UNIVERSITI PUTRA MALAYSIA

PRODUCTION OF HIGH YIELD ANIMAL HIDE GLUE FOR BONDING HIGH MOISTURE RESISTANT (HMR) GRADE PLYWOOD

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By

MOHAMMED ISSAM MOHAMMED

Thesis Submitted in Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

May 2000

This Work is Dedicated

To

My Parents, Brothers, Sister and Nephew Mahmud

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree Master of Science.

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Chairman: Associated Prof. Dr. Azni Idris

Faculty: Engineering

The driving force of this research study was the recovery of unwanted animal by-products such as animal skin and hide trimmings and flesh from the slaughter houses, or the scrap of animal skin and hide remains from leather industry. The collected animal by-products was firstly pretreated and later converted into gelatin. The study investigated a new extraction process using a dispersed micro-bubble technique to increase the recovery of animal glue (gelatin) within shorter time and disperse mixing process by using high shear mixing that worked to wipe the hydrolyzed glue from the surface of the collagen-containing material by providing a gentle and uniform agitation of the vessel content during the extraction stages. It was extremely effective to improve the yield of the glue production during the extraction process. The

second stage of the study evaluated the possibility of fortifying and blending this glue with melamine-based resins to improve its moisture resistance and shear strength, suitable for plywood industry. Two types of melamine cross-linker were used: (i) Melamine urea formaldehyde and (ii) Melamine formaldehyde.

The highest total yield obtained using the new extraction technique was 89.3% using 4500 rpm disperse mixing speed in which 16.9% was collected at an extraction temperature of 75°C, 50% at 85°C, and 22.5% at 95°C. The total yield obtained from the conventional extraction method over the same period of time was 36.9% with 12.1% collected at the temperature of 75°C, 16.9% at 85°C, and 7.9% at 95°C. Comparing the percentage yield by the new extraction method and the of conventional method, there was an improvement of 58.6% in yield recovery and there was about 4-10% improvement in yield and the extraction time was reduced to about 50-72% when compared to the existing commercial procedures used in both the glue and gelatin manufacture. Both the gelling strength and the viscosity of the gelatins produced by both methods were within the same range.

High shear strength and superior moisture resistant properties were obtained from plywood bonded with animal glue blended with melamine urea formaldehyde resin. The shear strength being 3.2 MPa for the dry treatment, 1.0 MPa for the cold treatment, and 2.5 MPa for the hot treatment. The shear

strength of plywood bonded with 100% animal glue were 1.4MPa, 0.1MPa and 0.6MPa for dry, cold and hot treatments, respectively. The improved animal glue gave a better performance compared to the traditional melamine urea formaldehyde with shear of 2.7MPa (dry), 2.7MPa (cold), and 1.9MPa (hot) treatments, respectively.

The pot life of the modified animal glue improved (about 66%) and the resistance towards bacterial attack was comparable to that of melamine urea formaldehyde alone (14 days).

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk ijazah Master Sains

PENGHASILAN PEREKAT BINATANG PEROLEHAN TINGGI UNTUK MEREKAT PAPAN LAPIS BERGRED KETAHANAN AIR TINGGI (HMR)

Oleh

MOHAMMED ISSAM MOHAMMED

Mei 2000

Pengerusi: Profesor Madya Azni Idris, Ph.D.

Fakulti: Kejuruteraan

Tujuan utama kajian penyelidikan ini adalah berdasarkan kepada penemuan bahan-bahan dari binatang yang dibuang seperti kulit dan daging binatang dari rumah sembelihan atau bahan buangan kulit binatang dari industri kulit. Produk binatang yang di perolehi terlebih dahulu dibersih dan dirawat dan kemudiannya di ubahsuai kepada gelatin.

Di perigkat awal, penyelidikan ini mengkaji proses pengekstrakan gelatin daripada kulit kering dimana dua proses iaitu proses bebuih-mikro (mikro-bubbles) dan proses campuran-taburan (disperse mixing) telah digunakan untuk meningkatkan amuan hasil gelatin dalam masa yang singkat. Peringkat kedua pula mengkaji kemungkinan penggunaan penguat resin asas-

melamina untuk meningkatkan rintangan kelembapan dan kekuatan regangan gam binatang yang boleh di sesuaikan bagi industri papan lapis. Dua genis agen ikatan silang (cross-linker) yang digunalean ialah, (i) Urea Formaldehid Melamina (Melamine Urea Formaldehyde) dan (ii) Formaldehid Melamina (Melamine Formaldehyde)

Jumlah hasil tertinggi yang diperolehi dengan menggunakan teknik pengekstrakan yang baru ini ialah 89.3% dengan kelajuan besi pengurai 4500rpm, yang mana ekstrak yang di peroleh ialah 16.9% pada suhu 75°C, 50% pada 85°C dan 22.5%pada 95°C. Manakala jumlah hasil yang diperolehi manggunakan kaedah pengekstrakan biasa dalam tempoh yang sama ialah 36 9%, di mana 12.1% pada 75°C, 16 9% pada 85°C dan 7 9% pada 95°C Dengan membandingkan peratus penghasilan daripada kaedah pengekstrakan baru dan yang diperolehi daripada kaedah biasa, maka telah terdapat peningkatan sebanyak 58 6%. Dibandingkan dengan kaedah operasi yang lazimnya digunakan dalam pengeluaran komersial gam dan gelatin, kajian ini menunjukkan telah berlaku peningkatan pengekstrakan sebanyak 4-10% dan masa pengekstrakan telah dikurangkan kira-kira 49 6-72%

Kedua-dua kekuatan gel dan kelikatannya dalam proses penghasilan gelatin bagi kedua-dua kaedah adalah sama

Ciri-ciri kekuatan ragangan dan rintangan lembapan yang optimum di perolehi dengan munggunakan gam binatang yang dicampur dengan urea formaldehid melamina sebagai penguat. Kekuatan regangan yang dihasilkan ialah 3.2MPa pada keadaan kering, 1.0MPa pada keadaan sejuk dan 2.5MPa pada keadaan panas. Kekuatan regangan untuk 100% gam binatang iaitu tanpa campuran penguat ialah 1.4MPa, 0.1MPa dan 0.6MPa untuk keadaan kering, sejuk dan panas, masing-masing.

Gam binatang yang dipertingkatkan ini telah menunjukkan keupayaan yang lebih baik berbanding urea formaldehid melamina biasa yang berkeregangan 2.7MPa, 2.7MPa dan 1.9MPa pada keadaan kering, sejuk dan panas, masing-masing.

Jangka hayat gam binatang yang telah di ubahsuai ini meningkat lebih kurang 66% dan rintangannya terhadap serangan bakteria barbanding dengan urea formaldehid melamina sahaja (14 hari).

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IN THE NAME OF ALLAH, MOST GRACIOUS, MOST MERCIFUL

"Who created me, and It is He who guides me; "Who gives me food and drink, "And when I am ill, It is He who cures me; "Who will cause me to die, And then to live (again); "And who, I hope, Will forgive me my faults On the Day of Judgement.

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SURAT Ash-Shu'araa

Ayat 78-82

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LIST OF ABBREVIATIONS

UF	Urea Formaldehyde
Neg.	Negligible
IEP	Isoelectric Point
N	Normality
^{o}C	Degree Celsius
dl	Deciliter
m	Meter
cm	Centimeter
mm	Millimeter
min.	Minute
h	Hour
Kpa	Kilo-Pascal
L	Liter
Kg	Kilogram
T_D	Denaturation Temperature
T.S.S.	Total Soluble Solids
d_b	Bubble Mean Diameter
DAF	Dissolved Air Flotation
CGA	Colloidal Gas Aphrons
MGD	Micro-Gas Dispersion
mpm	Meter Per Minute
rpm	Round Per Minute
Temp.	Temperature
DMU	Dimethylol Urea

M	Molar
P_f	Probability of Flotation
P_E	Probability of High Yield Within Short Extraction Time
P_C	Probability of Collision
P_A	Probability of Adhesion
P_D	Probability of De-Attachment
P_I	Probability of Interaction
E_f	Efficiency of Flotation
E_E	Efficiency of Extraction
E_C	Efficiency of Collision
E_A	Efficiency of Adhesion
E_D	Efficiency of De-Attachment
E_I	Efficiency of Interaction Between the Collagen-Containing Material Fibers After being Soften
MPa	Mega-Pascal
KN	Kilo-Newton
MF_{cl}	Melamine Formaldehyde Cross-Linker
MUF	Melamine Urea Formaldehyde
AN.GL	Animal Glue
STDV	Standard Deviation
MR	Moisture Resistant
BSI	British Standard Institution
HMR	High Moisture Resistant
%	Percentage
μm	Micro-Meter

CHAPTER I

INTRODUCTION

Background to the Study

Animal by-products from hide trimmings and flesh cause public nuisance and even the danger of spreading diseases. The sanitary disposal of such by-products presents great difficulties, as the hide trimming and flesh tend to clog drains and pits and decompose rapidly, leading not only to objectionable odors but also forming an ideal breeding ground for meat-spoiling organisms. Meat slaughtered and kept under insanitary conditions created by such by-products result in inferior keeping quality, and serving as a potential vehicle for disease transmission. Burning and burying of inedible by-products leads to the total loss of potential by-products and, unless properly carried out, may contribute to the spread of diseases. Animal hide is a very significant protein, forming 4-11% of the weight of the live animal (Table 1), and consequently is one of the most valuable by-products produced by the animal.

Recovery and utilization of unwanted hide from tanneries or abattoirs for other industries should be assessed. Animal hide is a suitable starting material

for glue and gelatin industries and these places could provide a relatively stable source of raw materials for the production of glue or gelatin.

Table 1. Hide in Percentage of Live Weight

Type of animal	Range of hide yield (percentage of live weight)
Cattle	
Average	5.1-8.5(average 7.0)
Average able hide stripper	4.0-6.0(average 2)
Hereford	8.5
Angus	7.5
Shorthorn	6.5
Charolais, bull, 15months old	8.5
Charolais, bull, 20months old	8.3
Charolais, bull, 30months old	6.7
Good steer	6.6-7.6
Poor steer	6.4-7 8
Good heifer	5.1-7.9
Branded cow	6.6-7.6
Canner, cutter	5.7-6.8
Bull	6.7-7.5
Bologna bull	7.0-8.1
Sheep	
Sheep and lamb	11.0-11.7
Swine	
Boar	10-12

(Source: Ockerman, 1988)

Animal glue historically means the material that represents traditional or popular image of "hide or bone glue" adhesives, which need to be heated and melted before usage.