BIO COATING AS AN ALTERNATE FOR WAX COATING FOR FOOD GRADE PAPER BOARDS

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Abstract: *1.45 million tons of paraffin wax-coated boxes of used products enter landfills every year, and 4.5 million metric tons of carbon dioxide is released during the recycling process. Therefore, the goal of the research is to find out an alternative to the synthetic wax coating seen on food product cartons. This research uses natural coating materials that are more effective than synthetic coating materials, such as hibiscus, gum Arabic, and turmeric. The natural antibacterial herb turmeric's curcumin is extracted using ethonal, and then heating is used to create the hibiscus extract.*
Three layers are coated on the package: the first layer is curcumin, which serves as the package's antimicrobial coating; the second layer is gum Arabic, which serves as a binder to hold the third layer of hibiscus. These two layers serve as a barrier on the packaging, and then the hibiscus extract gel is applied over them. Using a spray gun, these three coats are applied to the packaging. The method used to dry the coatings is air or sun drying.
The test findings are assessed for the burst strength, burst factor, moisture content, smoothness, calliper thickness, and micropsoic analyses of the wax coated and bio coated carton samples.

Keywords: bio-coating, paper board, natural coating

1. INTRODUCTION

The use of petroleum-based derivatives as coatings, such as polyethylene, waxes, and/or flour derivatives, typically regulates the barrier resistance and wettability of sheets. Although using these polymers increases surface hydrophobicity, their unfavourable environmental effects, low recycling capabilities, and environmental worries over creating trash without biodegradation have caused them to lose favour. Alternatively, novel methods for entirely bio-based paper coatings can be developed using biopolymers such as polysaccharides, proteins, lipids, and polyesters. However, the majority of biopolymers may have processing issues because of hydrophilicity, crystallisation behaviour, brittleness, or melt instabilities that prevent complete commercial use. Therefore, it is preferable to blend with other biopolymers, plasticizers, and compatibilizers to enhance the coating performance. The production of bio-based polymersand their composites as paper coatings will be explored, as well as their barrier qualities. Specifically, there are three layers of coating that may act as stability to the paper board, and turmeric is being utilised because it has antibacterial properties. The first layer of paper may have some microorganisms, and the layer of turmeric coating can kill those microbes. Then, the creation of a gum Arabic coating and a hibiscus coating may come next. These layers have binding properties and contribute some waterproofing properties, and the board will also have increased stability and operate as a barrier control. This bio-coating is environmentally friendly, economical and gives excellent results (Piselli et al., 2014).

2. LITERATURE SURVEY

In this section, properties of curcumin and Gum Arabic components for bio-coatings are discussed and presented below,

2.1 Impact of curcumin formulation on its antimicrobial activity

A hydrophobic, yellow-orange substance called curcumin is obtained from the Curcuma longa plant. However, due to its limited water solubility, it is less bioavailable and cannot be used in industry. To increase curcumin's water solubility and dispersibility and enhance its biological effects, it may be changed via micro/nanoencapsulation or nanonization (transformation in nanometric crystals) procedures (Gul & Bakht, 2015). Encapsulated curcumin may also be used as a preservative on foods to lengthen the shelf life of the food product.

2.2 Functional properties of gum Arabic

For example, solubility, viscosity, the degree of association with water and oil in an emulsion, and microencapsulation capability are all determined by gum arabic (GA). GA contains powerful anti-oxidant qualities. Due to its protective colloid activity, GA is an incredibly effective emulsifying agent and has found extensive usage in the mixing of oil and water to create food emulsions. The gum provides a smooth surface to frozen goods by controlling the arrangement of ice crystals due to its high water-holding capacity (Ololade, 2018). The use of GA as an encapsulating material for maintenance has been encouraged by its solubility and low-viscosity emulsion characteristics.

3. METHODOLOGY

The aim is to replace the wax coating with bio coating (Ift, 2007) which is made from materials like turmeric extract, gum Arabic and hibiscus extract. Each material was selected for its physical and chemical properties. Turmeric with the molecular formula $C_{21}H_{20}$, contains the major curcuminoids from turmeric (Curcuma longa) of the Zingiberaceae family. It is used for its antimicrobial activity to destroy any microorganisms present in the sample. Then Gum Arabic was used to act as a binder. The high water holding capacity of the gum makes the surface of dry objects smooth. The solubility and low viscosity emulsion properties facilitate the use of GA as encapsulated articles for personal care. Hibiscus is used with a barrier coating that acts as a barrier (Seas, 2014).

3.1 Layer work

The layer work implies about the number of layer of coating being given for the board and the composition of the coating. There are three layers coated one over another layers, first layer is curcumin, second layer is Gum Arabic and third layer is hibiscus layer.

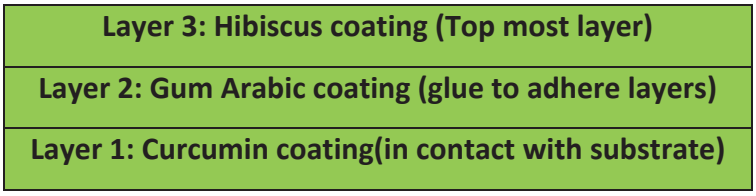


Figure 1: Layers of coating

3.1.1 Tumeric extract layer

Curcumin is a component contained in the root of turmeric and can be extracted from the root itself. Extracting curcumin from turmeric is usually not a very simple process. You may need a solvent such as ethanol or methanol to do this at home (Silva et al., 2018). Temperature control may also be required. One simple process to separate curcumin from turmeric is to separate curcumin from turmeric powder. To extract curcumin, you can follow the process below.

3.1.2 Gum arabic layer

Gum Arabic is a complex, fluffy aggregate of sugars and hemicelluloses composed of an arabic acid nucleus related to calcium, magnesium, potassium, and the sugars arabinose, galactose, and rhamnose (Mariod, 2018). It is supplied in mechanically ground or spray dried form. Solubility varies from 2 hours in raw gum form to 20 minutes in spray dried form. The solubility of the granulated instant soluble gum was found to be less than 5 minutes at room temperature compared to the spray dried form which was 20-30 minutes and 2 hours for the mechanically milled gum. The volume is up to 3 times that of the mechanical form. It was concluded that granulation of the gum under water spray significantly increased solubility. Gum Arabic is solid and hardens when mixed with water. The solidified rubber is originally highly viscous (Alkar & Nour, 2017). Then use the same process you did with the first coating layer. After the first coat, the gun should be cleaned. It can then be filled with hardened Gum Arabic. After the first layer dries, a second layer can be applied.

3.1.3 Hibiscus extract layer

Hibiscus powder is made by drying hibiscus flowers until all the moisture is dry. The dried flowers are then powdered. To prepare the extract, mix the powder with water in a 1:2 ratio and heat to 300°C until the water absorbs the powder extract. Then filter the liquid through Whatman filter paper. Therefore, there is no sediment of hibiscus powder compounds in the extract (Yin et al., 2013).

4. COATING PROCEDURE

The coating are applied layer by layer

STEP 1
Curcumin is extracted by mixing with ethanol in a 1:2 ratio, curcumin is extracted by ethanol and the remaining turmeric settles in the soil (Rastogi & Samyn, P, 2015).

STEP 2
Turmeric extract is filled into a spray gun and applied as the first layer in the sample box board

STEP 3
The second layer is a Gum Arabic coating where GA is in solid form and liquefied by soaking in water in a 1:1 ratio. Same procedure as the first layer. A second layer is coated.

STEP 4
Hibiscus extract is prepared with a composition ratio of 1:2 for 15 minutes at 300° C. to extract hibiscus into water.

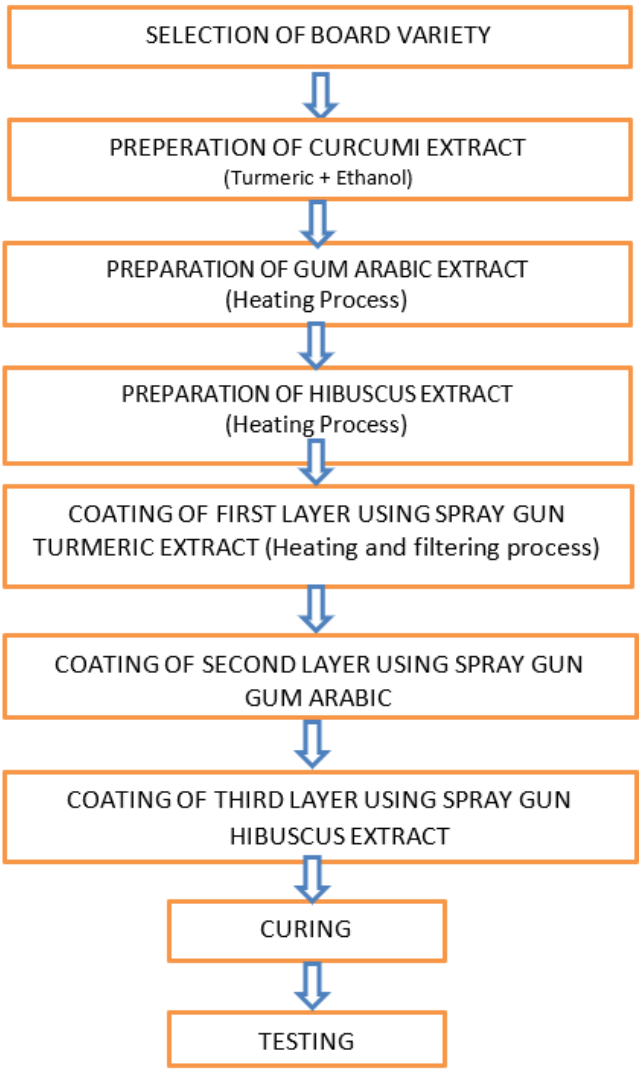


Figure 2: Workflow of coating Preparation

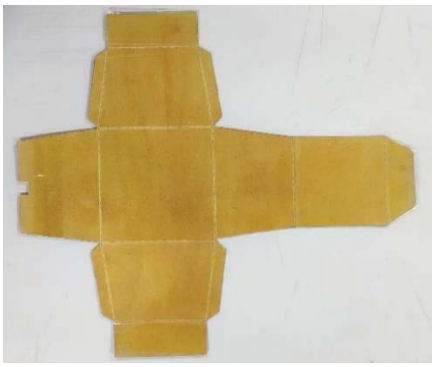


Figure 3: 3 Layer coated Carton

5. RESULT AND DISCUSSION

In this section properties of three types of Baker boards ad Bio coated board are tested their results are given in table 1

Table 1: Testing Results

S.NO.	TEST	RESULTS OF TESTING using 4 types of boards with 400GSM			
		BAKER BOARD1	BAKER BOARD 2	BAKER BOARD 3	BIO COATED BOARD
1	BURST STRENGTH (Kg/cm²)	8	7.5	7.3	8.3
2	BURTST FACTOR	20	18.75	18.25	20.29
3	MOISURE CONTENT (%)	4.1	3.9	3.5	4
4	SMOOTHNESS (seconds)	1600	1500	1300	1100
5	CALIPER THICKNESS (inches)	0.59	0.60	0.52	0.62
6	MICROSCOPIC ANALYSIS	Nano fine granules	Nano fine granules	Nano fine granules	Fine granules

5.1 Burst Strength (Kg/cm²)

A property of paper or paperboard used in packaging measures its tear strength, defined as the hydrostatic pressure required rupturing a sample of paperboard when applied uniformly over its surface. Burst strength is measured with a Mullen tester.

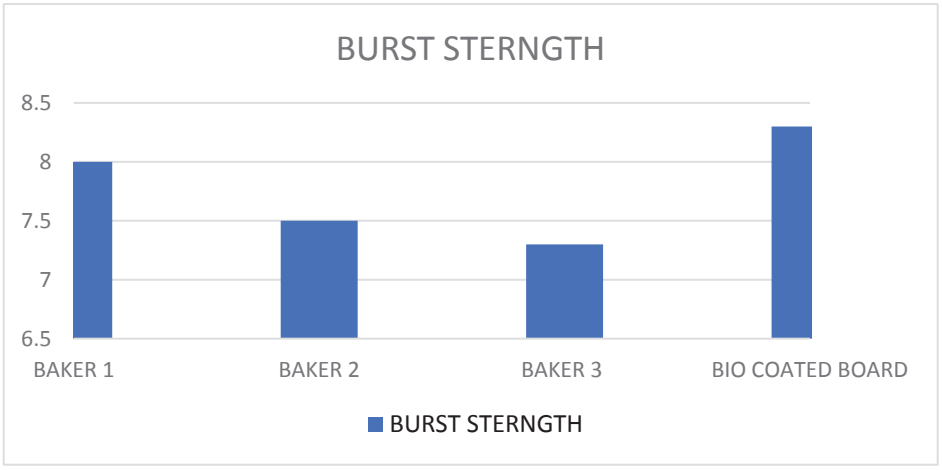


Figure 4: Burst Strength Test

Inference: This test considers three baker's coated paperboard packages along with bio-coated paperboard samples. Bio-coated paperboard gives improved, satisfying and improved results compared to other.

5.2 Moisture Content

Paper moisture varies between 2 to 12% depending on relative humidity, type of pulp used, degree of refining and chemicals used.

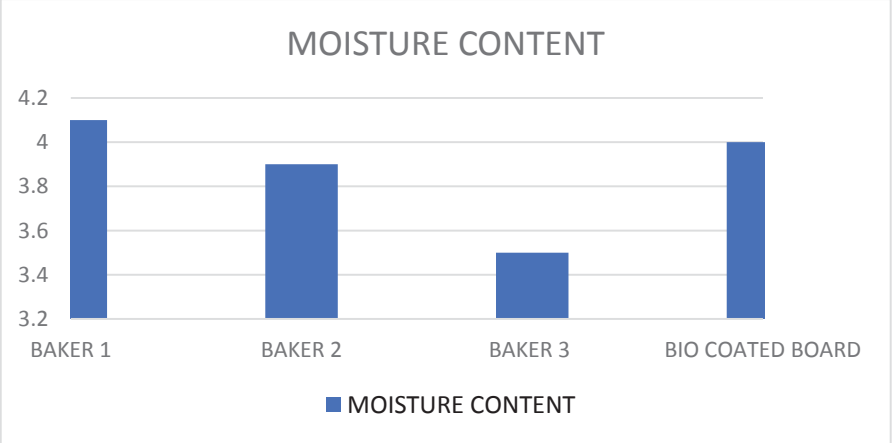


Figure 5: Moisture content Test

Inference: The moisture content of the board was tested at an ambient temperature of 39°C. Also, good results are obtained with bio-coated boards compared to other coated boards.

5.3 Smoothness

The smoothness is a gauge of the irregularities on the paper's surface. Numerous end uses, in particular the aesthetic of printing, are impacted by the feature.

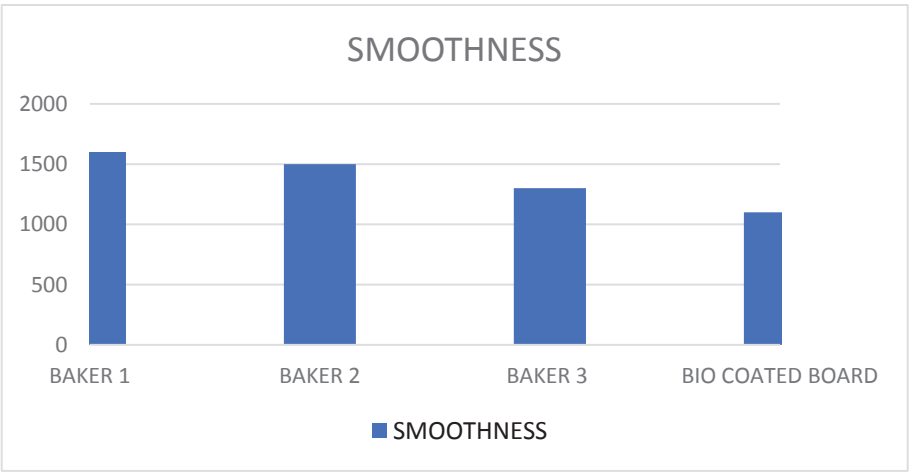


Figure 6: Smoothness Test

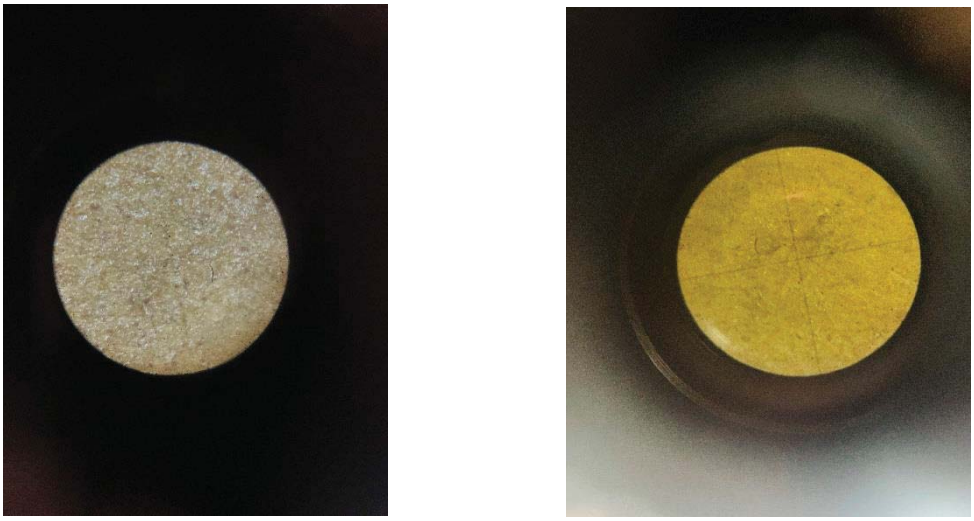
Inference: In a smoothness test compared to three bakers, the bio-coated board shows the smallest result as the wax-coated board contains a particle size of 3 µm. Bio-coated cardboard contains hibiscus granules with a size of 10 µm so it affects the smoothness of the board. But the coating no longer has peaks and valleys.

5.4 Thickness

Thickness is also called caliper. This method describes how to measure the thickness of a piece of paper or cardboard using a synthetic rubber cowl that is soft against the paper to minimize the effects of surface roughness.

5.5 Microscopic analysis

Electron microscopy (EM) is a technique for obtaining high-resolution images of biological and non-biological samples. Used in biomedical research to study the detailed structure of tissues, cells, organelles and macromolecular complexes. High resolution EM images are obtained by using electrons (which have very short wavelengths) as the source of the irradiating radiation. Electron microscopy is used in combination with various auxiliary techniques (thin sections, immunolabeling, negative staining, etc.) to answer specific questions. EM imaging provides important information about cellular function and the structural basis of cellular disease.



(a) *(b)*

Figure 7: Microscopic analysis of the hibiscus granules after coating a) normal filtered coating b) finely filtered granules

6. CONCLUSION AND FUTURE WORK

Therefore, this paper concludes that bio-coated paperboard is more efficient in packaging solid food materials. These paperboards can be used in bakery, solid food packaging, pharmaceutical and grocery applications. The project has been pre-planned and implemented to ensure flexibility and economical operation. This revolutionary coating has made many things desirable and economical. This bio-coating is environmentally friendly and highly promising. This project helps us to understand the importance of natural materials and has great applicability in our daily lives. Compared to wax-coated cardboard used in bakeries, bio-coated cardboard has shown good results during testing.

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