

CREATION AND IMPLEMENTATION OF A PROCEDURE TO ASSESS A SUSTAINABLE BIOBASED COMPOSITE MATERIAL PERFORMANCE AS AN ANTI FEEDANT IN GRAIN STORAGE

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ABSTRACT

Bharat is a unique country where various knowledge including traditional knowledge is one of it which is very beneficial for mankind. This research work is based on the traditional knowledge of utilization of neem leaves as antifeedant for grain storage.

The traditional application of neem leaves and its other products has many disadvantages noted by experience and from literature. The efforts were made to overcome these drawbacks in this research task by developing a very unique, innovative and cost-effective process of development of sustainable composite with neem leaves extract and pulp from waste paper.

The neem leaves were triturated with optimum quantity of water. This is then followed by filtration with muslin cloth. Simultaneously waste paper was shredded, soaked in water for overnight and then converted to pulp by treating in either beater or hydropulper. This slurry is drained to separate water and wet pulp is then dried to get as air dried pulp. Now both neem leaves extract and pulp are ready for blending. Both are thoroughly mixed. The extract was absorbed in air dried pulp with stirring before giving suitable shape to composite. The composite is then dried in shed.

HPLC, TLC and other chemical and physical analysis was carried out for optimization. This composite found most useful as antifeedant for grain storage, as per proven traditional knowledge. The process developed in this research work is very innovative unique and has many advantages.

Keywords: Traditional knowledge, Neem extract, waste paper pulp, Composite, Anti feedant for grain storage

Agriculture

The main occupation of India is Agriculture. Around 70 per cent of the population earns its livelihood from agriculture. Food is the primary need of man amongst the three basic needs of man that is food, water, and shelter. India is the largest producer of commodities like cereals, pulses, and oilseeds, and the quantity of food grains, pulses, and oilseeds.

The known fact of each coin has two sides, likewise with production three stages of losses according to [1] are studied: pre-harvest, harvest, and post-harvest losses, each of which has serious issues. Crops that expand under the attack of insects, rusts, and weeds experience pre-harvest losses. Losses incurred while harvesting are referred to as harvest losses. Post-harvest losses are those that happen both before and after the harvest but before human consumption. [1].

In India, losses resulting from post-harvest handling and storage are estimated to be 15 per year. According to FAO estimates, global storage losses occur 10 times a year. In India, farmers account for 65–70% of all storage, while traders and government agencies account for 30–35%.

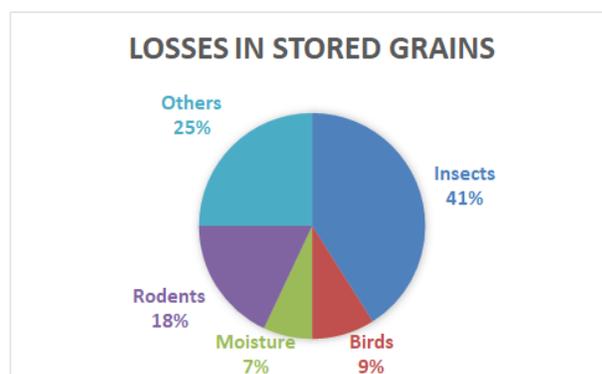


Fig. 1.1 - Losses in Stored Grains[2]

Infestation

Food grains worth Rs 7000 crores or 14 million tonnes (MT) are lost in India every year. The losses resulting from insect attack total Rs. 1300 crores [3]. According to FAO 2020-21, insects alone are responsible for 2% or more of the post-harvest losses. Insects consume the grains while also contaminating them through their feeding activities, making them unfit for human consumption and causing financial losses. Insect growth is aided by the following factors:

- storage structure
- temperature
- time spent storing
- moisture content.
- intergranular atmospheric composition
- relative Humidity

Together with the aforementioned parameters, insects lay their eggs on crops when they are growing in the field, which are invisible to the naked sight. After harvesting, the eggs are still present in the grains, and finally the favourable conditions lead to the growth.

- Life Origination
- Hidden Infestation
- Crevice and cracks
- Old Gunny bags
- Unhygienic Human handling
- Uncleaned processing plants
- Entry of insects from neighbouring stores
- Spilled grains under the stacks
- Old infested stores
- Uncleaned truck, trolleys, bullock carts

Typical Life cycle of insects is shown in the Fig. 1.2. The adult bug lays eggs, which are fertilised, grow into larvae, which then become pupae, which eventually develop into adult insects.

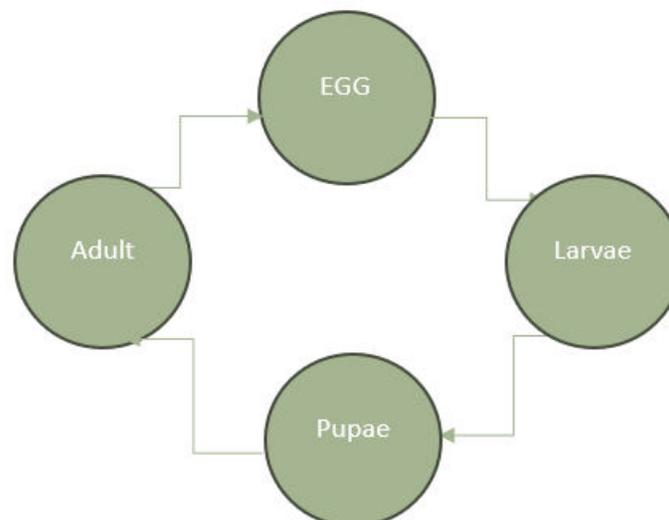


Fig. 1.2 - The Life cycle of insects

Owing to the drawbacks of artificial pesticides, harmful to the ecosystem and the environment in number of ways, such as by eradicating natural enemies, causing insect resistance and resurgence, contaminating the soil, water, and air, and leaving behind residues that can lead to a variety of illnesses in both humans and animals [4].

Neem tree is called kalpatru and its every part has usage. Neem leaves have been used since centuries as grain protectant as it is already proven.

Azadirachtin

- Azadirachtin belongs to tetranortriterpenoid a class of limonoids
- ISO common name Not available
- Other names Azadirachtin A
- Chemical formula $C_{35}H_{44}O_{16}$

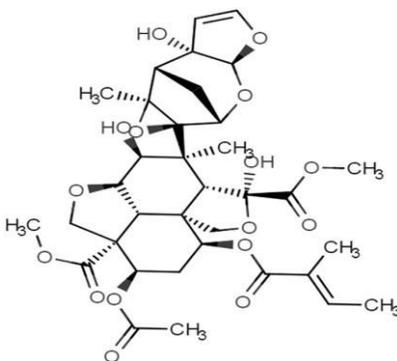


Fig. 1.3 - Chemical Structure of Azadirachtin

- Molecular weight $720.71 \text{ g mol}^{-1}$
- Melting point 154°C to 158°C
- Maximum absorption in the ultraviolet region (UV) at 217 nm
- Hydrophilic in nature, moderately soluble in water and highly soluble in polar organic solvents.
- It is non-volatile and photosensitive.

Azadirachtin is the most significant active ingredient; that repels the insects from grains. The others are quercetin, sodium nimbinate, gedunin, salannin, nimbin, nimbidin, and nimbidol. Ascorbic acid, n-hexacosanol, amino acid, nimbin, nimbanene, 6-desacetylnimbinene, nimbandiol, nimbolide, 7-desacetyl-7-benzoylazadiradione, 7-desacetyl-7-benzoylgedunin, 17-hydroxyazadiradione, and nimbiol are present in leaves [15–17]. Polyphenolic flavonoids such as quercetin and β -sitosterol were extracted from fresh neem leaves and shown to possess antimicrobial and antifungal characteristics.

Some species of mites and nematodes, as well as over 200 different insect pests, can be controlled by azadirachtin, a pesticide derived from extracts of the Indian neem tree. [5].

In practically every aspect of life, from domestic to commercial, paper is used. The value of recycling and reusing paper cannot be overstated. Recycling is the creation of new products from previously used materials. By safeguarding the environment's natural resources, recycling eventually saves energy. Collecting and sorting are required for recycling.

Agriculture the backbone of India. The production of grains and the losses related to it before, during, and after harvest demonstrate. Concentrating on insect post-harvest losses. The study of various insects comes next. When talking about conventional storage practices, storage practices also play a significant role. Although artificial pesticides are used nowadays, the environment is at risk from them. Neem leaves have been used for centuries to control insects in grains. However, waste paper recycling and conversion have been identified as being off track.

Neem leaves are traditionally used for decades by spreading a layer of grain on top of the leaves at the same time. However, over time, the leaves dry out and mix with the grains, giving the grains an unpleasant taste that makes them unfit for human consumption. The procedure has been determined; waste paper pulp will be combined with neem concentrate extract, and tablets will be formed and dried. During use, the formed tablets are easily separated from the grains, and after use, the tablets can be burned outdoors without endangering the environment and serving as a mosquito deterrent. This is merely a synopsis of the identified process. The materials, method, result, and discussion all include in-depth explanations or discussions.

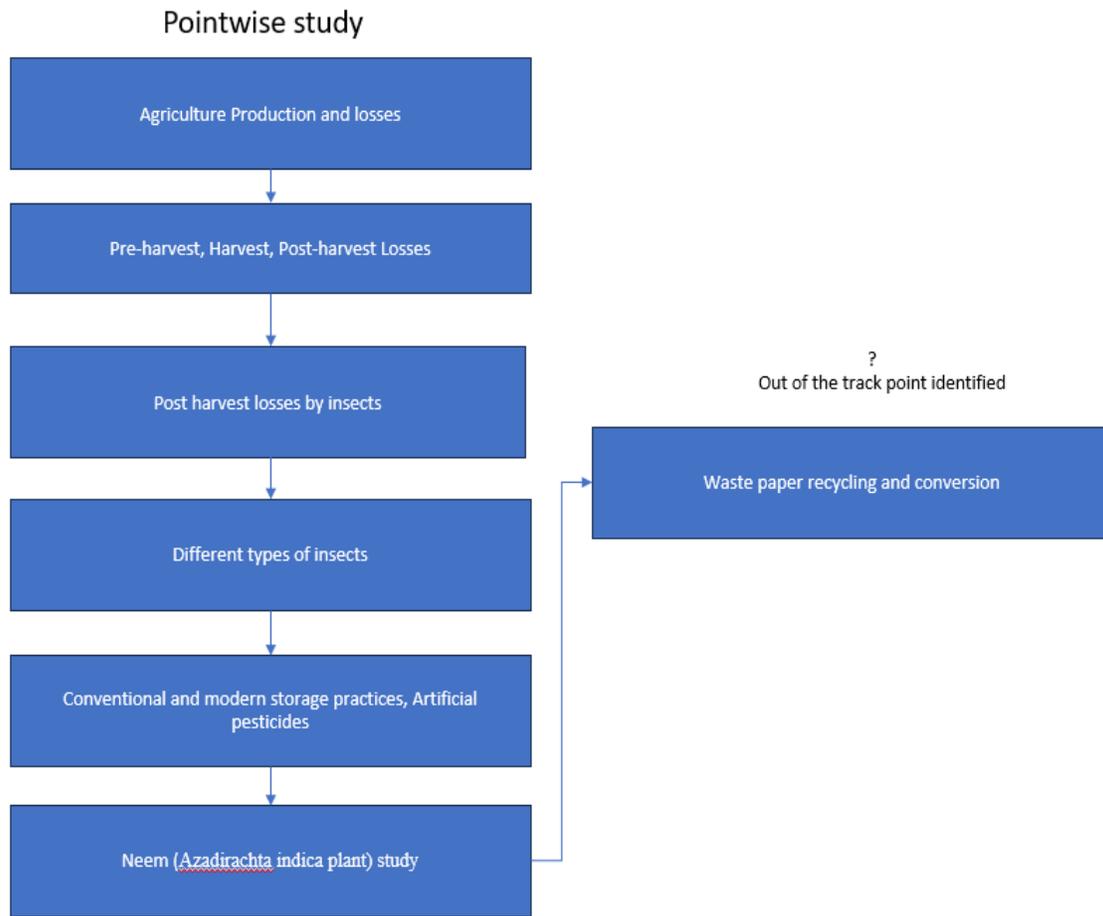


Fig. 1.4 – Process

Scope of Work

Utilizing the combination of waste paper pulp and the natural, local, cheap raw material i.e. Neem (Azadirachtin indica) the innovative way is aimed to prevent the grains from losses during storage.

The study focuses on identifying neem species and their pest repellent properties, extracting neem concentrate, mixing it with waste paper pulp, studying insects and pests in grains, assessing material and energy balance, and evaluating the product's cost indicated in the Fig 1.5.

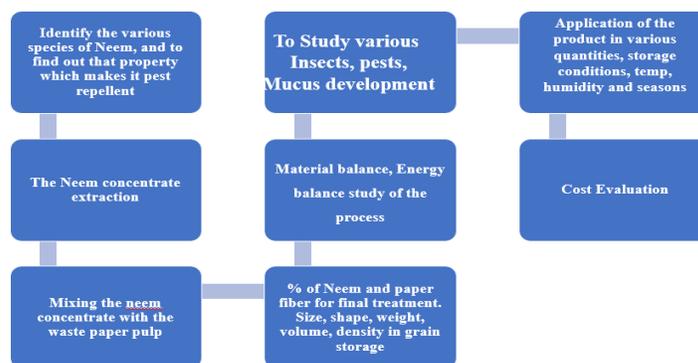


Fig. 1.5 - Scope of work

Growth of Insects in Grains:

The grains identified for study are wheat, Chana dal, green gram and groundnut.

Growth of insects in grains without application of insecticide

The grains of 500 gms of wheat, chana dal, green gram and groundnut were raw without any application of insecticide shall be stored in an airtight container and the observations were recorded. Wheat under observation without any application of insecticide (April 2022 – Oct 2022). 1 Kg wheat were kept under observation for a period of 7 months, temperature and humidity data were noted, infestation growth was observed every 15 days, it was noted that from mid of June live insects were observed, which kept on multiplying in numbers with preceding months July, august, sept and October 2022.

Bengal gram under observation without any application of insecticide (April 2022 – Oct 2022). 1 Kg Bengal gram were kept under observation for a period of 7 months, temperature and humidity data were noted, infestation growth was observed every 15 days, it was noted that few insects were observed in july, which kept on multiplying in numbers with preceding months august, sept and October 2022.

Green gram under observation without any application of insecticide (April 2022 – Oct 2022). 1 Kg green gram kept under observation for a period of 7 months, temperature and humidity data were noted, infestation growth was observed every 15 days, it was noted that from July live insects were observed, which kept on multiplying in numbers with preceding months august, sept and October 2022.

Groundnut under observation without any application of insecticide (April 2022 – Oct 2022). 1 Kg groundnut kept under observation for a period of 7 months, temperature and humidity data were noted, infestation growth was observed every 15 days, it was noted that from august live insects were observed, which kept on multiplying in numbers with preceding months, sept and October 2022.

Extraction of Concentrate of Neem Leaves by Trituration in Distilled Water

In this method of extraction, the 100 gms of neem leaves with 100 ml of distilled water were crushed by trituration. Squeezing out the concentrate with the muslin cloth and the concentrate percentage of azadirachtin is analysed on the TLC and HPLC. The concentrated extract is mixed with the 100 gms of waste paper pulp until the concentrate is absorbed in the pulp and a dough is formed. Followed by preparation of tablets. Sun drying the tablets and the application of the tablets in grains.

Extraction of Concentrate of Neem Leaves by Boiling Water

In this method of extraction 100 gms of neem leaves are boiled in 100 ml of water. Squeezing out the concentrate with the muslin cloth and the concentrate percentage of azadirachtin is analysed on the TLC and HPLC. The concentrated extract is mixed with the 100 gms of waste paper pulp until the concentrate is absorbed in the pulp and a dough is formed. Followed by preparation of tablets. Sun drying the tablets and the application of the tablets in grains.

Extraction of Concentrate of Neem Leaves in Ethanol

In this method of extraction the 100 gms of neem leaves with 100 ml of 70 percent ethanol are crushed by trituration. Squeezing out the concentrate with the muslin cloth and the concentrate percentage of azadirachtin is analysed on the TLC and HPLC. The concentrated extract is mixed with the 100 gms of waste paper pulp until the concentrate is absorbed in the pulp and a dough is formed. Followed by preparation of tablets. Sun drying the tablets and the application of the tablets in grains.

Soxhlet Extraction

Collection, weighing 100 grams and drying of neem leaves in shade at room temperature. Crushed the leaves in molten and pistil. Sieving the powder (20 grams). The solvent used is di chloro methane for 20 minutes at a temperature of 35 degree Celsius for 10 minutes cycle time.

From all the above extraction methods, it can be concluded that extraction by using 70% ethanol yields highest concentration of azadirachtin. The extraction of azadirachtin in boiling water gave the higher concentration of azadirachtin. While the Soxhlet extraction exhibited lower concentration of azadirachtin. Although the amount of extract obtained from the use of distilled water was lower, it could still be an option if the environmentally friendly solution is taken into account. The concentration of azadirachtin in the above extraction methods is more than sufficient for the insects to repel from the grains.

Growth of insects in grains using neem concentrate and waste paper pulp pallets.

The grains of 500 gms of wheat, chana dal, green gram and groundnut with the application of neem concentrate and waste paper pulp pallets shall be stored in an airtight container and the observations were recorded.

1 Kg of wheat, Bengal gram, green gram and groundnut were kept under observation with neem pallets for a period of 7 months, temperature and humidity data were noted, infestation growth was observed every 15 days, it was noted that from no live insects were observed by using neem pallets in the grains.

Conclusion

After listing and studying various proven traditional knowledge, the most emergent as well as important traditional knowledge of Bio-based neem leaves, as antifeedant for grains was identified and finalised for this research work. After noting the disadvantages of existing methods of application of neem leaves, directly in the grains as well as spraying or applying neem oil extracted from kernels, the innovative method was finalised to develop a composite material as an antifeedant for grain storage.

Universally, own a green neem tree called “Kalpatru”, traditionally known for its application. The leaves of the neem tree were crushed with the optimum amount of water. The extract was filtered and made ready for blending.

Waste paper recycling is also a universally adopted process for its reuse. The waste paper was shredded and soaked in water overnight. After washing it was converted to a pulp with the help of a hydropulper/ beater. After air drying, this pulp is ready for blending. The unique and innovative process of blending both neem leaves extract and pulp is the result of this research work, which is not yet trapped anywhere. The air-dried pulp and extract were thoroughly mixed and allowed to impregnate, before converting into tablet/ cake or suitable shape before drying.

The simple but very efficient, economical energy saving and environmentally friendly most versatile method for the development of sustainable composite is the outcome of this research work. The composite prepared has best result as an antifeedant for grain storage, as proven traditionally. The advantages of this research work is not only this developed unique and innovative composite but also the following advantages also.

- 1) Application of traditional knowledge
- 2) Utilization of locally available raw material
- 3) Utilization of local man power
- 4) Very simple but effective product
- 5) Very simple method/process
- 6) No need of any special equipment
- 7) Utilization of locally available equipments
- 8) Local as well as regional market for product
- 9) Very easy product transportation, if required
- 10) Effective, economical, energy as well as environmental saving product
- 11) For self employment and Made in India product

Which resulted in acceptance/ registration for patent

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