EFFORT TO UTILIZE Nata de Coco AS BULLET-PROOF MATERIAL

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ABSTRACT

The most common material used as anti-bullet today is a synthetic polymer Kevlar, which is very expensive and not degradable. The purpose of this study was to obtain an anti-bullets material from domestic raw materials, nata de coco. The expected material obtained will be light and biodegradable. Research was conducted by a team of researchers from the Department of Chemistry, Faculty of Science and Technology, Airlangga University in cooperation with PT. Tropica Nucifera Industry as producers of nata de coco, and researchers from the Research and Development Unit of Defense Department Indonesia. In this research, nata de coco was combined with jute fiber. This combination required the adhesive material which can paste these two fibres, flexible, resistant to water and oil. There were six variations of composition of nata de coco and jute fiber. Mechanical test of these samples showed that the variation 3 had the highest tensile strength. While the highest strain or elongation break was shown by variation 6. Generally, a good bullet proof material has high tensile strength and strain. However, ballistic tests conducted on six variations did not show satisfactory results. Combined all of six variations only stop a bullet from pistol FN 9 mm ammunition caliber 46 and the bullet was deep restrained in the sixth layer.

Keywords: *anti-bullets, nata de coco, jute fiber*

INTRODUCTION

One of the needs required by the military and police is bullet resistant vests. These vests are required needed to be lighter (maximum of 8 kg), heat resistant, waterproof and can catch the bullets. Until now bullet-proof clothes still have to be imported. To produce these clothes in this country, it's still very expensive because it requires the main raw material, Kevlar or Spectra, which is very expensive.

To meet the needs of bullet resistant vests, this research was carried out by forming a cooperation between research groups from Chemistry Department - Airlangga University, Research and Development Unit - Department of Defense and Tropica Nucifera Industry to make effort to use nata de coco as bullet-proof material. Nata de coco was chosen, because it is made from coconut water, a material available abundantly in Indonesia. Nata de coco consists of cellulose units with high degree of crystallinity. On the other hand, The Research and Development Unit of Defense Department Indonesia has conducted a research on the use of jute fiber as a bullet-proof material. Jute plant (*Boehmeria nivea*) has stem which contain fiber that can be processed into yarn. In that research, jute have been processed in various ways to obtain bullet-proof material. The best material obtained in that research is still not satisfaction because it's low capability to catch the bullets and this material is also still too heavy (2.8 kg).

Therefore, this research was done to produce a better bullet-proof material which is high capacity to catch the bullets and lighter so it will be comfortable for wearing by users. In this research, the material used is nata de coco which coupled with jute fiber in some various compositions.

EXPERIMENTAL SECTION

Materials

Nata de coco was produced by PT Tropica Nucifera Industry, knitted jute fiber was produced by artisan from Garut and

Bantul-Yogyakarta. Some chemicals were used as adhesive.

Instrumentation

Instruments used consist of a set of nata de coco production, a set of tools for knitting jute, Universal Torsee instrument, and a set of tools for ballistic testing.

Procedure

Production of nata de coco

Nata de coco is made from fermented coconut water and the procedure may take around 6 days. Nata de coco obtained was selected to get the good ones, dried and stored for further treatment.

Preparation of knitted jute

Knitted jute was obtained from artisan in Garut and Bantul-Yogyakarta.

Adhesive preparation

Five types of adhesive was prepared. These types were:

- based water adhesive
- based oil adhesive
- adhesive that is made through a graft copolymerization process
- adhesive that is made from resin with addition of hardener
- epoxy adhesive that is made by addition of crosslinker

Each types and mixture of these types was applied and observed until the preferred adhesive obtained. This adhesive was flexible, oil resistant and water resistant.

Bullet-proof material preparation

Six compositions of dried nata de coco and knitted jute was prepared with assisting of adhesive.

Characterization of material

Mechanical properties of material obtained was determined using Universal Torsee instrument to get the value of tensile strength (stress), strain and Young 's modulus for each material.

Ballistic test

Ballistic test of material obtained from this research was conducted at PINDAD-Bandung. Test was carried out by using the pistol of 9 mm caliber revolver with a shooting distance of 5 and 10 meters for each material. A ballistic test was also applied on a combination of these six materials using pistol FN 46 ammunition caliber 9 mm wit a shooting distance of 10 meters.

RESULTS AND DISCUSSION

Drying of nata de coco

The best result of nata de coco drying process was aired in space with good air flow. This drying process took three days around.

Knitting of jute fiber

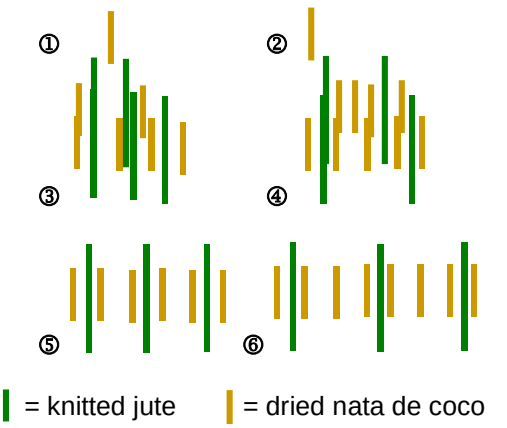
Jute fiber was knitted by artisan in Garut and Bantul-Yogyakarta in form of sheet around 20x20 cm.

Adhesive preparation

From observation of each adhesive application that have been done followed by optimization and evaluation, the adhesive which is flexible, water and oil resistant was obtained.

Bullet-proof material preparation

Six compositions of material were:



Characterization of material

The result of calculation from determination of mechanical properties is shown Table 1.

Table 1. Data of characterization of materials

Sample	*Sample weight (gram)*	*Stress* (σ) (N/mm^2)	*Strain* (ε) (%)	Modulus Young (N/mm^2)
Sample 1	69.3	69.144	4.00%	1728.611
Sample 2	71.9	66.885	3.33%	2006.550
Sample 3	70.4	113.050	6.67%	1695.750
Sample 4	89.3	35.350	4.67%	757.500
Sample 5	94.1	38.191	4.67%	818.382
Sample 6	99.1	45.685	13.33%	342.640

From this table is known that the highest stress value shown by sample 3 (113.050 N/mm^2), whereas the highest strain value

shown by sample 6. (13.33%). From these results, it was known that sample 3 was the strongest and sample 6 was the most elastic. The value of Young' Modulus depends on the value of stress and strain. The value of Young's Modulus is shown by sample 2.

Ballistic test result

Material 1-6 did not hold the bullets from the pistol of 9 mm caliber revolver with a shooting distance of 5 and 10 meters. The ballistic test on combination of six compositions using the pistol FN 46 ammunition caliber 9 mm wit a shooting distance of 10 meters was showed that the bullet can penetrate the layers to fifth. It means that the bullet was restrained on the sixth layer.

CONCLUSION

The ballistic test showed that each material can not restrain the bullets from the pistol of 9 mm caliber revolver with a shooting distance of 5 and 10 meters Combination of six composition can catch the bullets from the pistol FN 46 ammunition caliber 9 mm wit a shooting distance of 10 meters. The bullet was stuck in the sixth layer. From this ballistic test, it was clear that all of six compositions can not be used as bullet-proof material. The combination of these six compositions can catch the bullets but this material was too thick to use as bullet-proof material, although it was very light.

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