Characteristics and Properties of Hand Woven Fabric from Thai Rice Straw for Home Textile Product

Asst.Prof. Dr.Srikanjana Jatuphatwarodomtion
Department of Textile & Clothing, Faculty of Home Economics Technology
Rajamangala University of Technology Thanyaburi,
Rangsit Nakhanayok Road, Thanyaburi, Khang 6
Pathumtani, 12110, THAILAND
e-mail: srikanjana_j@rmutt.ac.th

Asst.Prof.Dr.Sakorn Chonsakorn
Department of Textile & Clothing, Faculty of Home Economics Technology
Rajamangala University of Technology Thanyaburi,
Rangsit Nakhanayok Road, Thanyaburi, Khang 6
Pathumtani, 12110, THAILAND
e-mail: sakom_C@rmutt.ac.th

Dr.Rattanaphol Mongkholsrathanasit
Department of Textile Chemistry Technology, Faculty of Industrial Textiles and Fashion Design
Rajamangala University of Technology Phra Nakhon,
517, Nakhonsawan Road, Kwang Suan Chitladda, Dusit District, Bangkok, 10300, THAILAND
e-mail: rattaphol.m@rmutt.ac.th

Dr.Natawat Jatuphatwarodom
Department of Textile & Clothing, Faculty of Home Economics Technology
Rajamangala University of Technology
Thanyaburi, Rangsit Nakhanayok Road, Thanyaburi, Khang 6
Pathumtani, 12110, THAILAND
e-mail: Natawat@rmutt.ac.th

Abstract

The objectives of this particular research are to separately boil the fiber of hybrid rice straw in order to distinguish its quality, yarn spinning of the mixed straw by hand, weaving of the mixed straw by hand, to test the physical properties of the hybrid rice straw fabric, and to develop a prototype product made from the hybrid rice straw. The research method is to separately boil the fiber of the hybrid rice straw for qualification with Sodium hydroxide, then rinse and dry the fiber which is blended into yarn by hand and woven by hand using a cotton yarn for warp. The hybrid rice straw is used for weft and then decorated with liquid repellent coating and then iron dried. Then the physical properties of the woven material is tested. Then the prototype products are designed and produced. The results reveal that the qualification test by boiling of the hybrid rice straw which is appropriate for hand spinning is 100g of dry rice straw, 20g of Sodium hydroxide per 5 liters of water for 60 minutes, 100-110 Celsius of temperature. The hand spinning is made by using three lines of the hybrid rice straw, with an S spinning spiral which is similar to rope. Then 1000g of the hybrid rice straw is spun into an average of 300g of yarn. Plain weaving has a width of 40 inches, 3665.00 Denier of thread, and the number of yarn twist per inch is 4.60. Tensile strength is 1337.39 Newtons, 7.40 percent flexibility, 3.74g per Denier, and 7.60 percent of crimp. The testing of physical properties of the woven material before and after the finishing of liquid repellency coating shows that before and after the yarn per square inch is 240 lines and 176 lines respectively. The weights of before and after are 661g and 951g per square inch respectively. The tensile strength tests before and after are 600.81: 654.54 Newtons for warp, 493.93: 538.26 and Newtons for weft. The woven material could not resist water before coating. After coating, the liquid repellency grade is at 5.5 and prototype products are produced as one master sofa and one set of dining table. The satisfaction rates are 4.58 and 4.62 respectively.

Key words: Thai rice straw, Hand Woven Fabric, Home Textile Product

1. INTRODUCTION

Thailand is an agricultural country. Cultivation has spread throughout the country with an area of 131.60 million hectares, about 65 million hectares for rice, about 20 percent of the total area in the country, receiving 24 million tons of rice straw with an average of 25.45 million tons per year and 16.9 million tons of residues per year. There is an average of 650 kg of rice straw and stubble in one hectare per year[1]. The famous ones of over a hundred varieties of rice are Justine rice 105, Phatum Thani, 17 kW, and Suphanburil [2]. Rice straw is the material left over from the harvest. There are many advantages of rice straw used as animal feed, crafts, and renewable energy. Current enterprise communities have adopted the use of rice straw for handicrafts such as paper, bags, rice straw bricks, rice straw mats, etc. There is also a business of rice straw briquettes, of which the major customers are farm owners who stock cow, sheep, and goats. The value is between 12-15 Thai baht per briquette
and retail prices are between 30-35 Thai baht per pack [3]. For the reasons mentioned above, researchers are interested in importing rice straw from farming to develop as textile products by sorting out suitable fiber for yarn spinning into a commercial fabric. The fabric is then decorated for special properties; then prototype products are designed. Then the satisfaction of consumers is surveyed. The research outcome will benefit Thailand's textile innovations to new natural fibers which are environmentally friendly, and will add value to waste rice straw from Thailand's agricultural activities and reduce the burning of rice straw.

Objectives

1. To sort out of fiber quality of hybrid rice straw by boiling.
2. To make a hand spin for hybrid rice straw.
3. To make a weaving of hybrid rice straw.
4. To test the physical properties of hybrid rice straw fabric.
5. To develop a prototype product from hybrid rice straw.

2. EXPERIMENT

2.1 Material: raw materials used in the research are hybrid rice straw yarn, sodium hydroxide, as yarn, black cotton 10/3 used for warp yarn, water reflective coating, Starguard FCS, acetic acid, and pH indicator paper.

2.2 Equipment: the tools used for sorting out of the fiber quality are digital scales, gas boiler, thermometer, spatula, basin, screen, and fiber spinning comb. The spinning tools are bobbin, and comb. The weaving tool is a Hand-loom No. 45. The tools for a prototype maker are paper patterns, scissors, sewing machine, thread, and needle.

2.3 Methods:

2.3.1 The classifications of fiber quality are done by boiling hybrid rice straw consisting of 100g of rice straw in 5 liters of water, sodium hydroxide according to 10%, 15%, and 20% with different amounts of weight of rice straw. Bring the straw boiled in 100-110 °C of hot water for 60 minutes, 90 minutes and 120 minutes respectively, washed thoroughly and then dried in the sun.

2.3.2 Hand-spun yarn is made of three lines of rice straw threaded together per each individual yarn. New fibers are overlapped between the old fibers, then the rice straw is rolled to weaving.

2.3.3 Hand-weaving of rice straw is made of black warp yarn; weft yarn is hybrid rice straw threaded into a Plain wave with water reflective coating and then rolled with a hot iron.

2.3.4 The decoration of water reflective coating is made using a length of one meter of fabric, starguard FCS 150 g in 5 liters of water, and then adjusting the pH with citric acid or acetic acid to approximately 4.5. The hybrid rice straw is then dipped in the mixed substance, then twisted and ironed to dry.

2.3.5 The testing of physical properties of the hybrid rice straw yarn straw is the standard of the American Society for Testing and Materials (ASTM) regarding burning, thread number, number of threads per inch, tensile strength, percentage of flexibility, percentage of distortion, and testing of the water resistance of the hybrid rice straw before and after getting the finishing of the water reflective coating.

2.3.6 The development of the prototypes from rice straw is implemented by taking water reflective coating fabrics designed and produced into products as one set of master sofa, and one set of dinning table. Customer satisfaction surveys and cost analysis are involved. The statistics used are percentage, average, standard deviation and One-way ANOVA.

3. RESULTS AND DISCUSSION

3.1 The quality classifications by boiling of the hybrid rice straw show that the most suitable ratio for hand-spun yarn are 100g of dry rice straw and 20g of sodium hydroxide per 5 liters of water at a temperature of 100-110 degrees for 60 minutes. It takes three days to dry in the sun. See Figure 1, which corresponds to boiling of Vetiver fiber where the recipe for boiling is 20% of sodium hydroxide for 60 minutes. The length of fiber is approximately 2-10 cm, chlorophyll is gone, it is a light yellow color and sticks together [4].

Figure 1: The appearance of the hybrid rice straw which is suitable for hand spinning.

3.2 The spinning of the hybrid rice straw revealed that choosing three of 15-20 cm length of fiber, making an S twisted by inserting a new set of fiber into the first three chosen ones will provide an average of 300 g of yarn from 1000 g of dry yarn (see figure 2).

Figure 2: The yarn produced from hybrid rice straw.
3.3 The weaving of the hybrid rice straw is implemented by using No. 10/3 of cotton for warp, No. 45 of weaving comb teeth, the hybrid rice straw is used for weft, producing plain weave which is 40 inches of width when completed (see figure 3).

![Handmade fabric from the hybrid rice straw](image)

3.4 The testing of physical properties of the hybrid rice straw fabric revealed that the characteristic of combustion is similar to cotton because straw yarn and cotton are classified in the group of cellulose fibers. When fired, they will burn quickly and continue until the fuel runs out. The flame is red and smells like burning paper, just like the burning of hibiscus tiliaeum yarn and the yarn from Nypa Fruticans Wurmb [5]. Ashes will be lumpy and brittle just like dust, and dark gray. The thread No. is 3665.00 Denier being S Turned where turn per inch is 4.60. Tensile strength is 7.40 percent 1337.39 Newtons. Flexibility is at 7.40, 3.74 g per Denier of density, and 7.60 percentage of curly. Additionally, rice straw fibers have 64% cellulose with 63% crystalline cellulose, and 3.5g per denier of strength [6]. Because the hybrid rice straw yarn is large, the number of threads per inch is minimal, this is consistent to the research in the testing of hand spun yarn which found that the tensile strength is 4.131 Newtons, the yarn size is 1286 denier (143 Tex), and the flexibility is 24.31 millimeters (Saovanee, 2014). In addition, the report from testing of the yarn from Nypa fruticans wurmb showed that the tensile strength is 13.41 Newtons, the yarn size is 33.04 Tex, and the spiral helix is 6.5 per inch spinning in the Z turn direction [7].

<table>
<thead>
<tr>
<th>Testing</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- warp lines</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>- weft lines</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Yarn per square inch</td>
<td>240</td>
<td>176</td>
</tr>
<tr>
<td>Fabric weight</td>
<td>661</td>
<td>951</td>
</tr>
<tr>
<td>Number of strength against abrasion</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Tensile strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- warp/newton</td>
<td>600.1</td>
<td>654.54</td>
</tr>
<tr>
<td>- weft/newton</td>
<td>493.93</td>
<td>538.26</td>
</tr>
<tr>
<td>Liquid repellency grade</td>
<td>0</td>
<td>5.5</td>
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</tbody>
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According to table 1, it was found that before and after coating, the fabric width is 40:35 inches, the warp is 20:22 lines, the weft is 12:8 lines, the amount of yarn per square inch is 240:176, the fabric weight is 661:951 g per square meter, the number of strength against abrasion is 4:3, the tensile strength is 600.10: 654.54 Newtons, the weft line is 493.93: 538.26, and the liquid repellency grade is at 0: 5.5 (level 5 is 70:30, and level 6 is 60:40), which means the decorated fabric has the ability to withstand water between 30- 40 percent. This is probably because the hybrid rice straw yarn is very large after being coated, and there are temperature differences on the warp and the weft which resulted from uneven surface on the fabric. Therefore, the fabric is unable to prevent the seepage of water. The testing of liquid repellency coating shows that the coated fabric is able to prevent the seepage of water at 100% [8]. The results of the abrasion test reveal that the average of the liquid repellency coating No.4 (Slight pilling) has gained small tablet on the fabric. The average after finishing No. 3 (Moderate pilling) has gained medium tablet on the fabric. The tensile strength of the mixed straw woven shows that both warp and weft thread after finishing up with the liquid repellency coating are stronger than before finishing, and the width of the fabric shrank to 35 inches.

3.5 The development of the prototypes of the hybrid rice straw has contributed products such as one master sofa set, which includes one long chair, two small chairs, and one dining table set, which includes one dining table and six chairs (see Figure 4).

![Prototype of Home Textile Products](image)

(1) Master sofa set and (2) Dinning Table

The results of a satisfaction survey of the textile product found that the average master sofa set and dinning table set received the most satisfaction (4.58: 4.62). There is high satisfaction levels on the coloring, exquisite tailoring, liquid repellency coating, and the structure of the red wood. The analysis of the cost of production found that the price of the fabric is 2872.50 baht per meter, the cost of the dinning table set is 53,909.62 baht, and 70,598.80 baht is the master sofa set’s cost. In this research, the material cost and other expenses are relatively high since being the first to introduce rice straw textile products. The boiling for the fibers' quality classification resulted in a huge loss; e.g., 1 kg of dried rice straw yields ½ kg when boiled. One kg of rice straw fiber is able to produce 300 g of yarn. However, the outcome of this research provides useful contributions to farmers to enhance the value of
rice straw, to reduce the burning of rice straw, and to be eco-friendly by reducing pollution.

4. CONCLUSIONS

The formula for boiling of the hybrid rice straw fiber which is suitable for hand spinning is 100 g of dry straw, 20 g of hydroxide per 5 liters of water, 60 minutes, and 100-110 degree Celsius temperature. The hand spinning of the hybrid rice straw yarn is implemented by three sets of 15-20 centimeters of fiber length, being S turn twisted like a rope. 1000 g of dried rice straw fiber is able to produce an average of 300 g of yarn. The hand weaving of the hybrid rice straw is done by using cotton for warp, and the hybrid rice straw for weft weaving into plain wave fabric. When completed, the fabric width is 40 inches. The testing of physical properties of the fabric revealed that there is 1337.39 Newtons of tensile strength, 7.40 percent of flexibility, 3.74 g per Denier of density, and 7.60 percent of crimp on the fabric which has thread number 3665.00 Denier, S turn twisted, and 4.6 screw per inch. The testing of physical properties of the hybrid rice straw before and after liquid repellency found that before coating, the fabric is unable to prevent the seepage of water, and after coating the fabric has a resistance level of 5.5 (30-40 percent). The abrasion test found that the average of the liquid repellency coating No.4 (Slight pilling) a small tablet is caused on the fabric and the average after finishing No.3 (Moderate pilling) medium tablet has gained on the fabric. The tensile strength shows that both warp and weft thread after finishing with the liquid repellency coating are stronger than before finishing, and the width of the fabric decreased to 35 inches. The development of the prototypes of the hybrid rice straw has contributed products such as one master sofa set and one dinning table set. Consumers are most satisfied by the developed products. The producing cost of the hybrid rice straw fabric found that the cost of fabric is 2,872.50 baht per meter, the cost of the dinning table set is 53,909.62 bath, and 70,598.80 baht is the cost for the master sofa set.

5. ACKNOWLEDGEMENTS

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6. REFERENCES