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Review Article

Pyrethrum an Organic and Natural Pesticide

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ABSTRACT

Pyrethrum (*Tanacetum cineraiifolium*) is a perennial plant in the family of Asteraceae which is cultivated for the production of six closely related esters called pyrethrins, which possess insecticidal properties. Pyrethrins can be separated into two groups of three ester compounds: pyrethrin I and II. The pyrethrin I fraction contains chrysanthemic acid products, including pyrethrin I, cinerin I, and jasmolin I. The pyrethrin II fraction is derived from pyrethric acid made up of pyrethrin II, cinerin II, and jasmolin II. Using natural pesticide may lead to organic farming, and advantage of organic farming is more beneficial to biodiversity and the environment, and of course organic produce reduces dietary exposure to pesticides. Organic farmers can use pyrethrins as an insecticide for fruit and vegetable crops. Easily degraded by oxygen, light and temperature, pyrethrum compounds are environmentally friendly and compatible with organic farming.

Keywords: Pyrethrum, Natural Pesticide, Medical Herb, Silk Road

INTRODUCTION

Botanical insecticides keep attracting more attention from environmental and small farmers worldwide as they are considered as a suitable alternative to synthetic insecticides. Pyrethrum (*Tanacetum cineraiifolium*) is a perennial in the Astraceae that has been widely used for pyrethrin production (Moslemi et al., 2018). The interest in sustainable agriculture has increased in these years, and the demand for plant-derived persticides which can be less toxic both to mammals and to the environment (Ogbaji et al., 2018; Shahrajabian et al., 2013, 2018, 2019a,b,c,d,e, 2020; Soleymani et al., 2012a,b; Sun et al., 2019a,b; Sun et al., 2020a,b). Insecticidal pyrethrins are extracted from the achenes within the flower heads, and represent the economically most important natural pesticide which are neurotoxins effective against a wide range of insect species, and broadly applied in private homes, gardens, stables and organic agriculture, because they have environmentally friendly properties (Yang et al., 2014). About 200 years ago, it was discovered in central Asia. During the Napoleonic wars (1804-1815) this insect power was used to control flea and body lice infestations by French soldiers. The white Chrysanthemum flower, pyrethrum, is a mentioned in early Chinese history and it is believed to have passed into Europe along the silk routes. The first record of the pyrethrum was 2000 years ago at the time of China's Chou Dynasty, then the flowers have been traded along ancient Silk Road and was grown in the Dalmatian region. But, the species of plant was unknown, so for convenience the history of pyrethrum usually starts with the mention in 1847 of the identified species *Chrysanthemum cinerariaefolium* found in Dalmatia which is part of Croatia. From 1885, bales of dried flowers were exported to the USA and during 1913, 500 tonnes were shipped. Although the earliest mention of the Chrysanthemum flowers from which it originates comes from early Chinese history, where it is believed that the flower passed into Europe along the silk roads. The term pyrethrum refers to the dried and powdered flower heads of a white-flowered, daisy-like plant belonging to the *Chrysanthemum* genus. Pyrethrum's insecticidal properties were recognized in the middle of the 19th century, when an American named Jumticoff discovered that many Caucuses tribes used it for the control of the body lice. The earliest cultivation of pyrethrum, also called Persian pyrethrum or Persian powders, was in the region of the Caucuses extending into Northern Persia. The first Persian powders that were processed and commercialized in Europe in the 1820s were most likely prepared from a mixture of *C. roseum* and *C. corneum*. The first major commercial planting was done in Yugoslavia prior to 1914, thereafter Japan was the main producer until 1939 when Kenya and other East African countries took over after the second world war (Mkawale, 2001). Pyrethrum was first introduced into Tasmania and a crop improvement program begun in 1978. The commercial production of the crop started with selected clones from the program in 1984, and the crop is well stablished and commercially viable in Tasmania. Tasmania is one the largest pyrethrum producer. On a dry weight basis a pyrethrum inflorescence contains the majority of the plant's active compounds, reported in the range 1-2% pyrethrins (Sastry et al., 2001). Pyrethrum is highly effective against many species of insects but its toxicity to people and warm-blooded animals is low because of its fast biotransformation (Duchon et al., 2009; Sharafzadeh, 2011). Pyrethrum could be used by municipal utilities or in organic, integrated or

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conventional crop cultivation because of its natural origin and high biocide effect; pyrethrum has been used mainly for protection of cereal products, vegetables and animals, and it could also be used to protect human habitats and animals against insects. There are some possible uses: the first is spraying the fine dry pulp of flowers and the other spraying their extract. A third form is incense sticks to protect against mosquitoes causing malaria (Toth et al., 2012). Pyrethrum is a white flower headed, tufted perennial herbaceous plant possessing deeply lobed leaves, with numerous and fibrous shallow root system (30 cm). The plant has numerous fairly rigid stems that grow up to 50 to 80 cm in height with blue-green deeply divided leaves that are covered on both sides by a dense woolly material. Pyrethrum requires rich soils in phosphorous, calcium and magnesium with a minimum soil pH of 5.6. The appropriate situation is fertile and well drained soils with reasonably possess good texture and structure. This crop is spring sown, with its first harvest occurring approximately 15 months after establishment and up to three subsequent annual harvests thereafter (Vaghefi et al., 2016). Ray blight is one of the most important disease of pyrethrum which produces typrical nercrotic symptoms on leaf margins, shoots and developing buds in spring (Vaghefi et al., 2016; Pethybridge et al., 2018).

MATERIALS AND METHODS

This short communication included randomised control experiments, review articles, observational and analytical designs which have been surveyed in Google Scholar, Scopus, Research Gate and PubMed by using keywords including Pyrethrum, Natural Pesticide, Medical Herb and Silk Road. All relevant papers in both English and Chinese language were searched. All authors screened the articles first by reviewing related titles, then abstracted and after that going through the whole manuscripts.

RESULTS AND DISCUSSION

The *pyrethrins* properties of insect flushing, excitation, quick knockdown, rapid degradation and low mammalian toxicity are desired in short term grain protection, but where long-term storage period is required, there is need for reapplication or additional of anti-oxidant (Atkinson et al., 2004). Chesang et al. (2017) concluded that increased proportion of unstabilized pyrethrins in combination with diatomaceous earth offer grain protection comparable to the commercial chemical grain protectants. Pyrethrins can be separated into two groups of three ester compounds: pyrethrin I and II. The pyrethrin I fraction contains chrysanthemic acid products, including pyrethrin I, cinerin I, and jasmolin I. The pyrethrin II fraction is derived from pyrethric acid made up of pyrethrin II, cinerin II, and jasmolin II. Pyrethrins also have the advantage over other synthetic insecticides of being rapidly broken down upon exposure to light and air, are metabolized quickly, and can be used in the production of organic farm products, and they generally considered to be non-polluting. Roncevic et al. (Roncevic et al., 2014) the roots of pyrethrum plants were characterized by a combination of loadings of iron, aluminium, nickel, chromium, strontium, and barium, while the stems, leaves, and flowers showed more contributions from sodium, potassium, calcium, magnesium, phosphorus, sulphur, manganese and copper. They have also observed that microelements such as copper, aluminium, and iron were more readily transderred into natural insecticide extracts. Duchon et al. (2009) suggested that pyrethrum maybe a potential candidate for the impregnation of mosquito nets and textiles in areas where resistance to pyrethroids has become problematic. Rehman et al. [28] stated that pyrethroids are broadly classified into first and second generation pyrethroids. The first generation (Type 10 pyrethroids are less toxic to mammals than the second generation (Type II) pyrethroids. Biologically active compounds quantified from pyrethrin extract is shown in Table 1. Relative proportions of the sex esters in a typical 50% extract of pyrethrum are presented in Table 2. Common names of natural esters and synthetic analogs and origin or possible origin of names are shown in Table 3. Some outstanding properties of pyrethrum are displayed in Table 4.

Table 1. Biologically active compounds quantified from pyrethrin extract.

Common name	abbreviations	Molecular	
		Formula	Weight
Pyrethrin I	Py I	C21H28O3	328.4
Pyrethrin II	Py II	C22H28O5	372.4
Cinerin I	C I	C28H28O3	316.4
Cinerin II	C II	C21H28O5	360.4
Jasmolin I	J I	C21H30O3	330.4
Jasmonlin II	J II	C22H30O5	374.4

Table 2. Relative proportions of the sex esters in a typical 50% extract of pyrethrum.

Cinerin I	3.7%				
Jasmolin I	2.0%	Pyrethrins I	24.7%		
Pyrethrin I	19.0%				
				Total Pyrethrins	50%
Cinerin II	5.8%				
Jasmolin II	2.0%	Pyrethrins II	25.3%		
Pyrethrin II	17.5%				

Table 3. Common names of natural esters and synthetic analogs and origin or possible origin of names.

Name	Origin
Natural materials	
Pyrethins	*Pyrethrum cinerariifolium* (old genus name)
Pyrethrin I	Derived from *chrysanthemum monocarboxylic* or chrysanthemic acid
Pyrethrins II	Derived from methyl ester of chrysanthemum dicarboxylic, i.e., pyrethric acid Pyrethrins and related cyclopentenolone derivates
Rethrins	Pyrethris and related cyclopentenolone derivates
Cinerins	*Tanacetum cinerariifolium*
Jasmolins	Similar structure to jasome from *Jasminium grandiflorium*

Table 4. Some outstanding properties of pyrethrum.

Rapid Action of this insecticide
Low mammalian toxicity
Broad spectrum of activity
Lack of insect immunity
Lack of persistence
Very effective insect repellent

CONCLUSIONS

Organic farming management of pests is not about wiping out the insects, it is about keeping biodiversity and reduce insect pests while having minimal impact on beneficial insects. Pyrethrum (*Tanacetum cinerariifolium*) is a small perennial plant cultivated for extraction of pyrethrins from dried flower achenes. Pyrethrum flowers are used for the extraction of an important insecticide, the pyrethrins, which is non-toxic to humans are other warm-blooded animals. Products containing natural pyrethrins are one of the major insecticide groups in organic farming and should widely used in all countries, especially developing countries. Pyrethrins are the active ingredients derived from the natural insecticide pyrethrum, and pyrethroids are synthetic or manufactured versions of pyrethrins. The active constituents of Pyrethrins are, Pyrethrin I, Cinerin I, Jasmolin I, Pyrethrin II, Cinerin II and Jasmolin II. The combined usage of pyrethrin I and II have significant influence for pest control. Pyrethrins are natural products and permitted in organic agriculture because they are degraded, by sunlight and changes in pH, into non-toxic products which are immobile in soil. Pyrethrum which is a natural insecticide has many properties, but the most important are raid action, very low toxicity for mammalian, lack of insect immunity, broad of activity, lack of persistence and degraded quickly by UV in sunlight and very effective insect repellent. Because, the human population is exposed to chemical pesticides which can lead to long term health hazards, the final goal of farmers should be at reducing consumption unnecessary pesticides and replacing chemical products with alternative organic and natural products to protect agricultural crops against insects. Organic farmers can use pyrethrins as an insecticide for fruit and vegetable crops. Pyrethrum can control pests in a difficult battle in a natural way.

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