BINDING AGENT FOR BIODEGRADABLE COMPRESSION MOLDED RICE STRAW FILLED RICE BRAN PACKAGING PRODUCTS

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I dedicated this entire work to my beloved family especially my father,
Syed Abu Bakar Bin Syed Abdul Rahman and my mother, Sumaliah Binti Awang and
also to my friends for their support and encouragement
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ABSTRACT

Rice bran (RB) has been used as a natural fibre in polyolefin which results in lower mechanical properties and low interfacial adhesion that need a coupling agent or binder at higher loading. Rice bran (RB) and rice straw (RS) which both is low cost materials were developed in the processing of biodegradable packaging by using compression moulding technique. Glycerol, rice starch and polyvinyl acetate (PVAc) have been used as binding agent in this study where their physical (mechanical, chemical, and thermal) properties were studied base on the percentage of binding agent used in RB/RS. Rice starch and PVAc increased the tearing strength and tensile strength of RB/RS. This was continued by fracture surface analysis using inverted microscopy where RS is clearly visible of phase separated without binding agent as compared to RS with binding agent. Although rice starch and PVAc exhibited good mechanical properties, but they showed poor water resistance because of high in hydrophilic molecular structure. Starch influenced the rapid thermal degradation of RB/RS. By incorporation of PVAc in RB/RS, thermal stability property is increased.

ABSTRAK

Dedak (RB) telah digunakan sebagai fiber semulajadi di dalam polyolefin yang menghasilkan ciri-ciri mekanikal dan lekatan antara permukaan yang rendah dan memerlukan agen pengangkuk atau agen pengikat pada bebanan tinggi. Kedua-dua dedak (RB) dan jerami padi (RS) yang merupakan bahan kos rendah telah digunakan di dalam proses pembungkusan biodegradasi dengan menggunakan kaedah acuan mampatan. Dalam kajian ini gliserol, kanji beras dan polivinil asetat (PVAc) telah digunakan sebagai agen pengikat di mana ciri-ciri fizikalnya (mekanikal, kimia dan terma) dikaji berdasarkan peratus agen pengikat yang digunakan di dalam RB/RS. Kanji beras dan PVAc meningkatkan kekuatan carikan dan kekuatan tegangan RB/RS. Hasil ujian ini disambung melalui analisis mikroskop berbalik di mana permukaan retak sampel dari ujian tegangan menunjukkan struktur fasa pemisahan RS tanpa agen pengikat boleh dilihat dengan jelas berbanding struktur RS dengan agen pengikat. Walaupun kanji beras dan PVAc mempamerkan ciri-ciri mekanikal yang baik tetapi bahan-bahan ini rintangan air yang rendah disebabkan struktur molekul hidrofilik yang tinggi. Kanji mempengaruhi kadar degradasi terma RB/RS menjadi lebih cepat . Dengan penggabungan PVAc di dalam RB/RS membantu meningkatkan kestabilan ciri-ciri terma.

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LIST OF ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
CH_4	-	Methane
CMC	-	Carboxymethylcellulose
CO_2	-	Carbon Dioxide
EAA	-	Ethylene Acrylic Acid
GP	-	Gas Permeability
GS	-	Gelatinised Starch
HB	-	Hydroxy-butyrate
HV	-	Hydroxy-valerate
PVAc	-	Polyvinyl Acetate
RB	-	Rice bran
RHDPE	-	Recycle High Density Polyethylene
RS	-	Rice straw
TPIP	-	1,4-trans-polyisoprene
TPS	-	Thermoplastic Starch
VHDPE	-	Virgin High Density Polyethylene
WVTR	-	Water Vapor Transmission Rate

LIST OF SYMBOLS

E	-	Tensile Modulus
g	-	Gram
KN	-	Kilo Newton
Tg	-	Glass transition Temperature
Tm	-	Melting Temperature
ρ	-	Density
µm	-	Micrometer

CHAPTER 1

INTRODUCTION

1.1 Background of Studies

Nowadays the used of synthetic polymer has been restricted because they are not non-totally recyclable and/or biodegradable so they pose serious ecological problems (Sorrentino et al., 2007). To overcome this problem, a big effort to extend the shelf life and enhance food quality while reducing packaging waste has encouraged the exploration of new bio-based packaging materials, such as edible and biodegradable films from renewable resources (Tharanathan, 2003). The use of these materials, due to their biodegradable nature, could at least to some extent solve the waste problem. However, like conventional packaging, bio-based packaging must serve a number of important functions, including containment and protection of food, maintaining its sensory quality and safety, and communicating information to consumers (Robertson, 1993).

Unfortunately, so far the use of biodegradable films for food packaging has been strongly limited because of the poor barrier properties and weak mechanical properties shown by natural polymers (Andrea Sorrentino et al., 2006). Until now, bioplastics contain more than 50% weight of renewable resources. Many bioplastics are mixes or blends containing synthetic components, such as polymers and additives, to improve the functional properties of the finished product and to expand the range of application (Valentina Siracusa et al., 2008).

Previously there were a lot of studies on biodegradable packaging base on biopolymer incorporated with synthetic polymer such as starch base with polyolefin and natural fiber with polyolefin. This biodegradable packaging was not totally degraded by environment due to the synthetic polymer still remain in these packaging materials. Besides that, the other problems also aroused where the starch usually incompatibles with polyolefin due to its polar structure and hydrophilic property which leads to water absorption. These properties make the mechanical properties of packaging decrease as well as chemical properties.

Fiber-reinforced composites are increasingly used due to their relative cheapness compared to conventional materials and their potential to be recycled. As a result natural fiber reinforced plastics are of interest as a replacement for synthetic fiber reinforced plastics in an increasing number of industrial sectors including the automotive industry, packaging, and furniture production. Generally, cellulose-based biofibers, including cotton, flax, hemp, jute and sisal, and wood fibers are used to reinforce plastics due to their relative high-strength, high stiffness and low density. Because of their annual renewability, agricultural crops-residues can be a valuable source of natural fibers. There are an estimated 500 million tones of agricultural residues available in North America alone each year (Ayse et al., 2007). Few comparative studies have been so far conducted using various rice straw components to reinforce polymer composites. Previous research on biodegradable packaging has mainly focused on rice husk and whole rice straw fiber-reinforced thermoplastic composites. Ishak et al. (2001) and Premalal et al. (2002) studied the hydrothermal aging and mechanical properties of rice husk/polypropylene (Fei Yao et al., 2007).

On the other hand, Panthapulakkal et al. (2005) and Marti-Ferrer et al. (2006) presented the effect of coupling agents on properties of rice husk/HDPE composites and rice husk/block copolymer polypropylene, respectively. For whole rice straw/polymer composites, Grozdanov et al. (2006) studied the rice straw/maleated-polypropylene composite containing 20 and 30wt% rice straw by extrusion and compression molding which results in higher tensile modulus (E) for composites containing higher rice straw content. Kamel (2004) studied rice straw/PVC composite with bagasse lignin as a coupling agent. The obtained composite showed

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