

ABSTRAK**PEMANFAATAN SERAT ALAM BIDURI (*Calotropis gigantea*)
SEBAGAI BAHAN INSULASI PANAS PADA KAIN
MULTILAPIS UNTUK APLIKASI JAKET MUSIM DINGIN**

Oleh

ARIF WIBI SANA**NPM: 18510006****Program Studi****Magister Terapan Rekayasa Tekstil dan Apparel**

Bahan insulasi panas komersial untuk jaket musim dingin umumnya menggunakan *down* (bulu angsa) dan *batting* poliester. Selain termasuk kategori bahan impor yang mahal, *down* diperoleh dengan cara mengeksploitasi hewan dan dapat memicu alergi sedangkan poliester merupakan serat sintetik yang kurang ramah lingkungan. Serat biduri (*Calotropis gigantea*) merupakan serat alam dengan karakteristik morfologi berongga, ringan, dan tahan air sehingga berpotensi menjadi bahan insulasi alternatif yang ramah lingkungan. Tujuan dari penelitian ini adalah membuat kain multilapis berisi bahan insulasi panas dari serat biduri untuk aplikasi jaket musim dingin serta membandingkannya terhadap *down* dan *batting* poliester. Metode penelitian diawali dengan membentuk serat biduri menjadi *web* dan *nonwoven*. Selanjutnya, bahan yang akan difungsikan sebagai lapisan insulatif disisipkan di antara lapisan dalam (kain poliester) dan lapisan luar (kain nilon *water repellent*) sehingga terbentuk kain multilapis dengan susunan menyerupai bahan jaket musim dingin. Serat biduri diuraikan pada mesin *bale opener* kemudian dibersihkan dan dibentuk menjadi lapisan *web* pada mesin *cotton selector*. Pengikatan *web* menjadi *nonwoven* dilakukan dengan metode *thermal bonding* menggunakan mesin *hotpress* pada suhu 130 °C selama 1 menit tanpa perlakuan tekanan. *Web* biduri dibuat menjadi 3 variasi massa asupan serat, yaitu: 10 g, 20 g, dan 30 g sedangkan *nonwoven* biduri dibuat menjadi 3 variasi komposisi, yaitu: (95:5)%, (90:10)%, dan (80:20)%. Masing-masing komposisi divariasikan lagi menjadi 3 jenis ketebalan, yaitu: 1 lapis, 2 lapis, dan 3 lapis. Performa kain multilapis berinsulasi serat biduri, *down*, dan *batting* poliester dievaluasi melalui pengujian resistansi termal dan resistansi evaporatif menggunakan alat *sweating guarded hotplate (SGHP)*, pengujian sifat konduktivitas termal menggunakan *fabric touch tester (FTT)*, dan uji daya tembus udara (DTU) menggunakan *air permeability tester*. Hasil penelitian menunjukkan bahwa pada masa bahan yang sama (30 g), nilai resistansi termal (R_{ct}) kain multilapis berinsulasi *web* biduri (1,35 m².°C/W) dan *nonwoven* biduri (0,82

$\text{m}^2 \cdot ^\circ\text{C}/\text{W}$) dengan komposisi (95:5)% lebih tinggi dibanding kain multilapis pembanding berinsulasi *down* ($0,81 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$) dan *batting* poliester ($0,60 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$). Nilai resistansi evaporatif (R_{et}) kain multilapis berinsulasi *nonwoven* biduri ($43,6 \text{ m}^2 \cdot \text{Pa}/\text{W}$; $39,6 \text{ m}^2 \cdot \text{Pa}/\text{W}$; dan $34,9 \text{ m}^2 \cdot \text{Pa}/\text{W}$) pada semua variasi komposisi lebih rendah dibanding kain multilapis pembanding berinsulasi *down* ($55,8 \text{ m}^2 \cdot \text{Pa}/\text{W}$) dan *batting* poliester ($49,5 \text{ m}^2 \cdot \text{Pa}/\text{W}$). Nilai R_{ct} dan R_{et} pada kain multilapis berinsulasi biduri meningkat seiring dengan peningkatan massa dan ketebalan bahan sedangkan pada nilai DTU berlaku sebaliknya. Hubungan yang sangat kuat dan positif terlihat pada nilai R_{ct} dan R_{et} . Hasil optimum diperoleh pada kain multilapis berinsulasi *nonwoven* biduri dengan komposisi (95:5)%, ketebalan 2 lapis (massa 30 g) dengan nilai R_{ct} $0,82 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$, R_{et} $43,6 \text{ m}^2 \cdot \text{Pa}/\text{W}$, dan DTU $2,22 \text{ cm}/\text{s}$. Kain multilapis dengan bahan insulasi *web* dan *nonwoven* biduri berpotensi untuk diaplikasikan sebagai bahan pengisi insulatif pada jaket musim dingin.

Kata kunci: biduri, insulasi panas, kain multilapis, jaket musim dingin



ABSTRACT**THE UTILIZATION OF BIDURI FIBER (*Calotropis gigantea*) AS
THERMAL INSULATION MATERIAL IN MULTILAYER
FABRICS FOR WINTER JACKET APPLICATION**

By

ARIF WIBI SANA**NPM: 18510006****Major****Master of Applied Science in Textile Engineering and Apparel
Technology**

*Commercial heat insulation materials for winter jackets commonly use down and polyester batting. Besides being included in the category of expensive imported materials, down is obtained by exploiting animals and can trigger allergies while polyester is a synthetic fiber which is less environmentally friendly. Biduri fiber (*Calotropis gigantea*) is a natural fiber which has hollow morphology, lightweight, and waterproof so that has a potency to become an environmentally friendly alternative insulation material. The aim of this research is to make a multilayer fabric containing heat insulation material from biduri fibers for winter jacket applications and compare it to down and polyester batting. The research method was initiated by forming the biduri fibers into web and nonwoven. Furthermore, the material that will be functioned as an insulative layer was inserted between the inner layer (polyester fabric) and the outer layer (water repellent nylon fabric) to form a multilayer fabric with an arrangement imitating the material of a winter jacket. The biduri fibers were processed on the bale opener machine and then cleaned and formed into a web layer on the cotton selector machine. Nonwoven was manufactured by thermal bonding using a hotpress machine at 130 °C for 1 minute without pressure. The web of biduri was made into 3 mass variations of fiber intake; 10 g, 20 g, and 30 g while the nonwoven biduri was made into 3 variations in composition; (95:5)%, (90:10)%, and (80:20)%. Each composition was also varied into 3 types of thickness; 1 layer, 2 layers and 3 layers. The performance of multilayer fabrics insulated with biduri fiber, down, and polyester batting was evaluated through testing for thermal and evaporative resistance using a sweating guarded hotplate (SGHP), testing for thermal conductivity using a fabric touch tester (FTT), and testing for air permeability (AP) using air permeability tester. The results showed that at the same mass (30 g), the value of thermal resistance (R_{ct}) of multilayer fabrics*

insulated with biduri web ($1.35 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$) and biduri nonwoven ($0.82 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$) with a composition (95:5)% were higher than multilayer fabric insulated with down ($0.81 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$) and polyester batting ($0.60 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$). The evaporative resistance (R_{et}) values of multilayer fabrics insulated with biduri nonwoven ($43.6 \text{ m}^2 \cdot \text{Pa}/\text{W}$; $39.6 \text{ m}^2 \cdot \text{Pa}/\text{W}$; and $34.9 \text{ m}^2 \cdot \text{Pa}/\text{W}$) in all composition variations were lower than multilayer fabric insulated with down ($55.8 \text{ m}^2 \cdot \text{Pa}/\text{W}$) and polyester batting ($49.5 \text{ m}^2 \cdot \text{Pa}/\text{W}$). The R_{ct} and R_{et} values of multilayer fabrics insulated with biduri increased with increasing mass and thickness of the material, whereas the AP value applies vice versa. A very strong and positive relationship was seen in the R_{ct} and R_{et} values. The optimum results were obtained on multilayer fabrics insulated with biduri nonwoven with a composition (95:5)%, 2 layers thickness (mass 30 g) with an R_{ct} value of $0.82 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$, R_{et} $43.6 \text{ m}^2 \cdot \text{Pa}/\text{W}$, and AP 2.22 cm/s. Multilayer fabrics insulated with biduri web and nonwoven show the potency to be applied as an insulative fill material for winter jackets.

Keywords: *biduri, thermal insulation, multilayer fabric, winter jacket*

