**Efficacy of *Ruta chalepensis*, *Lantana camara* and *Ocimum basilicum* extracts in controlling *Sitophilus oryzae*, *Acanthoscelides obtectus* and *Tribolium castaneum* infestations in stored grains**

**ABSTRACT**

**Aims:** Chemical pesticides used against insect pests of stored food have adverse effects on both health and the environment. Insects cause extensive damage to stored grains and their value added products. Among the stored grain pests *Sitophilus oryzae* (Rice weevil), *Acanthoscelides obtectus* (Bean weevil) and *Tribolium castaneum*  (Red flour beetle)are considered as destructive pests in India. Plants may provide alternatives to currently used insect control agents as they constitute rich source in bioactive molecules. So, the present work aims to evaluate the insect repulsive and insecticidal power of *Ruta chalepensis* (Fringed rue), *Lantana camara* (Lantana) and *Ocimum basilicum* (Basil) essential oil (EO) the ultimate is to develop a biological and ecological control strategy against pests.

**INTRODUCTION**

There are currently about 7.6 billion people on Earth and by 2030 and 2050, that number is expected to increase to about 8.6 billion and 9.8 billion, respectively[1]. Every year, almost 2 million tons of insecticides are used worldwide[2]. Food grains and pulses play a vital role in the food chain because they are the most widely consumed and commonly stored food products worldwide particularly in tropical and sub-tropical areas, solutions to the issues of food insecurity[1]. Where traditional structures like earthen pots, silos, gunny bags, steel drums and baskets are used in the villages to store 70% of the harvested grains. Food grains and pulses can lose quality after harvest due to a number of reasons and the greatest concern is the harm caused by insects[1]. Products that are stored may become contaminated by primary pests or develop secondary contamination from previously damaged grains; secondary contamination may also result from improper handling, drying and threshing of grains or from other pests (primary pests)[3]. Some chemical pesticides have been banned by the World Health Organization (WHO) and more are being phased out. In this context number of research are focusing on plants in an effort to isolate or identify secondary metabolites that have the potential to possess insecticidal, repulsive or anti-palatable properties against insects[4]. Essential oils and their constituent parts have been shown to have repellent and insecticidal qualities and to play a significant role in protecting grains that have been kept[5].

Studies have been conducted on the essential oils of Ruta chalepensis, Lantana camara and Ocimum basilicum as a potential substitute for controlling pests of stored grains. Essential oils can be extracted using a variety of methods, including the traditional approach of distilling water vapor, percolation, extraction of solid fluid and supercritical fluid extraction. One of the oldest techniques is hydro-distillation (HD) presents steam distillation (SD) in which the vapor develops from the herb's suspension in the balloon[6]. Insect pests mostly cause damage to products that are kept in storage by direct feeding and contamination from insect parts. In storage there are significant losses, The Food and Agricultural Organization (FAO) calculated that the yearly losses in insect-related storage grain amounts up to 13 million tons. While a variety of insect species are accountable for the decline in grain yield, beetles and moths are the most common ones are Acanthoscelides obtectus, Sitophilus oryzae and Tribolium castaneum is a frequent and dangerous pest that targets wheat, corn, flour and other items in areas with tropical temperatures[7]. The red flour beetle or Tribolium castaneum is a serious pest in goods that are kept in storage and frequently results in large losses of food and grains. T. castaneum directly eats storage materials and as a result of its infestation, the storage environment's temperature and humidity rise which would ultimately cause mold development—including the proliferation of toxic species—to accelerate. At the moment, synthetic insecticides play a major role in keeping insect pests out of long-lasting stored goods[7]. The mandibles of the Tribolium species are not powerful enough to chew through the tough outer layer of grain, hence they cannot feed on complete grains that are intact[8].

Because they will constantly reproduce and infest almost every food item on board, they rank among the worst pests on ships carrying edible produce of any type[8]. Some of the prevalent and harmful pests of cereals that are kept in storage belong to the genus Sitophilus Schoenherr and Sitophilus oryzae(rice weevil), is most prevalent in warm, tropical and subtropical regions[9]. The rice weevil, may feed on both brown and white rice because its larvae develop inside rice kernels while its adults eat on rice. The kernels of rice are rubbed, lose their pericarp coating and turn white while being polished[10]. Because of the mechanical action of the polishing process and the resulting low nutritional quality of white rice. The rice weevils are negatively impacted by it. The rice weevil's female creates a hole in the kernel with her teeth, places the egg inside, and then plugs the hole to keep the egg safe[10].

As the polishing process rubs the rice kernels, it could damage this protection and consequently could increase the vulnerability of larvae to natural enemies[10]. All varieties of beans have been impacted by the bean weevil (Acanthoscelides obtectus), with Phaseolus multiflorus being the most severely affected. Soybeans and chickpeas were occasionally targeted as well. When larvae ate the inside of grains, they caused harm. Depending on how big they are, 1-26 larvae may grow into grains. Grains lost their usefulness for eating and planting[11]. In the Mediterranean and Middle East region, Ruta chalepensis is widely dispersed. Many nations employ traditional herbal medicine to treat a wide range of illnesses and one such remedy is the aerial section of this plant. It is taken orally as an antipyretic, anti-analgesic and antispasmodic, anthelmintic, abortifacient, inflammatory, relieves rheumatic pain and helps with mental health issues. It also helps with menstrual issues. It is applied topically for snakebite, insect repellent and hair tonic purposes. R. chalepensis usually referred to as Fijin or Sathab, is used as a flavoring agent in food and beverages and in traditional herbal medicine in Jordan[12].

The most common species in this genus, Lantana camara, also referred to as wild or red sage, grows luxuriantly at heights of up to 2000 m in tropical, subtropical and temperate climates. Camara species was most likely taken from the West Indian slang term for the widespread species. This woody creeper has flowers that are red, pink, white, yellow and violet in color. There are instances when the branches and stems are covered in spines or prickles. The plant has been used to cure a wide range of illnesses in various regions of the world. Lantana camara was used in traditional medicine to treat tumors and malignancies[13]. Fever, sickness and stomachaches were treated with a tea prepared from the leaves and blossoms. Throughout Central and South America the leaves were applied topically to treat wounds, chicken pox, and measles infection. Plant-derived medications were used to treat high blood pressure, rheumatism, colds, and fevers[13]. Ocimum basilicum known as sweet basil, is a native plant of the Indo-Malayan region and a member of the Lamiaceae family. The "king of herbs" as it is known is said to include a large number of phytochemicals with important nutritional, antioxidant and health effects. Ocimum basilicum has been grown since ancient times in India because of its profound spiritual and religious connotations. It is also thought to bring good energy into homes. Sweet basil is utilized as an ingredient in dental and oral health care products, scents and was used by Saints in Vedic times to suppress their appetites. Basil essential oils are made up of a wide variety of chemical components that vary according to the plant's origin, flower and leaf color, scent, and chemotype. Additionally, the morphological and aromatic qualities of plants are significantly impacted by agronomic practices and environmental factors[14].

**Study Design:**

The World Health Organization (WHO) has banned the use of certain chemical insecticides and others are in the process of being prohibited. The numerous studies are increasingly invested in plants to isolate or identify secondary metabolites which are able to have insecticidal, repellent, or anti-palatable activity against insects. Essential oils and their individual constituents have been known to play an important role as protectants of stored grains and proved to possess repellent and insecticidal properties.The essential oil of *Ruta chalepensis*, *Lantana camara* and *Ocimum basilicum* has been studied as an alternative in the control of stored grain pests. Different species of insects are responsible for yield reduction of grains, beetles and moths are the predominant ones *Tribolium castaneum, Sitophilus oryzae* and *Acanthoscelides obtectus* is a very common and serious pest which attacks maize, wheat, flour and other foodstuffs.

**Methodology:**

**Identification and selection of plants**

Plant is identified by its morphological basis. The insecticidal activity of *Ruta* plants is primarily attributed to the presence of secondary metabolites, especially alkaloids. *Lantana* plants contain a variety of secondary metabolites, including alkaloids and terpenoids, which are known for their bio-active properties, allelopathic effects and insect-repellent properties.The strong aroma of basil can act as a natural repellent against certain insects.

**Selection, identification and rearing of insects**

Rice weevil are tiny, reddish-brown beetles with a long snout, about 2-3 mm in length. They have four light yellow or reddish spots on their wings. The insects are collected from infested grains (Bengal gram) containing rice flour along with some old media which helps them to adjust the new conditions of media in a closed container. Red flour beetle is about 4mm long, roughly the size of a small grain of rice. The insects are collected from infested grains (wheat grains) from local market, wheat flour along with some old media which helps them to adjust the new conditions of media in a closed container. Bean weevils are slightly smaller than rice weevils, typically around 3-4 mm long.The insects are collected from infested beans (Hyacinth Bean) from local market, then the adult insects are transferred into new media containing whole beans along with some old media which helps them to adjust the new conditions of media in a closed container. Then kept in dark and silent conditions to increase the number.

**Extraction of phytoconstituents in selected plants**

Essential oil was extracted from leaves of selected plants by hydro-distillation using a simple distillation method. Distillation was carried out by boiling of fresh plant material with water in a 1-liter flask surmounted by a 60 cm long graduated column connected to a condenser. Organic solution of the essential oil obtained was dried with anhydrous sodium sulfate (Na2SO4), then weighed, and stored at respective temperature in a tightly closed brown/amber glass bottle to protect it from air and light.

**Formulation and efficacy study of the final product.**

The samples were sent to GC-MS to identify the phytoconstituents.

**Result and discussion**

Rearing of insect

  

Red flour beetle culture

Bean weevil culture

Rice weevil culture

Hydro-distillation value

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SL.NO | Plant leaves | Fresh leaves(g) | Amount of water(ml) | Distillation time(hours) | Storage temperature | Obtained extract(ml) |
| 1 | *Ruta chalepensis* | 100 | 500 | 3 | 4°C | 75 |
| 2 | *Lantana camara* | 100 | 500 | 3 | 4°C | 95 |
| 3 | *Ocimum basilicum* | 100 | 500 | 3 | Room temperature | 56 |

**Conclusion**

Plants were selected based on their properties like insecticidal, repellence or anti-palatable activity, aromatic activity of PVOC’s against the selected insects. The plants were identified based on there morphological basis. Hydro-distillation method was carried out for the extraction of essential oil is one of the most convenient methods when compared to other extraction methods. The higher yields of essential oil were proportional to the increase in hydro-distillation time. The bio-activity of essential oils in pest management of stored grains is linked not only to their lethality, but also to behavioural changes aiming the increase in food safety and quality.

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