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Effectiveness of Biobased Sustainable Composite Material For Grain Storage

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ABSTRACT

In many regions of the world, the insect seriously damages grain that has been stored. Despite being useful, chemical pesticides have a number of disadvantages, such as being expensive, non-biodegradable, and having negative impacts on both people and the environment. Pests have become resistant to the majority of chemicals and synthetic pesticides that are now on the market. As a result, farmers are looking for more potent and practically viable alternatives. According to research, compounds derived from plants contain a significant amount of insecticidal power. There is a necessity of using a resource for reusable biomaterials that are inexpensive, accessible locally, and safe for the environment. It is imperative to create such grain protectants using local, naturally occurring, inexpensive raw materials that won't hurt the environment and lessen insect attack on crops. This paper deals with the effectiveness of biobased sustainable composite material for grain storage**.** Azadirachtin is extracted from the dried neem kernel powder using methanol as solvent. A composite material was developed and used as an antifeedant. With greatly improved bioactive qualities (insecticide/insectifuge), it was shown that the newly created material maintains good capabilities as antifeedant material for grain storage. Moreover, no smell or flavor migration to the packaged product was noticed.

Keywords: Pests, Neem, Biomaterials, antifeedant

INTRODUCTION

These days, crop pests are heavily controlled with the use of pesticides. Artificial pesticides are frequently employed to manage a variety of insect pests because they are affordable, flexible in application, and, most importantly, a dependable means of control. There is no denying that pesticides have helped to enhance agricultural production, but synthetic pesticides have also seriously endangered worker health during production, formulation, and field applications, in addition to causing unparalleled ecological devastation (Ansari B.A. and Kumar K 1988). Using products with a plant origin is one of the greatest control strategies to address the issues of synthetic chemical risks. Plant-based products are becoming more and more popular because to their accessible availability, low persistence, low toxicity to non-target organisms, and biodegradability. The active ingredient in natural products, azadirachtin, is taken from the Azadirachta indica A plant and is one of the most promising natural compounds. Neem tree (Family Meliaceae) , whose long-known antiviral, antifungal, antibacterial, and insecticidal qualities (Harikrishnan R., Rani M.N. and Balasundaram C. 2003). Grains (e.g. wheat, rice, maize) and their flour are highly sensitive to microbiological and entomological infestations. Significant physicochemical and organoleptic changes are caused by infestation, which also lowers grain quality and ultimately results in financial losses (Baik & Donelson, 2018). In this situation, and to enhance the preservation of food quality, extra focus needs to be placed on insect pest defense, specifically creating insect-repelling packaging. Given that paper-based packaging is renewable, biodegradable, and extensively embraced by customers (Coles, 2013), this objective is even more crucial for this material. Paper-based packaging promotes sustainability through food preservation and conservation, waste reduction, and customer happiness. Due to consumer perceptions of natural botanical compounds as healthier preservatives and the growing demand for safer food products, numerous studies have been conducted in the food industry with the goal of extending the shelf life of foodstuffs, improving their quality, and safety through the use of essential oils or their components (Suppakul, Sonneveld, Bigger, & Miltz, 2008). Many farmers around the world have been using botanicals for decades to manage stored insect pests (Araya and Emana, 2009). Neem leaf powder was suggested to be one of the most important botanicals for preventing beetle infection in seeds that had been kept. Neem includes a number of limonoids, or active ingredients. The main ones are azadirachtin, salanin, nimbin, and meliantriol. Many of these limonoids have antifeedancy, growth-regulating, sterilizing, insecticidal, ovicidal, and repellent properties against a variety of insects and pests found in storage (Akou-Edi, 1984; Makanjuola, 1989; Schmutterer, 1990). In order to increase the shelf life and quality of food grains after harvest and prolong their storage life, this study looked into the impact of neem leaf tablet.

Materials and methods

Collection of Neem (Azadirachta indica) Leaves

Fresh Neem leaves (Azadirachta indica) were procured from the MGM University campus in Chh. Sambhajinagar. The leaves were allowed to air dry for ten days in a room free of dust. A fine powder was obtained by sieving the dry leaves after they had been pounded with a pestle and

mortar. The powder was kept out of direct sunlight in dust-proof lockers and kept in clean, well-covered jars.

Collection of grain samples

The grains identified for study are wheat and chana dal. The grains of 500 gms of wheat and, chana dal were used for this study were obtained from local market and stored in an airtight container and the observations were recorded.

Collection of waste paper

The recyclable waste paper was collected from local paper vendor.

Preparation of Waste Paper Pulp: Following was the sequence used for making of paper pulp shown in Fig. 1 to 8. First of all known quantity of waste paper was weighted. Using the shredder machine small pieces of paper was made. These pieces were kept in water for soaking for 24 hours. After this the material was transferred to beater. The objective of using a beater was to create longer, hydrated, fibrillated fibers. After the beater process the pulp was introduced in to hydropulper. Hydrapulper, is commonly used for waste pulp production. From the hydropulper, a thick discharge of was obtained and it was called wet pulp. This wet pulp was dried in sun for 72 hours to remove the moisture.

			
Fig.1.Weighing of waste paper	**Fig. 2. Shredding of waste paper**	**Fig.3.Soaking of Paper**	**Fig. 4.Beater**
			
Fig.5.Hydropulper	**Fig. 6. Discharge of Pulp from Hydropulper**	**Fig. 7. Wet Pulp**	**Fig. 8. Sun drying of Pulp**

Soxhlet Extraction

This procedure served as the standard for cold press extraction. A 20 g pulverized sample of powdered neem leaves was put on a filter paper "thimble" and put into the soxhlet extractor. Following the 936.15 AOAC (1990) protocol, a 500 ml flask of Di-Chloro Methane as a solvent was joined at the bottom and heated till evaporation. Using the solvent to assist wash off some of the biopesticide, this cycle was repeated four times. Using the solvent to assist wash off some of the biopesticide, this cycle was repeated four times and three extractions were obtained. .

Extract Analysis

Using a modular Perkin Elmer HPLC, the azadirachtin content of each extract was measured in accordance with the EPA method created by Schneider and Ermel (1987). The settings of the chromatograph were as follows: a 25 × 4.6 mm stainless steel column; 1 ml/min flow rate; a UV VIS detector (215 nm); a sample volume of 20 µl; a mobile phase comprising 30% organic solvent (methanol) and 70% water; and a relative retention period of 2.5 minutes. By employing azadirachtin 95% (Sigma) ($C_{35}H_{44}O_{16}$; mol. mass 720.72) as a standard, the identification process was finished.

Preparation of Neem Tablet Composite

50 grams (wt basis) of neem extract was mixed with 100 grams of paper pulp for 1 hour and the weight of the pulp with neem extract was 120 grams, following the same patterns 50 grams of neem extract was mixed till a dough of pulp was formed and the final weight of the wet pulp with neem extract was 550 grams. The specifications of Neem tablet are given the Table 1. Figure 8 shows neem tablet.

Table No. 1. Specifications of Neem tablet

SN	Particulars	Details
1	Shape	Circular
2	Circumference	13 cm
3	Diameter	8.28 cm
4	Thickness	1.065 cm
5	Area	53.81 cm^2
6	Volume	57.30 cm^3
7	Mass	4.10 g
8	Density	0.071 gm / cm^3

Fig. 8. Neem Tablet

Fig. 9 . Use of Neem Tablet in wheat and chana dal

Results and Discussion:

High-performance liquid chromatography analysis

The HPLC study showed that the methanol neem leaf extract had many peaks. As the concentrations increased, the chromatogram from the methanolic extracts revealed a rising peak height/area.

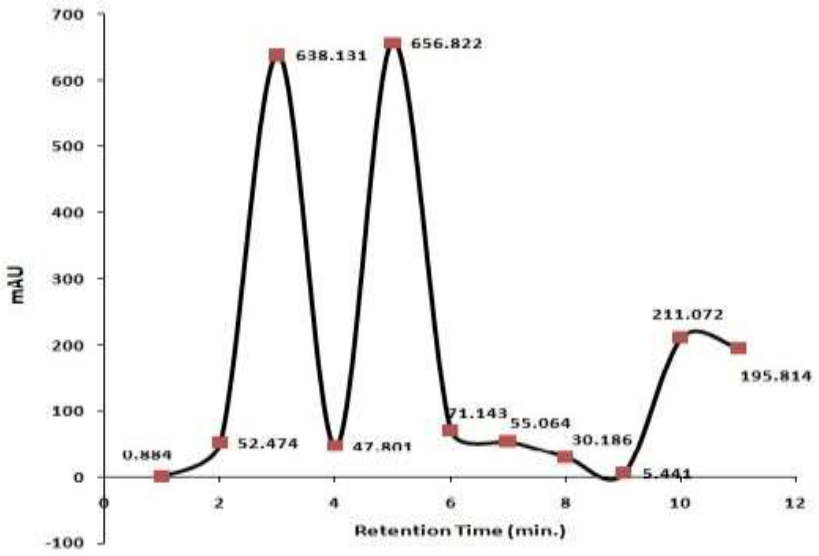

Fig.10: Chromatogram of varying concentrations of methanol neem leaf extract at 215 nm by high-performance liquid chromatography analysis

A comparative study of grains with and without antifeedant material have been carried during April 22023 to October 2023. Chana dal and wheat , 1 kg of each were kept under observation without any application of insecticide (April 2023 – Oct 2023) and observations were recorded and shown in Table 2.

Table 2. Monthly Observation of insects in wheat and chana dal under different climatic conditions

Month (Year2023)	Average Temperature (º C)	Average Humidity (%)	Observations	Weight of Grains (gms)	
				Wheat	Chana Dal
April	12 - 38	57	No insects	1000	1000
May	18 - 42	52	No insects	1000	1000
June	18 - 40	63	Few insects	1000	1000
Jully	23 - 37	80	Many insects	1000	1000
August	24 - 36	77	Insects + Hole in grains	975	980
September	22 - 36	74	Large no of insects , Powder of grains	950	935
October	13- 33	74	Large no of insects, Powder of grains	900	810

For 1 kg of wheat, and chana dal each, 3 tablets of neem were inserted in the grains and kept for a period of 1 year in jar for which no insect growth was observed as shown in Fig. 9 and after the usage of grains the neem pallets can be simply burned in the environment which act as mosquito repellent making the pallets environmentally friendly. Samples of wheat and gram were placed under observation for seven months. Temperature and humidity data were recorded, and the growth of the infestation was monitored every fifteen days. It was noted that no insect growth was observed in April to October 2023, as indicated in Table 3.

Table 3. Monthly Observation of Insects in wheat and chana dal under different climatic conditions

Month (Year 2023)	Average Temperature (ºC)	Average Humidity (%)	Observations in wheat and chana dal	Weight of Grains (gms)
April	12 - 38	57	No insects	1000
May	18 - 42	52	No insects	1000
June	18 - 40	63	No insects	1000
Jully	23 - 37	80	No insects	1000
August	24 - 36	77	No insects	1000
September	22 - 36	74	No insects	1000
October	13- 33	74	No insects	1000

Conclusion:

The method used to extract and separate Azadirachtin from dry neem leaves is easy to follow and practical. The resulting product is repeatable and between 70 and 90 percent pure. It is verified by the HPLC investigations that the technique used has enabled the extraction of Azadirachtin from the neem leaves.

Neem extract (Azadirachtin) was grafted onto waste paper pulp as a connecting agent to create a waste paper-based antifeedant substance. The newly created material exhibits excellent performance as an active antifeedant for grain-based food grains products such as wheat and chana dal because it maintains the product's ability to absorb water and mechanically, while also greatly enhancing its bioactive qualities without transferring flavors or odors into the packaged good.

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