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An overview on the most important native medicinal plants against flour beetle

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ABSTRACT

Contamination with pests is the main problems of stored food products and can defects them from harvest time until storage. Pests have high proliferation rate, global distribution, and sometimes damage foods up to a hundred percent. Nowadays plant materials are used for pest control in warehouses. Volatile essential oils are important compounds to combat fungal pathogens, insects, herbivores and pests in stored food products. Herbs and botanicals have insecticide and insect repellent properties and are good alternative to chemical insecticides. This paper was aimed to have an overview on the most important native medicinal plants against flour beetle. All required information was obtained by searching key words such as flour beetle, medicinal plant extracts or essential oils and Iran of published articles in authentic scientific databases such as Sciencedirect, Blackwell wiley, Springer, Scopus, Pubmed, Google scholar and Scientific information database (SID) and Magiran. *Eucalyptus globulus, Perovskia atriplicifolia, Azadirachta indica Adr. Juss, Artemisia sieberi Besser, Carum copticum C. B. Clarke, Cuminum cyminum L, Bunium persicum Boiss, Elletaria cardamomum Maton, Nerium oleander L, Lavandula officinalis L, Ferula assafoetida L, Rosmarinus officinalis L. Artemisia dracunculus L, Foeniculum vulgare, Satureja hortensis L, Zygophyllum fabago L, Delphinium persicum, Calotropis procera (Ait.) R. Br* are the main medicinal plants can affect on flour beetle. They have various compounds and based on the results of phytochemical studies each of active compounds of medicinal plants could have potential anti pest effects against flour beetle. Therefore, it is recommended that all active ingredients are investigated in experimental and pharmacological studies and in case of positive effects, they used for production of natural anti pest compounds against the flour beetle.

KEY WORDS: Insect, Flour beetle, Medicinal plants, Iran.

1. INTRODUCTION

Population growing in the world is causing food crisis. In this condition, foods and agricultural products should be stored and protected from insect's contamination by different materials such as synthetic chemical pesticides (Chaubey, 2007). Contamination with pests is the main problems of stored food products and can defect them from harvest time until storage. Pests have high proliferation rate, global distribution, and sometimes damage foods up to a hundred percent (Modarres Najafabadi, 2002).

Infectious and non-infectious diseases are day by day increasing in prevalence. Epidemiological studies have highlighted detection of disease course and strategies of disease prevention and management (Al-Saqladi, 2007; (Badparva, 2014; Bahmani, 2012; Badparva, 2014; Badparva, 2014; Delpisheh, 2008). Cereals are one of the most important foods for human that are kept in warehouses post-harvest until consumption and are vulnerable product to pests (Hill, 1990). Flour beetle is a serious considered pest of stored cereals that not only can cause significant loss in crop nutrition, but also can reduce their quality due to the rapid increase in population and contamination with their feces and larval shells (Tapondjou, 2002).

Studies show that 10-40 % of world warehoused cereals are destroyed by pests annually causing considerable economic loss (Chaubey, 2007). About ten percent of stored cereals of warehouses are destroyed by pests in Iran (Masotti, 2003). Studies showed that pesticides have harmful effects to human and can endanger environment health.

Excessive and continuous use of pesticides has caused serious problems such as direct toxicity to parasitoids, predators, pollinators, fish, humans, development of pest resistance to pesticides and outbreaks of pests, loss of pesticides efficacy and remaining toxic residues on crops and cereals (Tapondjou, 2002). Associated problems with the use of chemical pesticides enhanced efforts to find effective, safe and functional alternative compounds (Rafieian-Kopaei, 2012).

Some advantages of herbal insecticides such as less toxicity to humans, rapid degradation in environment, their suitability for small-scale applications and their wide spectrum effects considered them suitable as an alternative to chemical insecticides (Nasri and Shirzad, 2013).

Nowadays plant materials are used for pest control in warehouses. Volatile monoterpenes or essential oils are important compounds for combat with fungal pathogens, insects, herbivores and pests in stored food products (Sharafati-chaleshtori, 2014; Langenheim, 1994). Herbs and botanicals have insecticide and insect repellent properties and are good alternative to chemical insecticides (Negahban and Moharramipour, 2007).

Medicinal herbs are safe and cheap sources to treat diseases (Mahfuz and Khalequzzaman, 2007; Mahmud, 2002; Pimentel, 1977, 1980; Zettler, 1991; Topondjon, 2005; Bahmani, 2014; Mervat Sh Sadak, 2016; Bahaa, 2016; Kh, 2015; Yasser, 2015; Fitri, 2016; Gad and Abdel-Moez, 2015; Khaled, 2016; Kartini Zailanie, 2015; Helmina Br. Sembiring, 2015; Bahmani, 2013, 2014, 2015, 2016; Delfan, 2014; Sarrafchi, 2016; Amirmohammadi, 2014; Eftekhari, 2012;). Their bioactive effects are due to biological materials, especially phenolic compounds which have antioxidant activities (Bahmani, 2013, 2014, 2015; Gholami-Ahangaran,, 2012; Parsaei, 2016; Mohsenzadeh 2016; Jivad, 2016; Parsaei, 2016; Samarghandian, 2016; Parsaei , 2016; Mohsenzadeh, 2016; Forouzan, 2012; Gholami-Ahangaran, 2012; Delfan, 2014; Asadi-Samani, 2014; Bahmani, 2014; Delfan, 2014; Saki, 2014; Sewell and Rafieian-Kopaei, 2014). The therapeutic effect of many medicinal plants has been shown in previous studies (Asadbeigi, 2014; karamati, 2014; Bahmani, 2014; Saki, 2014; Bahmani, 2014). The aim of this review study was to reporting native medicinal plants used to eradicating flour beetle in warehoused cereals.

2. MATERIALS AND METHODS

All required information was obtained by searching key words such as Flour beetle, medicinal plant extracts or essential oils and Iran of published articles in authentic scientific databases such as Sciencedirect, Blackwell wiley, Springer, Scopus, Pubmed, Google scholar and Scientific information database (SID) and Magiran.

3. RESULTS

Eucalyptus globulus, Perovskia atriplicifolia, Azadirachta indica Adr. Juss, Artemisia sieberi Besser, Carum copticum C. B. Clarke, Cuminum cyminum L, Bunium persicum Boiss, Elletaria cardamomum Maton, Nerium oleander L, Lavandula officinalis L, Ferula assafoetida L, Rosmarinus officinalis L. Artemisia dracunculus L, Foeniculum vulgare, Satureja hortensis L, Zygophyllum fabago L, Delphinium persicum, Calotropis procera (Ait.) R. Br are the main medicinal plants can affects on flour beetle. Additional information about native medicinal plants against flour beetle was shown in table 1.

Table.1. Scientific, family and Persian name of important native medicinal plants against flour beetle of Iran

No	Scientific name	Family name	Persian name	Description
1	*Eucalyptus globulus*	Myrtaceae	Eucalyptus	Results of a study showed that the mortality rate of flour beetle by *E. globulus* essential oil in concentrations of 0.35, 0.7 and 1.41 µl/cm^2 were 19.44, 16.7 and 18 %, respectively. The average repellency rate of this Eos, in four concentrations of 0.93, 0.62, 0.31, and 0.1µl/cm^2 was 83.2 %. (Bagheri F. 2011).
2	*Perovskia atriplicifolia*	Lamiaceae	Brazambal	Obtained results of a hurdle food preservation method showed that a dose of 100 Gy of gamma radiation alone caused 12.5 % deaths among adult flour beetle. Mortality rate of flour beetle with essential oils of *P. atriplicifolia*, alone was 6.25%. But 7 days after irradiation exposure with 7.66 ml/L of air contained EOs, mortality rate of insect was 32.5% (Ahmadi M. 2009).
3	*Azadirachta indica* Adr. Juss	Meliaceae	Chrish	Results of a study showed that the inhibitory effects of the leaves of *A. indica* Adr. Juss on the flour beetle was 5.33 grams per 100 grams of food (Modareseh-Najafabadi SS. 2009).
4	*Artemisia sieberi* Besser	Asteracae	Darmaneh	Results of a study showed that essential oils of *A. sieberi* Besser have a high impact on the growth rate and relative food consumption of adult flour beetle (Negahban M. 2007).
5	*Carum copticum C. B. Clarke*	Apiaceae	Zeniyan	Results of an experimental study showed that increasing the concentration of essential oil of *C. copticum C. B. Clarke* has been significantly effective on flour beetle feeding index. Essence of C. copticum significantly reduced relative growth rate, feed conversion efficiency and eaten food by flour beetle. With increasing

				concentration, feeding index decreased significantly (Sahaf BZ. 2008).
6	*Cuminum cyminum* L.	Apiaceae	Zireh sabz	Results of a study showed that a concentration of 2000 ppm of *C. cyminum L.* has a good anti flour beetle effect. Relative growth rate of flour beetle in 10000 ppm concentration in comparing to control decreased about 55 percent (Khodadoust M. 2008).
7	*Bunium persicum* Boiss.	Umbelliferae	Zireh siyah	Results of a study showed that the highest mortality rate was 36.3% and 40% in female and male flour beetle, respectively due to impact of *B. persicum Bois.* essential oil after 9 hours (Morovaj GHH. 2009)
8	*Elletaria cardamomum* Maton.	Zingiberaceae	Hel	Results of an experimental study showed that *E. cardamomum Maton.*essential oil at concentrations of 0.46 µl/cm^2 and 0.79 µl/cm^2 causes of death in 55.00 ±6.1 % and 16.67±6.15 % population of males and females flour beetles, respectively (Nazemi-Rafi J and Moharami pour S. 2007).
9	*Nerium oleander* L.	Apocynaceae	Kharzahreh	Results of a study showed that *N.oleander* L. extract had 7.5 - 10.25 % and 54.25-59 % repellency effects at the lowest and highest concentrations. *N.oleander* L. extract's death effect on flour beetle at concentrations of 1.99 µl/cm^2 and 27.78 µl/cm^2 were 8.75 ± 1.02 % and 59.00 ± 2.37 %, respectively (Mirkazemi F. 2008).
10	*Lavandula officinalis* L.	Lamiaceae	Ostokhodus	Results of an experimental study showed that repellency effect of *L. officinalis L.*extract on flour beetle at a concentration of 27.78 µl/cm^2 was 5.5% (Mirkazemi F. 2008)
11	*Ferula assafoetida* L.	Apiaceae	Anghuzeh	Results of an experimental study showed that repellency effect of *F. assafoetida* L.extract on flour beetle at a concentration of 1.99 µl/cm^2 was 30.50% (63 Mirkazemi F. 2008
12	*Rosmarinus officinalis* L.	Lamiaceae	Aklil Koohi	Results of an experimental study showed that mortality rate of flour beetle at a concentration of 185.2 µl/L of essential oil of *R.officinalis* L. were 5 % after 12 hours (Karami E. 2011).
13	*Artemisia dracunculus* L.	Asteraceae	Tarkhoon	Results of an experimental study showed that mortality rate of flour beetle at a concentration of 185.2 µl/L of essential oil of *R.officinalis* L. were 95 % after 24 hours (Karami E. 2011).
14	*Foeniculum vulgare*	Apiaceae	Raziyaneh	Results of an experimental study showed that mortality rate of flour beetle at a concentration of 185.2 µl/L of essential oil of *F.vulgare* were 18 % after 24 hours (Karami E. 2011).
15	*Satureja hortensis* L.	Lamiaceae	Marzeh	Results of an experimental study showed that mortality rate of flour beetle at a concentration of 185.2 µl/L of essential oil of *F.vulgare* were 18 % after 24 hours (Karami E. 2011).
16	*Zygophyllum fabago* L.	Zygophyllaceae	ghich	Average larvicidal effect of hexane extract of *Z.fabago L* at 50 %, 25%, 12% and 6% concentrations were 84.53 ± 0.03 %, 74.22 ± 0.01 %, 51.03 ± 0.02 % and 32.98 ± 0.05 %, respectively (Karami E. 2011).
17	*Delphinium persicum*	Zygophyllaceae	Zaban dar ghafa	Average larvicidal effect of hexane extract of *D. persicum* at 50 %, 25%, 12% and 6% concentrations were 79.38 ± 0.00 %, 69.07 ± 0.01 %, 45.87 ± 0.03 % and 30.41 ± 0.01 %, respectively (Karami E. 2011).

18	*Calotropis procera* (Ait.) R. Br	Asclepiadaceae	Estabragh	Average larvicidal effect of hexane extract of *C. procera* (Ait.) R. Br at 50 %, 25%, 12% and 6% concentrations were 51.03 ± 0.05 %, 35.56 ± 0.01 %, 22.68 ± 0.02 % and 12.37± 0.01 %, respectively (Karami E. 2011).

DISCUSSION

Currently one of the most common methods of pest control in food warehouses is use of pesticide compounds. But due to their toxicity and other side effects on human, application of custom pesticides is limited (64). Obtained results showed that *E. globulus, P. atriplicifolia, A. indica Adr. Juss, A. sieberi Besser, C. copticum C. B. Clarke, C. cyminum L, B. persicum Boiss, E. cardamomum Maton, N. oleander L, L. officinalis L, F. assafoetida L, R. officinalis L. A. dracunculus L, F. vulgare, S. hortensis L, Z. fabago L, D. persicum, C. procera (Ait.) R. Br* is the main important medicinal plants against flour beetle.

Phytochemical studies showed that 1,8 cineole and Artemisinin are the main compounds in *E. globulus* and *A. sieberi* plants, respectively (Stamopoulos, 2007). Major components in essential oil of *C. copticum* are thymol, trip nene, phellandrene, pinene Group, myrcene Group that mostly are oxygenated monoterpenes (Nagulakshmi, 2000). Major compounds of *Cuminum cyminum* L. are sabinene, flavonoids, polysaccharides, coumarin, Cuminaldehyde, pinene and terpinene (Demirci, 2008) but cuminaldehyde compounds, alpha and gamma terpinene have been identified as main components in essential oil of *Bunium persicum* Boiss. (Shankaracharya and Shankaracharya, 1988).

Phytochemical studies show that chemical compounds of *Elletaria cardamomum* Maton. are various such as limonene, sabinene, n heptane, phytal, eugenyl acetate, linalool, beta-pinene, alpha-Pinene, sitosterol, citronellol and terpinenes (Gopalakrishnan, 1990; Duke and Duke, 1992). Important chemical ingredients of *Lavandula officinalis L.* are β-ocimenes, cineole, camphor, sesquiterpenes, Caryophyllene oxide, tannin, rosmarinic acid derivatives, coumarine, linalyl acetate and linalool (Denner, 2009).

Main chemical compounds of *Ferula assafoetida* L.gum are di, tri and tetra sulfide, can pherol, sesquiterpene coumarins derivatives such as epi samarcandin and umbelliprenins (Rajabian, 2007; Hassani, 2008; Omidbaigi, 2005). Bud essential oil of *Rosmarinus officinalis L.* in addition to eugenol other compunds can also be found such as phenol, α-copaene, caryophyllene, Alpha-humulene, Alpha farnesene, cadinene, caryophyllene oxide (Wenqiang, 2007). Estragole, methyl eugenol and benzodiazepine are the main chemical compounds of *Artemisia dracunculus* L. (Ribnichy, 2004). Main chemical compounds of essential oil of Foeniculum vulgare are anethole, di- anethole, photo anethole, fenchone and camphene (Curry, 1987). Satureja hortensis L. is a rich source of carvacrol and flavonoids (Calsamiglia, 2007).

Based on the results of phytochemical studies each of active compounds of medicinal plants could have potential anti pest effects against flour beetle. Although there are a lot of compounds in herbs which may have ant-pest activities, however, in most cases the anti-microbial activity of plants have been attributed to their phenolic compounds (Sharafati-chaleshtori, 2010; Sharafati, 2011; Rahimian, 2013; Sharafati-chaleshtori, 2014; Amanpour, 2015; Bahmani, 2013). Therefore, a part of these plant actions should be due to their phenolic compound. These compounds are the predominant components of a lot of other plants (Asadi, 2013; Bahmani, 2013; Parsaei, 2013; Amirmohammadi, 2014; Shirzad, 2009; Taghikhani, 2012; Taghikhani, 2014; Shirzad, 2011; Heidarian E, Rafieian-Kopaei, 2013; Madihi, 2013; Baradaran, 2014; Nasri, 2013; Rabiei, 2014; Nasri, 2014; Madihi, 2013). Phenolic compounds in medicinal plants also have antioxidant activity (Nasri, 2013; Rafieian-Kopaie, 2013; Baradaran, , 2012, 2013, 2014; Rafieian-Kopaei, 2013; Sedighi, 2012; Nasri, 2013, 2014, 2015; Rafieian-Kopaei, 2013; Nasri, 2015; Rafieian-Kopaei, 2014; Karimi, 2015). Therefore, these groups of plants may have other therapeutic properties, having more beneficial effects (Azadmehr, 2011; Nasri and Rafieian-Kopaei, 2013; Nasri, 2013, 2015; Setorki, 2013; Akhlaghi, 2011; Rabiei, 2013; Rabiei, 2014; Rafieian-Kopaei, 2011, 2014; Mirhosseini, 2014; Rahnama, 2015; Shaygannia, 2015).

In sum, it is recommended that all active ingredients are investigated in experimental and pharmacological studies and in case of positive effects, they used for production of natural anti pest compounds against the flour beetle.

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