

## Development & Analysis of Natural Powder Material

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### Abstract:

This research article presents the development and comprehensive analysis of natural powder materials, focusing on their synthesis, characterization, and potential applications. Natural powders were produced using advanced size reduction and purification techniques to ensure consistent particle morphology and purity. Key properties such as particle size distribution, morphology, porosity, and flowability were systematically investigated using methods including laser diffraction, scanning electron microscopy, and flow tests. The study highlights the influence of processing parameters on powder behavior and performance, demonstrating how tailored fabrication can enhance material properties for targeted uses. Results indicate that optimizing particle characteristics significantly improves the functional performance of natural powders in applications ranging from composites to coatings. The findings contribute valuable insights into the scalable production and quality assurance of natural powder materials, supporting their broader adoption in sustainable industrial processes.

**Keywords — Wheat bran, Bio composites, Processing, Structure property relationship**

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### I. INTRODUCTION

#### A. Overview of Composite Material

The reinforcement of composites with natural fibers has attracted growing interest from both academia and industry due to their notable advantages over synthetic fibers. A wide variety of natural fibers-including flax, hemp, jute, wood, rice husk, sisal, coir, and banana fiber-have been explored for use in plastics and thermoplastics. These fibers offer benefits such as low weight, reasonable strength and stiffness, biodegradability, renewability, and cost-effectiveness. Plant-based proteins, like wheat gluten, also present promising thermoplastic properties, enabling the production of biodegradable films and packaging. Hemp, flax, and kenaf are particularly valued for their mechanical performance and environmental friendliness in composite materials. Traditionally used for products like rope, hemp fibers are now found in textiles and

consumer goods, being fully biodegradable and recyclable. Natural fiber-reinforced polymer composites are emerging as sustainable alternatives to wood-based materials, especially in structural applications. Plant fibers, classified as bast, leaf, or fruit fibers depending on their source, exhibit properties influenced by plant type, growth conditions, and extraction methods. Their hydrophilic nature and composition, primarily cellulose, contribute to their unique functional characteristics, making them increasingly important in the development of eco-friendly composite materials.

#### B. Natural Powder Material – Wheat Bran

Wheat bran, a by-product of the milling process, is increasingly utilized in both food and non-food applications. Its use in human diets has risen steadily, with wheat bran-containing food products growing from 52 in 2001 to around 800 by 2011.

Wheat bran is valued for its high content of minerals, dietary fiber, B vitamins, and bioactive compounds, all of which offer notable health benefits. Consumer demand for healthier, natural ingredients has driven greater incorporation of wheat bran in food production, particularly in bakery and cereal products, which account for about 60% of the bran-enriched market. Recent interest has also focused on its application in fried cereal snacks, where wheat bran may function as a barrier to reduce oil absorption during frying. This article reviews wheat bran's nutritional profile, its impact on the quality and sensory attributes of cereal foods, and its potential as a functional ingredient in fried snacks.

## **II. LITERATURE REVIEW**

Lukasz Majewski et al. the paper presents a procedure of the manufacturing and complex analysis of the properties of injection mouldings made of polymeric composites based on the poly(butylene succinate) (PBS) matrix with the addition of a natural filler in the form of wheat bran (WB). The scope of the research included measurements of processing shrinkage and density, analysis of the chemical structure, measurements of the thermal and thermo-mechanical properties (Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TG), Heat Deflection Temperature (HDT), and Vicat Softening Temperature (VST)), and measurements of the mechanical properties (hardness, impact strength, and static tensile test).

J. Santhosh, N. et al. Balanarasimman, they have studied various natural powders such as coir, sisal, jute, coir and banana are used as reinforcement materials. In this paper both treated and untreated banana powder are taken for the development of the hybrid composite material. The untreated banana powder is treated by sodium hydroxide to increase the wet ability. The untreated natural powder and sodium hydroxide treated powder are used as reinforcing material for both Epoxy resin matrix and Vinyl ester resin matrix. The variation in mechanical properties are studied and analyzed. Here, the tensile strength has calculated by universal testing machine, impact strength has calculated by pendulum impact tester and flexural strength has calculated by

universal testing machine with flexural test arrangement of the specimen. Then the treated and untreated specimens.

Neha Bansal, Simran Ahuja et al. Agricultural-waste *Sesamum indicum L./recycled-low density polyethylene bio-composites: Impact of gamma radiation on mechanical and thermal properties.* Composites synthesized from natural waste and recycled plastic is quite a promising and interesting field for scientists and polymer industries. In the present study, bio-composites based on agriculture residue *Sesamum indicum L.* and recycled-low density polyethylene were synthesized by extrusion and injection molding technique.

M Ramesh et al. have provided indisputable advantages over synthetic material as low cost, non-toxic, minimum waste disposal problems, samples with different fiber were fabricated by using hand layup method. This paper that natural fiber composites are more advanced and has various advantages in the industrial sector.

Suman deviet et al. has studied that due to high nutritional and medicinal value of amla it can be used for some food products. Amla powder can be used in various foods. Amla in the form of powder can be used in several food applications.

Danuta matykiewicz et al. has studied different 105 combinations of different resins, different powders and a big data in the form of tests, properties, etc. Obtained with the help of different methods and technologies. In short he made several experimental combinations in order to get best materials. He also studied different combinations of multilayer composites.

Rozman et al. have made the conclusion that the coir fiber filled polypropylene composites with lignin as a compatibilizer was performed better flexural properties than control composites. Tensile properties were not at all improved where lignin was incorporated as a compatibilizer. The use of coir fiber reinforced polypropylene composite for the panel of automotive interior applications is studied in this research.

Rout et al. have studied the significance of surface treatment on the coir reinforced polyester composites. The coir fiber was subjected to alkali treatment, vinyl grafting, and bleaching before

adding them with general purpose polyester resin. The mechanical characteristics like tensile strength, bending and impact strength were increased because of surface treatment. Bleached fiber composite (at 65°C) showed better flexural strength. NaOH treated fiber/polyester composite exhibited better tensile strength. Because of the chemical treatments of fibers the water absorption tendency of composite was reduced.

Monteiro et al. have carried out a study on the mechanical characteristics of coir fiber reinforced polyester composites. The coir fiber percentage was increased up to 80 % and found that up to 50% fiber loading, composites were become rigid, and after that composite behaves like agglomerates. A systematic study on the influence of lignin as a compatibilizer on the physical property of coir fiber reinforced polypropylene composites was performed.

A. Ramakrishana et.al Last few decades have seen composite materials being used predominantly in various applications. Many types of natural fibers have been investigated for their use in plastics including Flax, hemp, jute, straw, wood fiber, rice husks, wheat, barley, oats, cane (sugar and bamboo), grass reeds, Kenaf, ramie, oil palm empty fruit bunch, sisal, coir, water pennywort, kapok, paper-mulberry, raphia, banana fiber, pineapple leaf fiber and papyrus. Their volume and number of applications have grown steadily. Natural fibers offer both cost savings and reduction in density when compared to glass fibers. Natural fibers are an alternative resource to synthetic fibers, as reinforcement for polymeric materials for Development and Analysis of Natural Composite Material SVERI's COE, Pandharpur 13 the manufacture is cheap, renewable and environment friendly. This paper discusses in detail about the uses& applications of jute and banana fiber composites.

### III. EXPERIMENTAL SETUP

#### A. Material Selection

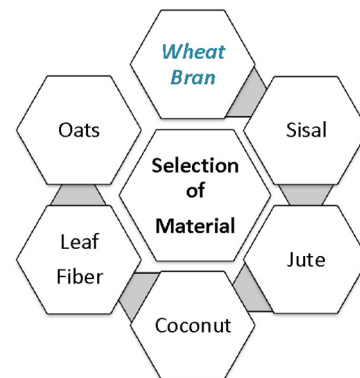


Figure 1: Material Selection

As per methodology, in Maharashtra region most of the farmers produce wheat. wheats outer cover is called wheat bran which is most of the time not useful for the farmers and gets wasted or used as food for animals so that's the reason for selecting this material for this project.

Most grains, like wheat and oats, have a hard outer layer. When they are processed, this layer becomes a by-product, and is called bran. In the case of processing wheat to make wheat flour, one gets miller's or wheat bran. It is packed with nutrition, and offers many dietary benefits.

The interrelation behavior between the matrix and the wheat bran powder will be obtained through characterization. The natural powder has generated wide research and engineering interest in the last few decades because of their small density, high specific strength, low cost, light weight, recyclability and biodegradability and has earned a special category of natural powders. The various advantages of natural powders such as biodegradability, renewable, low cost, eco-friendly and comparable high mechanical properties make it more noticeable.

#### B. Manufacturing of Mould

As per methodology, the mould is manufactured by silicon rubber for simply removal of samples. It is taken as 3:1 ratio of silicon rubber and hardener. It is semi jelly like in structure. In this mould preparation following steps are followed;

- Firstly, silicon rubber liquid and hardener mix up together for manufacturing of mould.
- Ratio of silicon and its hardener is 3:1

- After taking ratio for poured a liquid solution into die.
- Then in this mould, in between 6 chocks are placed for getting specimen dimensions and then poured the liquid solution.
- This liquid solution after pouring it takes 12 hours for curing to solidification.
- After solidification its total weight is 1.25 kg.
- Then take a mould cavity; its height is 8 cm & diameter is 13 cm.

**C. Manufacturing of Specimens**



Figure 2: Prepared Samples

Once all materials are prepared and the workstation and moulds are set up, the lay-up process begins with mixing the resin and hardener according to the supplier’s specified ratios, which can be measured by weight or volume. Accurate measurement is crucial, as improper proportions can compromise the chemical reaction and the final strength of the composite matrix. Using screw-in pumps for dispensing helps prevent cross-contamination between resin and hardener containers, which could otherwise trigger premature hardening. The mixture should be stirred slowly for at least two minutes to ensure thorough blending and to minimize air bubble formation. Various compositions of epoxy resin and wheat bran powder, such as 60:40, 50:50, and 70:30 ratios, are prepared to study the effects of different formulations. Additionally, samples are created using different wheat bran powder particle sizes (50, 100, 150, and 200 microns) to analyse how particle size influences material behavior.

**IV. EXPERIMENTAL ANALYSIS**

**A. All samples of 50-50%**

The wear test result at 50-50% composition of different micron sizes (50µ, 100µ, 150µ & 200µ) specimens at selected varied speed at 400 rpm by varying loads from 1kg to the 5kg for 10 minutes of time interval,

TABLE I

COMPARISON OF WEAR TEST RESULTS

400 RPM	50 µ	100 µ	150 µ	200 µ
1	0.11	0.09	0.17	0.12
2	0.31	0.27	0.39	0.35
3	0.54	0.44	0.39	0.52
4	0.75	0.66	0.7	0.76
5	0.96	0.83	1.09	0.81

TABLE II

COMPARISON OF WEAR TEST RESULTS

800 RPM	50 µ	100 µ	150 µ	200 µ
1	0.1	0.12	0.15	0.08
2	0.33	0.32	0.25	0.3
3	0.59	0.48	0.56	0.79
4	0.83	0.8	0.97	1.03
5	0.85	0.99	1.48	1.34

**B. Samples of 60%-40%**

TABLE III

COMPARISON OF WEAR TEST RESULTS

400 RPM	50 µ	100 µ	150 µ	200 µ
1	0.04	0.13	0.05	0.12
2	0.29	0.211	0.21	0.34
3	0.64	0.39	0.36	0.61
4	0.73	0.44	0.48	0.93
5	1.09	0.64	0.91	1.16

The wear test result at 60-40% composition of different micron sizes (50µ, 100µ, 150µ & 200µ) specimens at selected varied speed at 400 rpm by varying loads from 1kg to the 5kg for 10 minutes of time interval.

TABLE IV

COMPARISON OF WEAR TEST RESULTS

800 RPM	50 µ	100 µ	150 µ	200 µ
1	0.09	0.1	0.07	0.13
2	0.32	0.27	0.26	0.4
3	0.6	0.53	0.45	0.63
4	0.95	1.04	0.57	0.86
5	0.92	1.07	0.78	1.13

### C. Orientation

50-50% volume fraction: In 50-50% volume fraction, it consists of 50% wheat bran powder and 50% epoxy resin and hardener. At this volume fraction it is analysed that wear is very less than B and C.

60-40% volume fraction: In 60-40% volume fraction it is consists of 60% wheat bran powder and 40% epoxy resin. At this volume fraction it is analysed that wear of sample is more than A and less than C.

70-30% volume fraction: In 70-30% volume fraction it is consist of 70% wheat bran powder and 30 % is epoxy resin. At this volume fraction it is analyzed that wear of samples is more than A and B because of the more powder is present than epoxy resin.

## V. CONCLUSIONS

A detailed study on the mechanical behavior of wheat bran-epoxy composites, focusing on varying volume fractions and natural powder orientations, yielded critical insights. The research proposes innovative methods for value-added utilization of abundant wheat bran, demonstrating its potential as a sustainable reinforcement in bio-composites when combined with epoxy resin and hardener. Additionally, the investigation highlights the importance of pretreatment techniques to optimize

the performance of these bio-composites. Wear testing revealed that wheat bran significantly influences surface characteristics, with larger particle sizes (200 $\mu$ ) exhibiting higher wear rates compared to smaller particles (50 $\mu$ ) due to inadequate interfacial bonding. The analysis further showed a direct correlation between increasing load and friction force, emphasizing the role of particle size in wear resistance. These findings underscore the necessity of optimizing grain structure and bonding efficiency in composite design, providing actionable strategies for developing durable, eco-friendly materials from agricultural by-products.

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