



A Study on Ecological Importance of Mealworm Larvae (*Tenebrio molitor*) in the Region of Churu, Rajasthan

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Figure 1. Yellow mealworm – *Tenebrio molitor* – larva [Photo credit: Flickr/AJC1, CCBY-SA 2.0]

ABSTRACT:- This research is conducted on the ecology of mealworms and their habitats in Churu, Rajasthan, providing valuable insights into the species and their ecological significance in this region. Insects thrive in a wide variety of habitats, having developed specialised adaptations in feeding habits, behaviour, and other biological traits that enhance their diversity. They represent 73% of all animal species, making them the most dominant group of organisms on Earth. Even conservative estimates suggest that five to eight million insect species remain undiscovered. Among these, Coleoptera (beetles) are the most diverse, comprising about 38% of all insects and 10% of all animal species.

Mealworm belongs to the coleoptera order which is the largest order of insects, consisting of the beetles and weevils. Mealworms are beneficial insects due to their high nutrient content, making them a valuable food source for pet food, protein-rich animal feed, and even human consumption. In addition, mealworms possess the remarkable ability to break down plastic waste, including polystyrene which is a synthetic polymer derived from the monomer styrene. So, these mealworms can digest polystyrene at a rate of approximately 34-39 mg per day.

KEYWORDS:- Ecology, Mealworm, Agriculture, Food-waste, Churu, Animal food.

INTRODUCTION: Insects, fascinating creatures belonging to the Arthropoda phylum, are uniquely classified in the Insecta class and are found all over the Earth. Insects have often been used as a food and protein source for animals because they are easy to farm and have a lower environmental impact. Mealworm larvae are one example of these insects. An adult mealworm is known as the “Darkling beetle”.

Tenebrio molitor, commonly known as the mealworm, is a pest of grain, flour, and food stores. Mealworms are common and widespread insects that occasionally infest stored products. Mealworm larvae are elongated, cylindrical, and hard-bodied, with a yellow to golden-brown colour and adult mealworms are nocturnal, black beetles with hard shells, measuring about one inch in length. Both adults and larvae are typically found in moist, dark, and undisturbed areas. Common habitats of these mealworms include accumulations of stored grain, damp or damaged grain residues, stored grain products, and moist organic matter. Mealworms are ectothermic organisms, which means their body temperature depends on the surrounding environment. So, the temperature of their habitat is crucial for their survival, growth, and reproduction.

The ideal temperature range for mealworm survival varies based on the species and their life stage. Generally, most mealworms thrive at temperatures between 20°C and 30°C, with a relative humidity of 70% to 80%. The life-cycle of mealworm goes through complete metamorphosis which includes all four development stages such as egg, larvae, pupae and adult. The lifespan of a mealworm is typically around 3 to 6 months.

Additionally, mealworms are easy to breed and feed, boasting a valuable protein profile. They are industrially produced as feed for pets and zoo animals, including birds, reptiles, small mammals, amphibians, and fish. Mealworms are typically fed live but are also available in canned, dried, or powdered forms.

LITERATURE REVIEW:-

A study on Larvae of mealworm (*Tenebrio molitor* L.) as European novel food was done by Siemianowska *et. al.* (2013). The objective of this study was to assess the nutritional value of mealworm larvae (*Tenebrio molitor* L.).

A study on Comparison of volumetric and surface decontamination techniques for innovative processing of mealworm larvae (*Tenebrio molitor*) was done by Rumpold *et. al.* (2014). In this study it concluded that volumetric methods are effective for inactivating the gut microbiota in insects.

A study on Mealworm larvae production systems: management scenarios was done by Maillard *et. al.* (2018). In this study the author's goal is to present original research findings to operators interested in developing insect-based value chains for feed, as well as to decision-makers seeking to understand the key issues involved.

A study on Metabolic response of yellow mealworm larvae to two alternative rearing substrates was done by Melis *et.al.* (2019). The objective of this study was to examine the metabolic and nutritional responses of yellow mealworm larvae to dried brewer's spent grains (BSG) and wheat bran (WB) as rearing substrates.

A study on Improving the nutritional values of yellow mealworm *Tenebrio molitor* (Coleoptera: Tenebrionidae) larvae as an animal feed ingredient: a review was done by Syahrulawal *et.al.* (2023). This review aims to summarise different strategies that could be used to enhance the nutritional value of yellow mealworm larvae (YML) as an ingredient in animal feed.

A study on Influence of dietary protein content on the nutritional composition of mealworm larvae (*Tenebrio molitor* L.) was done by Benning *et. al.* (2023). The purpose of this study was to analyse the chemical composition of mealworm larvae (*Tenebrio molitor* L.) raised on various diets with differing nutritional compositions.

A study on Present status of poultry enterprise in Rajasthan: An overview was done by Nikita *et. al.* (2021). This review focuses on poultry production across different districts within the state of Rajasthan.

STUDY AREA:- Churu, a city in the desert region of Rajasthan, India, is renowned as the gateway to the Thar Desert. Serving as the administrative headquarters of Churu District, the city is a hub of both history and culture. The district covers an area of approximately 16,830 km², with a road network spanning 1,901 km. It is divided into eight tehsils: Churu, Sidhmukh, Ratangarh, Taranagar, Rajgarh, Sardarshahar, Sujangarh, and Bidasar.

The district is home to more than 900 villages, 248 panchayats, and a population of about 2 million people.

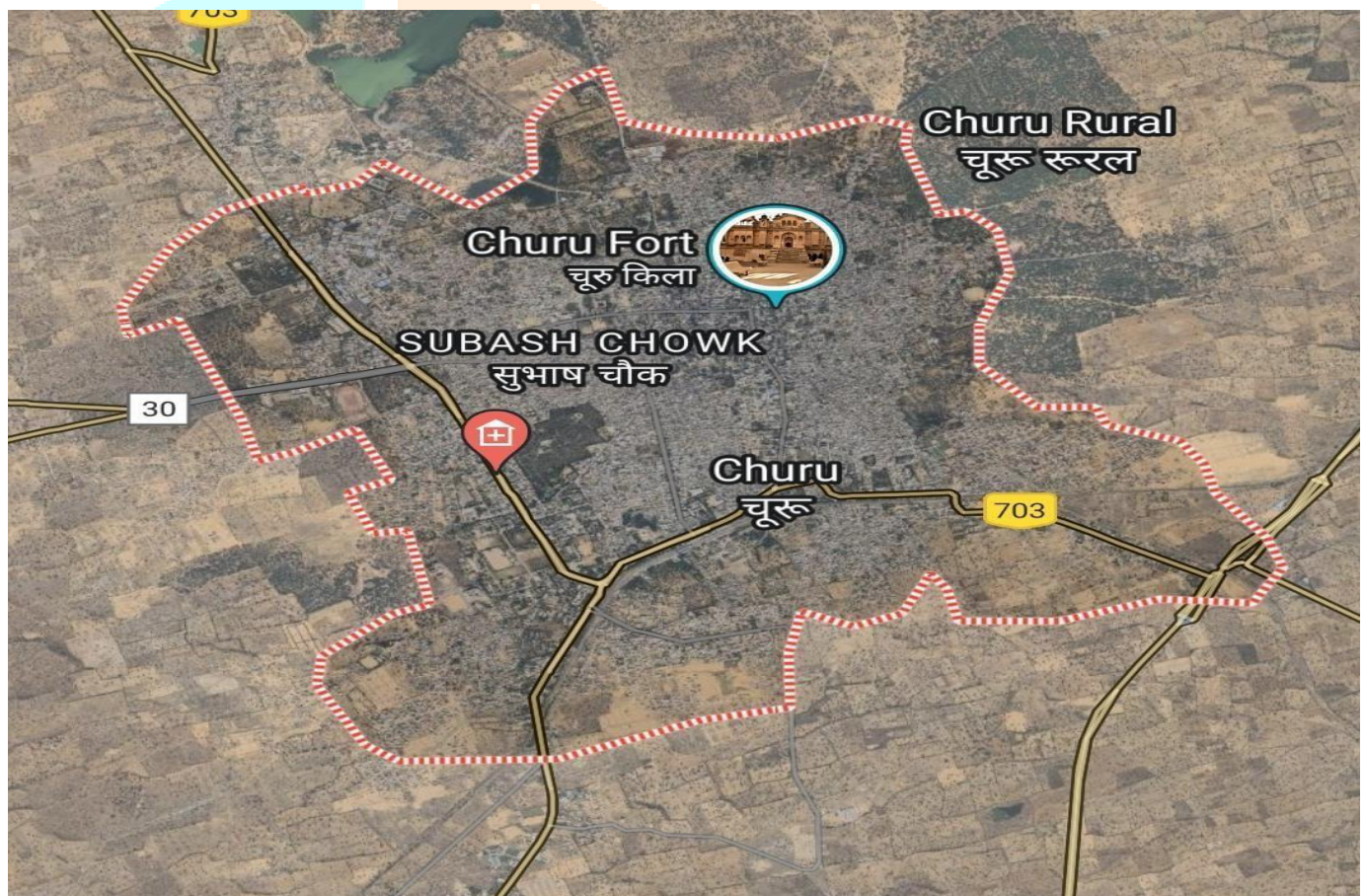


Figure 2: Churu map

The economy of Churu and its surrounding areas is primarily based on animal husbandry and hand embroidery, with dairy farming serving as the main source of income for the rural population. Major crops include barley and legumes. The district experiences significant temperature variations, with extremes ranging from -2°C to 50°C. Relative humidity generally remains below 30%, except during the brief southeast monsoon period, when it can rise to around 60%. The rainy season typically occurs from July to mid-September, with an average annual rainfall of just 328 mm.

Churu is also a popular tourist destination, known for its impressive architecture, including the grand havelis of Kanhaiya Lal Bagla and Surana, as well as its 400-year-old fort. The Tal Chhapar Sanctuary, located in the region, is famous for its blackbucks and is home to a variety of bird species. This makes Churu an ideal weekend getaway spot from New Delhi, offering visitors a unique blend of history, culture, and natural beauty.

Additionally, farming is a popular occupation of this region. Soil fertility plays a vital role in agricultural success, but the area's soil quality is compromised by high levels of soluble salts, resulting in elevated pH levels. Despite this, the region boasts high biodiversity, with a wide variety of insects and other organisms.

METHODS AND MATERIALS:- The study was conducted in the Taranagar, Churu, region of Rajasthan from July 2024 to August 2024. Mealworm specimens were collected in the laboratory to examine their roles in Human life and for the environment.

RESULTS AND DISCUSSION:- Insects represent an integral component of terrestrial ecosystems, providing numerous benefits to both humans and the environment. Mealworm is a beneficial insect which plays a crucial role in food-waste management as well as it provides protein source for animal feed.

Mealworms, the larvae of the darkling beetle (*Tenebrio molitor*), are often seen as pests because they can infest stored grains and food products. However, mealworms can be a valuable resource, playing an important role in human life beyond just being a nuisance.

A sustainable food option:- One of the most important roles mealworms play is as a sustainable food source. As the global population continues to grow, the demand for protein is increasing. Traditional livestock farming, while essential, uses a lot of resources and has a big environmental impact. Mealworms offer a promising alternative.

Mealworms are rich in protein, healthy fats, vitamins, and minerals. They are also very efficient at converting feed into protein, using less land, water, and food compared to traditional livestock like cattle, pigs, and chickens. Additionally, mealworm farming produces fewer greenhouse gases, making it a more environmentally friendly option.

In many cultures, insects, including mealworms, have been eaten for centuries. Today, mealworms are becoming more accepted in Western diets and are being used in various food products like protein bars, snacks, and even flour. Their mild, nutty flavour makes them easy to add to different dishes.

As an animal feed:- Mealworms are not just for humans; they are also an excellent source of nutrition for animals. They are widely used as a high-protein feed for pets, zoo animals, and livestock. Birds, reptiles, fish, and small mammals all benefit from the nutrients mealworms provide. In fish farming, mealworms are a great feed option, helping to support the sustainable growth of the industry.

Because mealworms can be farmed on a large scale, they are a practical and environment friendly option for animal feed. Unlike some traditional feed sources that strain natural resources, mealworms can be raised using organic waste, reducing their environmental impact.

Agriculture sector is the most crucial sector of the Indian economy. Poultry in the agriculture segment is one of the fastest growing sectors in India with an average growth rate of 6 percent in egg production and 12 percent for broiler production per annum. Rajasthan is ranked 14th in egg production and contributes 10 percent of meat production in India. In Rajasthan Churu district accounts for around 6.84 percent of total poultry production in the state.

Chickens require protein, especially when they are sick, growing, moulting, or laying eggs. Mealworm

larvae provide a high-protein boost for chickens during these times. Mealworm farming offers poultry farmers a valuable resource. There are many benefits to breeding mealworms, making it a worthwhile long-term investment. The protein in mealworms supports muscle development, feather growth, and overall health in chickens. They are also rich in essential amino acids, which are crucial for various bodily functions. Adding mealworms to a chicken's diet can improve both egg production and quality.

As a rich source of high protein, mealworms can be used not only to effectively train chickens but also serve as nutritious treats. In addition, mealworms make excellent bait for fishing and are great supplementary treats for lizards and hedgehogs.

Breeding mealworms is a simple process that requires minimal materials and low maintenance. For farmers, having a steady supply of mealworms on hand in their barn is far more convenient and cost-effective than purchasing them regularly. For example, mealworms in the market cost between ₹1,500 and ₹3,500 per kilogram. While buying them is convenient and requires no maintenance, it becomes pricey if we need a large amount. In contrast, setting up a mealworm farm involves an initial investment of about ₹8,000 to ₹25,000 for materials and equipment. Although it demands time and effort, farming mealworms can be more cost-effective in the long run, with the price per kilogram often falling below ₹800. So, it can be quite cheaper for farming than buying them.

Helpful in waste management:- Mealworms have another surprising benefit—they can help manage plastic waste. According to a study, mealworms can eat and break down polystyrene, a type of plastic that is hard to get rid of. This could help solve some of the issues caused by plastic waste, which becomes a major environmental issue.

Additionally, mealworms are also helpful in breaking down plastic, we could reduce the amount of waste that ends up in landfills and oceans, helping to protect the environment. This approach could work alongside traditional recycling methods to create a more sustainable future.

Work as a supporter of the ecosystem:- Mealworms are also an important part of the ecosystem. They help in improving soil health by breaking down organic matter, which promotes nutrient cycling and supports plant growth. In agricultural settings, mealworms can help in maintaining soil fertility and improve crop yields, making them valuable for farming.

Economical importance of mealworm:- The growing mealworm industry creates new economic opportunities in farming, processing, and research. Mealworms can be used to produce biodiesel, providing a renewable energy source. They are also effective in bioremediation, helping to break down organic pollutants such as plastics and heavy metals, which supports environmental cleanup efforts. Mealworm frass, or insect waste, serves as a valuable organic fertiliser rich in nitrogen, phosphorus, and potassium. Additionally, compounds derived from mealworms have potential applications in cosmetics, such as skincare products, and pharmaceuticals, including antimicrobial agents. So, as demand for sustainable products increases, mealworm farming could become a viable business venture, providing jobs and economic growth in rural areas and contributing to local economies.

Competitor of black soldier fly:- Mealworms and black soldier flies each offer unique benefits for sustainable solutions. Mealworms are valuable for food production, animal feed, and certain waste management tasks. They are particularly useful in producing protein for human consumption and pet food.

In contrast, black soldier flies excel in quickly processing organic waste and converting it into protein-rich biomass and compost, making them ideal for large-scale waste management and feed production. Their rapid growth and efficiency in handling waste make them highly effective for industrial applications. One of the major differences between mealworm and black soldier fly is: black soldier fly is less prone to disease. That is why it is not considered as a pest or vector whereas mealworm is considered as a pest. So, both

insects have potential roles in creating more sustainable systems, with their specific advantages suited to different needs and applications.

CONCLUSION:- *Tenebrio molitor* larvae have great potential as a protein source in poultry and swine diets. Mealworms are more than just pests; they are a valuable resource with the potential to help solve some of the biggest challenges we face today. From providing a sustainable source of protein to helping with waste management and supporting the ecosystem, mealworms play many important roles in human life and become a key part of a more sustainable and resilient future.

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