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Bio Based Coating Materials in Food Packaging

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***Abstract*- The aim is to develop different Bio-Based materials like corn zein, potato peel powder, egg shell extract. The coating is applied on paperboards used for food packaging. The proposed method is to compare the different bio-based coatings on paperboard material used for food packaging. This was done by measuring the mechanical property like tensile strength, barrier property like Oxygen Permeability (OP) and water absorption. From the results the coating which best suits the need for food package can be determined.**

Key words- Biodegradable, Renewable, Bio-Polymers, Food Packaging.

I. INTRODUCTION

Naturally renewable biopolymers have been the focus of much research in recent years because of interest in the potential use as edible and biodegradable films and coatings for food packaging. The properties, technology, functionalities, and potential uses of biopolymer films and coatings have been extensively studied [1]. Biopolymer-based packaging materials originated from naturally renewable resources such as polysaccharides, proteins, and lipids or combinations of those components offer favorable environmental advantages of recyclability and reutilization compared to conventional petroleum-based synthetic polymers [2]. Biopolymer films and coatings may also serve as gas and solute barriers and complement other types of packaging by minimizing food quality deterioration and extending the shelf life of foods. Moreover, biopolymer-based films and coatings can act as efficient vehicles for incorporating various additives including antimicrobials, antioxidants, coloring agents, and nutrients.

Renewable biopolymers available for forming coatings on paper packaging materials are generally made from proteins, polysaccharides and lipids used alone or together [3]. Bio based polymers can be applied to paper or paperboard with different coating techniques, such as surface sizing, solution coating, compression molding, and curtain coating depending on the appropriate coating material and type of paper used [4]. Surface sizing is one of the most frequently used processes for applying an aqueous coating to a paper substrate. In surface sizing, the solid content of the coating is limited and is typically lower than 10% to 15%.

A low solid content does not yield a fully continuous coating and increases the amount of drying needed. A higher coating weight and better gas-barrier properties can be obtained using curtain-coating technique in which the paper industry has begun to show a considerable interest [5]. A thick and continuous coating, necessary in several cases to obtain coverage of the paper, is not possible to obtain by solution coating. However, this coating technique results in interesting mechanical properties.

The compression-molding technique is suitable for applications where complete coverage and thick coatings were necessary, and which, therefore, involved significantly more coating material compared to solution coating.

Protein-based coatings Proteins cover a broad range of polymeric compounds that provide structure or biological activity in plants or animals. Proteins have successfully been formed into films and coatings and their film properties have been quantified [6].

II. MATERIALS AND METHODS

The bio-based material like corn zein, potato peel powder, egg shell extract is used as coating for paperboard food packaging. The coating solutions are prepared and the coating is done on paperboard which is used for food packaging. The coated paperboards are printed and tested for Water absorption, Oxygen Permeability (OP), Tensile strength (TS), gloss and color density are done.

A. Preparation of Corn Zein Coating

The corn zein solution is prepared by dissolving zein in aqueous ethanol solution (50%). The solution is stirred on a magnetic stirrer- ROTA MANTLE for two hours at 500 C. Zein solution is then plasticized with glycerol (GLY) for the concentration of 50%. After the addition of plasticizer, stirring was continued for further period of two hours.

B. Potato peel Powder Coating

The potatoes are hand washed with tap water. The potatoes are peeled and the peel was air dried at 15+/ - 4% relative humidity at 23 +/-20C for 3 days. About 2 kg was dried in one batch [8]. The moisture content of the dried peel was 1o g/100 g. The dried peel was ground by a multi mill and then sieved to prepare Potato Peel powder. 2% PP powder was mixed with 50% water to prepare a PP solution. The mixture was pre-homogenized with a high shear probe mixer at 20,000 rpm for 5 min.

The homogenate was treated by high pressure homogenization, to destruct biopolymers in the solution. The solution was maintained in a water bath for 30 min and then cooled on ice-water. Once cooled, glycerol was mixed into the solution at 30 or 50% (w/w) of Potato Peel powder. After mixing, soy lecithin was incorporated at 2% (w/w) of PP powder. The mixture was homogenized using the high shear probe mixer at 20,000 rpm for 5 minutes.

C. Egg Shell Extract Coating

The eggshell mixture was prepared by mixing 620 g eggshell waste in 400 ml water and was ground using a homogenizer for 10 min to separate the eggshell membrane from the eggshell. The ground eggshell was placed in the separation vessel. Air is injected into the water flow by the air–water mixer. The eggshell separation unit was normally run with 0.95 SCMH (standard cubic meter per hour) air flow at 265 kPa and l90 LPH (liters per hour) water flow.

The air/water mixture flows from the bottom of the separation vessel causing the lighter component of the eggshell (eggshell membrane) to float up while the heavier calcium carbonate settles out at the bottom of the vessel.

The membrane and calcium carbonate particles were collected separately and weighed after they were dried overnight, after which the recovered percentage of each component was then calculated. Higher air flow rate (1.41 SCMH) and high air pressure (551 kPa) were tried in order to investigate the effects of operating conditions on the separation efficiency. After the DAF process, the recovered eggshell calcium carbonate (ECC) still contained residual amounts of eggshell membrane vinegar treatment was done, 25% of the recovered ECC powders were submerged in 50% of vinegar solution (5% acidity) at room temperature for 2 hours. The coating was done with the help of RK print coat instrument and the testing for Water absorption, Oxygen Permeability (OP), Tensile strength (TS), print characteristics are carried out.

The three paperboards straw board, pulp board, duplex board of 300GSM was coated with corn zein, potato peel powder and egg shell extract by using RK Print Coat Instrument. The coating was done for 35microns thickness. The coated paperboards are tested for tensile strength, water absorption.

III. RESULTS AND DISCUSSION

A. Tensile strength analysis

Tensile strength for various bio based coated boards are tabulated in Table I and the bar chart is shown in Fig.1. Based on the results, the tensile strength of the coated boards with all the three bio based coating solutions exhibit improved mechanical strength compared to the uncoated boards.

Table I
Test Results For Tensile Strength

Boards	UCB (MPa)	PPP (MPa)	ESE (MPa)	CZ (MPa)
Straw	1.727	2.166	1.799	0.870
Pulp	3.012	11.62	5.748	5.292
Duplex	2.120	14.81	8.07	5.863

UCB- Uncoated board, PPP- Potato Peel Extract, ESE- Egg Shell Extract, CZ- Corn Zein

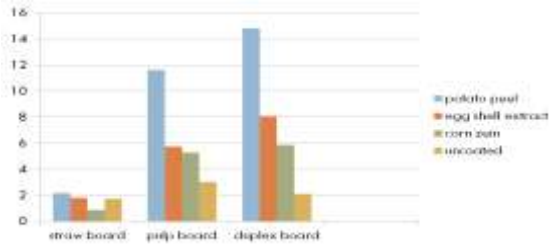

Fig.1. Graphical Representation Of Tensile Strength Results

Among the three coatings when tested for tensile strength, the paperboard with potato peel extract coating is having a value of 14.81 Mpa which is greater than the uncoated board with 2.12 Mpa.

So among the three coatings the potato peel extract coating has higher tensile strength. Among the three boards the duplex board coated with potato peel extract exhibits improved tensile characteristics.

B. Water Absorption analysis

Results from the water absorption test for the biobased coated boards are tabulated in Table II and the bar chart is shown in Fig.2. Based on the results, the water absorption of the coated boards with all the three bio based coating solutions exhibit improved barrier properties compared to the uncoated boards.

Table II
Test Results For Water Absorption

Boards	UCB (g/m^2)	PPP (g/m^2)	ESE (g/m^2)	CZ (g/m^2)
Straw	189.3	158.5	87.79	78.02
Pulp	133.9	51.12	49.185	110.175
Duplex	160.25	17.54	50.728	114.175

UCB- Uncoated board, PPP- Potato Peel Extract, ESE- Egg Shell Extract, CZ- Corn Zein

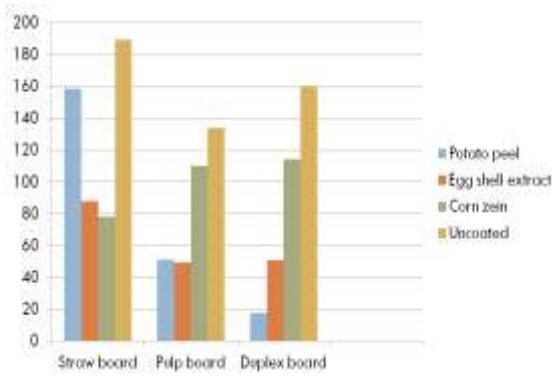

Fig.2. Graphical Representation of Water Absorption Results

The three coated paper boards when tested for water absorption, the potato peel extract coating is having a value of 17.5 g/m^2 which is lesser than the uncoated board 160.25 g/m^2.

From the three coatings the potato peel extract coating is best. Among the three boards the duplex board coated with potato peel extract exhibits improved characteristics.

IV. CONCLUSION

From the experimental investigation carried out with different bio based coating like potato peel, corn zein and egg shell coatings on different substrates namely straw board, pulp board, duplex board then the coated paper boards are tested for tensile strength, water absorption, it is concluded that the potato peel coating solution is the best suitable material for the food packaging which has improved mechanical as well as barrier property.

The bio based coatings applied on paperboards is best suitable for packaging food products as the shelf life of the food product is increased and also the package is biodegradable.

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