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INSECT AND PEST IDENTIFICATION REPELLENT SYSTEM IN WAREHOUSES UTILIZING EMF RADIATION AND ULTRASOUND EMISSION

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ABSTRACT
Insects and pests pose significant challenges in warehouse environments, leading to economic losses and hygiene concerns. Traditional methods of pest control often involve chemical solutions, which can be harmful to both the environment and human health. In this project, we propose an innovative pest repellent system utilizing electromagnetic field (EMF) radiation and ultrasound emission. The system comprises a Node MCU microcontroller connected to a potentiometer for analog tuning. The potentiometer allows users to adjust settings to optimize repellent effectiveness. Analog values from the potentiometer are fetched and processed by the Node MCU, which generates pulse-width modulation (PWM) signals. These signals are then used to drive an EMF transmitter, emitting electromagnetic radiation within the warehouse space. Simultaneously, an ultrasound device operating at a specific frequency of 40 kHz is employed to emit ultrasonic waves. These waves are known to disrupt the sensory organs and communication systems of insects and pests, deterring them from the area without causing harm to humans or the environment. The integration of EMF radiation and ultrasound emission provides a dual-action approach to pest control, targeting a wide range of insects and pests while minimizing the need for chemical interventions. Furthermore, the system's adjustable parameters allow for flexibility in adapting to varying pest pressures and environmental conditions within the warehouse. Overall, this innovative pest repellent system offers a sustainable and eco-friendly solution for warehouse management, promoting pest control without the adverse effects associated with traditional methods.

Keywords:
EMF, Ultrasound, pest, Repellent System, Rice Weevils.

1. INTRODUCTION

Post-harvest loss in India refers to the reduction in quantity and quality of food crops after harvesting and before reaching the consumer. Stored grain infestation is a very serious problem as various life stages of insects cause economic damage and deteriorates the quality of food grains and food products. There are number of stored grain insect pests that infest food grains in farmer stores and public ware houses and massively surge due to un-controlled environmental conditions and poor ware housing technology used. Due to lack of proper ware housing facilities, stored grain insects largely damage food grains in stores as well during shipping and transportation. For better protection appropriate methods for disinfecting the food grains are required.

Warehouses serve as crucial hubs in the supply chain, storing and distributing goods to meet consumer demand. However, these expansive spaces often face challenges in maintaining optimal conditions due to the presence of insects and pests. These unwanted intruders not only cause damage to stored goods but also pose health risks and sanitation concerns

We investigate the development and implementation of an advanced pest identification and repellent system tailored for warehouse environments. The proposed system harnesses the power of electromagnetic field (EMF) radiation and ultrasound emission to detect, deter, and manage insect and pest populations effectively.The utilization of EMF radiation and ultrasound emission represents a departure from conventional pest control techniques, offering several distinct advantages. EMF radiation serves as a non-invasive tool for insect detection, exploiting the unique physiological responses of insects to electromagnetic stimuli. Through the

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analysis of EMF signatures, the system can accurately identify and classify pest species, enabling targeted intervention strategies.
In conjunction with EMF radiation, ultrasound emission serves as a potent repellent mechanism against a wide range of pests. Ultrasonic waves, beyond the threshold of human hearing, disrupt the sensory organs and communication channels of insects, inducing discomfort and deterring them from inhabiting the treated area. Unlike chemical pesticides, ultrasound-based repellents pose no direct harm to humans, making them an environmentally friendly and sustainable solution for pest management. The implementation of this innovative system in warehouse environments offers multifaceted benefits. By providing real-time monitoring and early detection capabilities, it enables proactive pest management, minimizing the risk of infestations and associated economic losses. Moreover, the non-toxic nature of EMF radiation and ultrasound emission ensures compliance with stringent safety regulations and promotes the adoption of eco-friendly practices within the logistics industry.

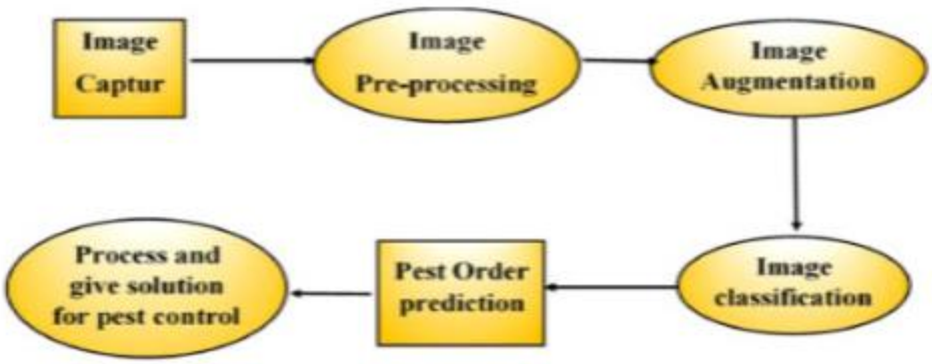

Fig F.1 Algorithm of Pest Identification

2.MATERIALS
2.1 HARDWARE
2.1.1 NODEMCU (ESP8266)

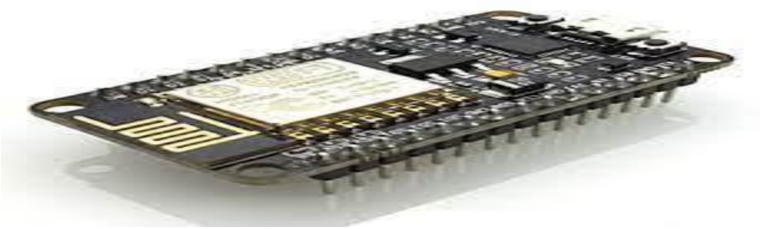

Fig 2.1 NodeMCU

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10- bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes.

2.1.2

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2.1.3 LIQUID CRYSTAL DISPLAY (LCD)

A Liquid Crystal Display (LCD) is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of colour or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. LCD has material, which continues the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered from similar to a crystal. They are used in similar applications where LEDs are used. These applications are display of display of numeric and alphanumeric characters in dot matrix and segmental displays.

Fig 2.2 LCD Display

2.1.3TRANSFORMER

This document presents the solution for a 12V 1A fly back converter based on the Infineon OPTIREG™ TLE8386-2EL controller and IPD50N08S4-13 OptiMOS™-T2. The user is guided through the component selections, the circuit design and, finally, an overview of the experimental results is presented. The TLE8386-2EL is part of the Automotive OPTIREG™ family and it implements a low-side-sense current mode controller with built in protection features. The device is AECQ-100 qualified. The IPD50N08S4-13 is an AEC-Q101 qualified 80V N-channel enhanced mode MOSFET, it is part of the Opti MOS™-T2 family. Intended audience This document is intended for power supply design engineers, application engineers, students, etc., who need to design a Fly back converter for automotive power applications where a galvanic isolation between two voltage domains is required

2.2 SOFTWARE

2.2.1 Uploading

Before uploading your sketch, you need to select the correct items from the Tools Board and Tools Serial Port menus. The boards are described below

2.2.2 PROGRAMMING

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the Tools Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 on the Arduino Uno comes returned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

3. DEVICE METHODOLOGY:

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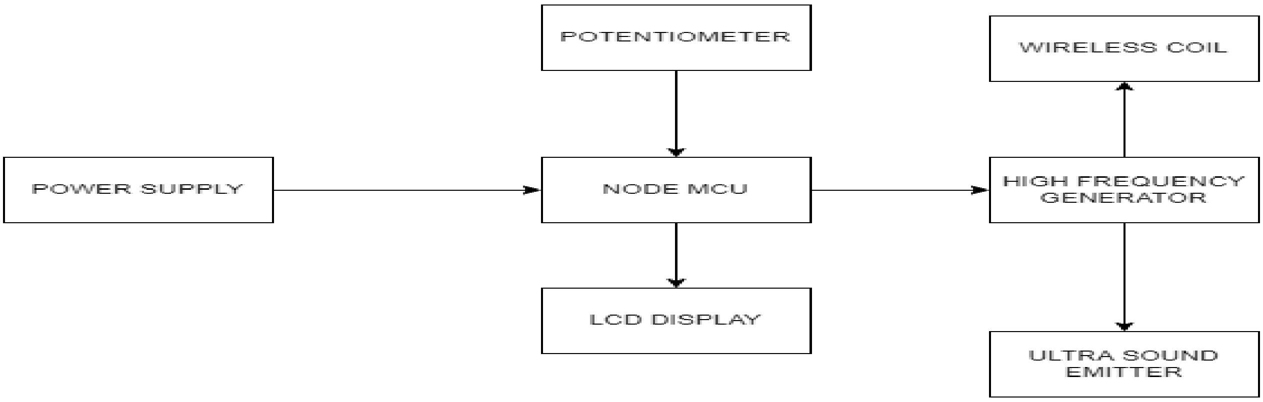

Fig 2.3 Block Diagram

3.WORKING

The methodology employed in creating the pest repellent system is rooted in a comprehensive understanding of both pest behavior and the principles of electromagnetic fields (EMF) and ultrasound emissions. The system's design integrates hardware and software components to ensure its effectiveness in deterring pests within warehouse environments.

At the heart of the system lies the NodeMCU microcontroller, chosen for its versatility and compatibility with various peripherals. The microcontroller is responsible for orchestrating the entire operation of the system. Connected to the NodeMCU is a potentiometer, serving as the user interface for adjusting settings. By turning the potentiometer, users can tune analog values, allowing for fine-tuning of the pest repellent parameters.

Upon receiving analog values from the potentiometer, the NodeMCU processes this data and generates pulse-width modulation (PWM) signals. These signals serve as control signals for both the EMF transmitter and the ultrasound device. The EMF transmitter emits electromagnetic radiation within the warehouse space, creating an environment inhospitable to pests. Simultaneously, the ultrasound device operates at a specific frequency of 40 kHz, emitting ultrasonic waves that disrupt pests' sensory organs and communication systems, further deterring their presence.

The software component of the system involves programming the NodeMCU microcontroller with firmware to handle data acquisition, signal processing, and control logic. Signal processing algorithms are implemented to analyze the PWM signals and determine the appropriate output for both the EMF transmitter and the ultrasound device. Additionally, a user interface is developed to provide a graphical representation of the system's settings, enabling users to monitor and adjust parameters in real-time.

In order to calculate the efficiency of our suggested model of pest repellant system using EMF and ultrasound, the mortality of insects is measured. Ultrasound is well-known for its efficient insect repelling function, as evidenced by numerous studies. We are conducting the research to find the effectiveness of EMF, even though it has already been proven effective at frequency above 23 MHz along with controlled temperatures. The available frequency for our localities is maximum 20 MHz, so we are doing the result to find the mortality of insects at 20 MHz.

In this investigation, we conducted trials at a frequency range of 19 MHz for two different insect species that are typically found in Tamil Nadu. Examples are Rice Weevils (**Sithophilus Oryzae**)and Red Flour Beetle (**Tribolium Castaneum).** The experiment is carried out to determine the death rate, which is determined using Abbott's Formula, one of the most generally used formulas among pest experts.To utilize this formula and determine its accuracy, a "Replication" of the experiment is performed during the same time period, and the mean value is used for computations.

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Thus, the experiment is carried out by fixing the container to the EMF supply, as well as the connections stated earlier in the materials. The Container is made of plastic, and circuits. The power supply is provided by an electrical power plug and the frequency used is displayed on the display provided over the top, which has a Control Knob that can be tuned to control the frequency range

Fig 3.1 EMF Container

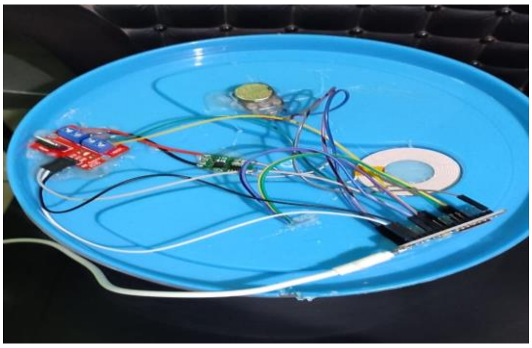

Fig 3.2 EMF Circuit

In order to standardize the data, one kilogram of rice and one hundred insects are the fixed quantities, while the frequency is set at 19 megahertz. For comparing the results, culture an set of same insects on another container, with an conditioned atmosphere to analyze the behavioral nature of the insects in growing Environment.

3.2 STEPS FOR CONDUCTING EXPERIMENT
The following procedures are used to carry out the experiment:

- Step One: Prepare the same amount of rice for comparison studies and to determine the number of insects in a controlled treatment. Then, place the insect into a container with a few tiny holes for air penetration and observe its behavior.
- Step Two: Introduce the insects to the rice in the EMF-equipped container.
- Step Three: Once the EMF is turned on and the frequency is adjusted to 19 MHz, observe the insects' behavior.
- Step Four: After an hour, turn off the electricity. To count the insects, separate the rice and the insects using a 2 mm sieve. Record the date of the separation and the number of alive and dead insects.
- Step Five: Utilizing Abbott's Formula, determine the adjusted percentage to conclude the experiment after confirming the maximum Mortality.

3.3 CALCULATION OF MORTALITY %:

3.3.1 ABBOTT'S FORMULA:

- **FORMULA**

Abbott's Formula for corrected mortality = $$\frac{T - C}{100} * 100$$

Where

T: Mortality in Treatment and

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C: Mortality in Control

Result and Discussion

4.1 OSERVATIONS AND CALCULATIONS:

4.1.1 TABULATION FOR Rice Weevils (S.Oryzae)

S.no	Hours of Treatment(Hr)	No of Trials	No of Insects alive after Treatment(n in T)	No of Insects alive under Control(n in C)	Corrected (%)
1.	1	1.	100	100	1
		2.	100		
		3.	98		
		Mean	99.3(99)		
2.	3	1.	100	100	0
		2.	100		
		3.	100		
		Mean	100		
3.	6	1.	96	100	5
		2.	88		
		3.	100		
		Mean	94.6(95)		
4.	12	1.	67	100	41
		2.	53		
		3.	56		
		Mean	58.6(59)		
5.	24	1.	22	100	83
		2.	17		
		3.	13		
		Mean	17.3(17)		
6.	48	1.	4	100	99
		2.	0		
		3.	0		
		Mean	1.3(1)		

Table 4.1 Trials of EMF Efficiency on S.Oryzae

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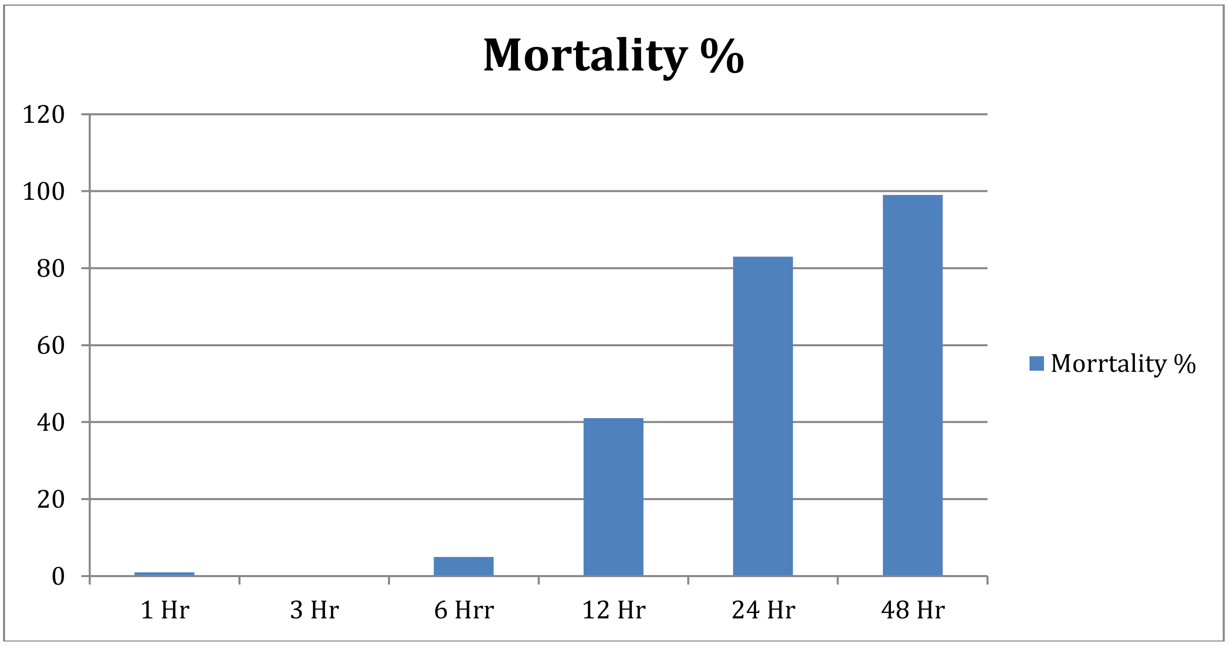

Graph 4.1 Bar Graph between Mortality and Efficiency of S.Oryzae

4.1.2 EXPERIMENTTAL IMAGES:

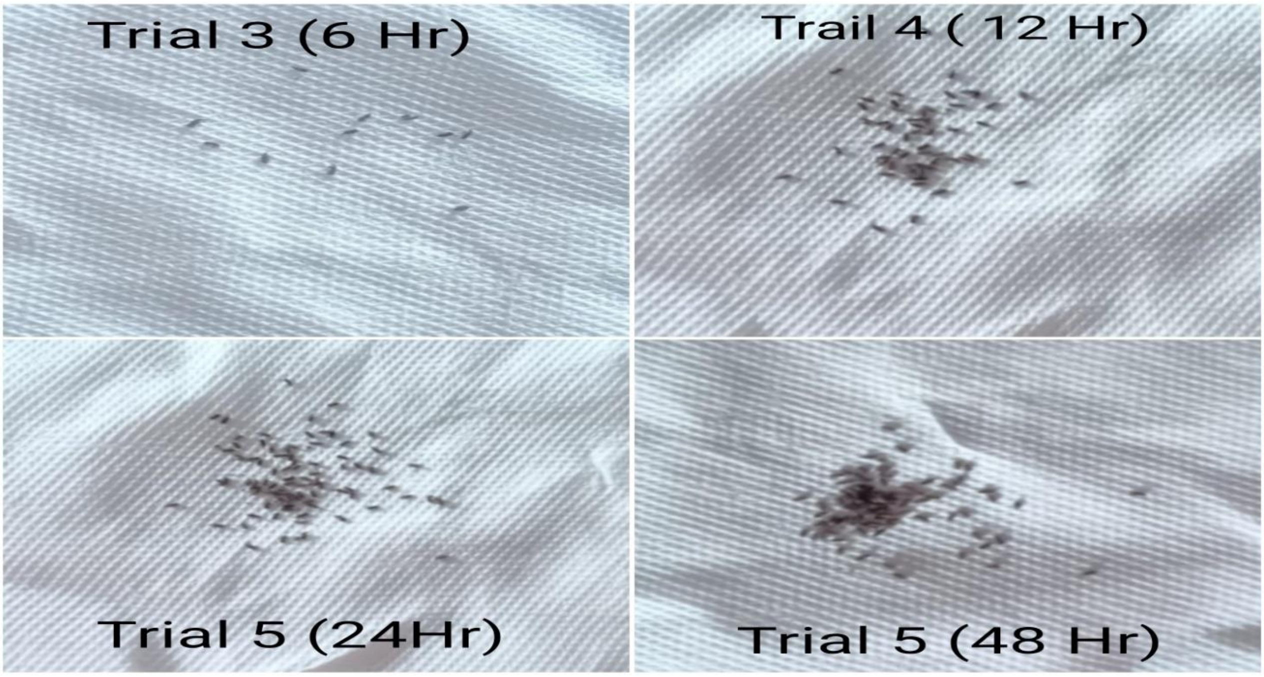

Fig 4.1 Insects (S.Oryzae) Death in each Trial

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4.2.1 TABULATION FOR Red Flour Beetle (T.Casteneum)

S.no	Hours of Treatment(Hr)	No of Trials	No of Insects alive after Treatment(n in T)	No of Insects alive under Control(n in Co)	Corrected (%)
1.	1	1.	100	100	0
		2.	100		
		3.	100		
		Mean	100		
2.	3	1.	100	100	0
		2.	100		
		3.	100		
		Mean	100		
3.	6	1.	100	100	3
		2.	100		
		3.	90		
		Mean	96.6(97)		
4.	12	1.	88	100	20
		2.	70		
		3.	83		
		Mean	80.3(80)		
5.	24	1.	44	100	51
		2.	54		
		3.	50		
		Mean	49.3(49)		
6.	48	1.	21	100	82
		2.	20		
		3.	12		
		Mean	17.6(18)		

Table 4.2 Trials of EMF Efficiency on T.Casteneum

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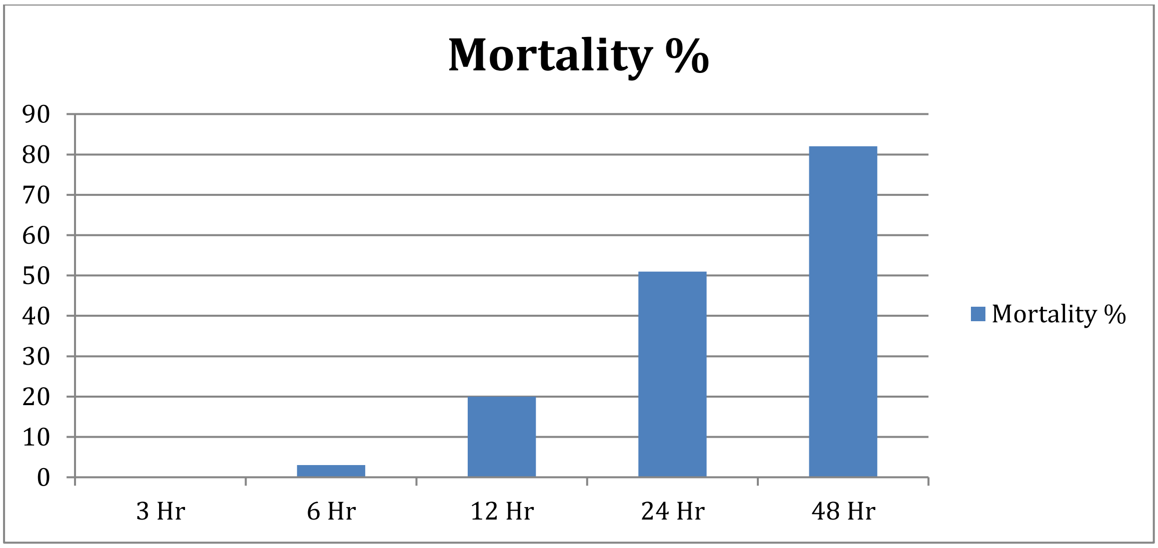
4.5.2 GRAPH OF EFFICIENCY:



Fig

Graph 4.2 Bar Graph between Mortality and Efficiency of (T.Castanneum)

4.4.3 EXPERIMENTTAL IMAGES:

Fig 4.2 Insects (T.Castaneum) Death in each Trial

CONCLUSION

In conclusion, the proposed pest repellent system offers a sustainable and innovative solution to the persistent problem of pest infestations in warehouse environments. By harnessing the power of electromagnetic fields (EMF) and ultrasound emissions, the system effectively deters pests without relying on harmful chemicals, minimizing environmental pollution and health risks. The integration of adjustable parameters and real-time monitoring capabilities enhances the system's usability and adaptability to varying pest pressures and environmental conditions. Overall, the proposed system represents a significant advancement in warehouse pest management, promoting safety, sustainability, and efficiency.

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