oil are carvone and limonene (Aćimović et al., 2014c), while in dill herb, the dominant compounds are α and β-phellandrene (Starumite et al. 2012). In caraway seed, the main compounds are carvone and limonene (Aćimović et., 2014a), in anise and fennel, trans-anethole (Aćimović et al., 2014b; Aćimović et al., 2015b), while in cumin, γ-terpinene-7-al and cumin aldehyde (Aćimović et al., 2014d).
Functional properties of Apiaceae plants

Functional properties of Apiaceae plants stem from or are determined by the roles and functions of their essential oils. Coriander, dill, cumin, fennel, anise and caraway have great pharmacological potential (Aćimović et al., 2011a; Heamalatha et al., 2012; Jamwal et al., 2013; Aćimović and Dojčinović, 2014; Agrahari and Singh, 2014). The study of natural products has been the single most successful strategy for the discovery of new medicines used to treat a great number of diseases. Plants were used for healing centuries ago, and in recent years, a large number of studies have documented the efficacy of plants and their chemical constituents as a source of new bioactive natural products. The antidiabetic, hypolipidemic and antioxidant activities exhibited by the Apiaceae are a result of the synergistic action between the bioactive compounds present in the seeds (Rajeshwari et al., 2011).

Antimicrobial potential of Apiaceae plants. Plants from Apiaceae family possess a strong antimicrobial activity against a wide range of pathogens. Active compounds from essential oils are effective against many gram positive and gram negative bacteria, so they can be used as natural antibiotics or in combination with synthetic antibiotics to reduce the resistance to standard remedies (Toroglu, 2011). Helicobacter pylori is well recognized as a major etiologic factor in gastroduodenal diseases such as chronic gastritis, peptic ulcers and others. Caraway, anise, fennel and coriander can be successfully used against this bacterium (Atapour et al., 2009; Zaidi et al., 2012).

Candida albicans is an opportunistic pathogen for some immunologically weak and immunocompromised people. It is responsible for painful mucosal infections. Fennel, caraway and dill possess antifungal properties against this fungus (Skrobonja et al., 2013; Chen et al., 2013). There are many other microorganisms such as Klebsiella pneumonia and Pseudomonas aeruginosa against which dill and fennel can have a strong antimicrobial activity (Kaur and Arora, 2009), or viruses such as herpes simplex virus, human cytomegalovirus (HCMV) and measles virus against which anise has antiviral properties (Lee et al., 2011).

Antioxidant potential of Apiaceae plants. Antioxidants from Apiaceae plants can be used to reverse the harmful and pathological effect of free radicals (Christova-Bagdassarian et al., 2013). The same conclusions are reported by other authors (Oktay et al., 2003; Gülçin et al., 2003; Ramadan et al., 2013; Darougheh et al., 2014). Free radicals could damage biomolecules which could lead to severe diseases. Coriander shows potential for preventing oxidative stress-related diseases and would be useful as a supplement in combination with conventional drugs to enhance the treatment of diseases such as cancer (Tang et al., 2013), while caraway improves immune functions (Moubarz et al., 2014). Dill can be used as hepatoprotectant (Tamilarasi et al., 2012; Ali, 2013), while fennel exhibits inhibitory effects against acute and subacute inflammatory diseases and type IV
allergic reactions and shows a central analgesic effect. Due to all these positive influences, it can be used in relieving inflammation (Choi and Hwang, 2004). Anise is also a promising source of natural radical scavengers, anti-peroxidative and anti-diabetic agents such as phenolic compounds that may have potential applications in combating oxidative stress caused by free radicals (Shobha et al., 2013). Results indicate that cumin has efficient free radical scavenging and metal chelating activity to protect biomolecules like proteins, lipids and DNA against oxidative stress (Dua et al., 2012).

Hypoglycemic potential of Apiaceae plants. It is reported that caraway, coriander and fennel have hypoglycemic effects. This could be due to the effect of increasing pancreatic secretion of insulin from the cells of islets of Langerhans (Shaffie et al., 2010). The result suggests an antidiabetic property of dill seeds (Mishra, 2013), as well as cumin seeds (Eidi et al., 2004). In addition, the treatment of type 2 diabetics with anise seeds effectively controls oxidative stress by altering the number of erythrocyte and serum biochemical parameters without any detrimental effects (Rajeshwari et al., 2010).

Hypolipidemic potential of Apiaceae plants. Hyperlipidemia can be inherited and increases the risk of the blood vessel diseases leading to stroke and heart disease. By introducing coriander seed in nutrition, the risk of vascular complications could be reduced by lowering plasma lipid levels (Dhanapakiam et al., 2008). Fennel showed hypolipidemic activity by decreasing the deposition of triglycerides in the fatty liver form. It also facilitates better blood flow through the coronary arteries by preventing the deposition of lipids by reducing serum and liver lipids. Therefore, fennel can be used for the prevention of cardiovascular diseases (Oulmouden et al., 2014). Similarly, caraway, dill and cumin seeds extracts also decreased lipid levels when induced in the nutrition of hyperlipidemic rats (Dhandapani et al., 2002; Hajhashemi and Abbasi, 2008; Saghir et al., 2012).

Anticancer potential of Apiaceae plants. Caraway possesses the potential of being a promising anticancer agent in improving brain tumor therapy (Aydin et al., 2013). Furthermore, dill showed non-cytotoxicity in normal cells, whereas it exhibited great anticancer activity on KB-Oral cavity and MCF7-Breast cancer cells (Peerakam et al., 2014). Treatment with anise seed extract had antiproliferative and apoptotic effects on cancer cells (Kadan et al., 2013). Thus, anise could be one of the supplements that contribute to cancer prevention and treatment. It could also be a natural source of novel anticancer compounds with antiproliferative and/or apoptotic properties. Fennel also exhibited an antitumor effect by modulating lipid peroxidation and augmenting the antioxidant defense system in Ehrlich ascites carcinoma bearing mice with or without exposure to radiation (Mohamad et al., 2011). Experiments show that coriander possesses high anticancer activity against colon cancer H-29 Cell lines (Nithya and Sumalatha, 2014). Similar results have been obtained for cumin as well (Prakash and Gupta, 2014).
Conclusion

Due to all positive characteristics, such as antidiabetic, hypolipidemic and antioxidant activities, likewise antimicrobial and anticancer properties, Apiaceae seeds as well as their essential oils appeared as promising for safe use in everyday nutrition as food supplements and as raw materials in the pharmaceutical and food industries.

Acknowledgements

The authors would like to thank the Provincial Secretariat for Science and Technological Development, Autonomous Province of Vojvodina [114-451-2373/2014-03].

References


Received: March 19, 2015
Accepted: May 21, 2015

SEME APIACEAE KAO FUNKCIONALNA HRANA

Milica G. Aćimović¹, Ljiljana M. Kostadinović¹,
Sanja J. Popović¹ i Nevena S. Dojčinović²

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije,
Bulevar cara Lazara 1, 21000 Novi Sad, Srbija
²Univerzitet u Novom Sadu, Prirodno-matematički fakultet, Departman za biologiju i ekologiju, Trg Dositeja Obradovića 3, 21000 Novi Sad, Srbija

Rezime


**Ključne reči:** začini, konzervansi, antioksidansi, hipoglikemik, hipolipidemik, antikancerogen.


*Autor za kontakt: e-mail: acimovicbicmilica@gmail.com*