DEVELOPMENT OF MOULDED COMPOSITE TEXTILE TEXTURES FROM PLANT AND AGRO-WASTE MATERIALS

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ABSTRACT

The present study focused on the development of woven and moulded composite textures using plant and agro-waste materials. Rice and wheat straws and leaves are the most abundantly available plants and agro-waste materials of Punjab and have not been studied yet as it is required. During the study, three types of plant and agro-waste materials were selected for the development of textile textures. Two-textures for each of three types of selected materials (total six textures) were developed through weaving and moulding. Three plant waste materials, i.e. wheat and paddy straws and date palm leaves, suitable for use in natural form were woven in plain weave, and moulded composite textures were developed using epoxy resin. The weight (GSM) of PSP₄(paddy straw × polyester), WSP₅(wheat straw × polyester), and DPP₆ (date palm leaves × polyester) was 21.60 gm, 27.05gm and 29.45 gm, respectively. The thickness of WSP₅ was minimum (7.630 mm), while a thickness of DPP₆ was highest (10.01 mm). The developed woven and moulded composite textures from straws and leaves were found suitable for tiles for interior designing, office utilities such as coaster plates, paperweights, trays, pen holders, fancy boxes and file folders.

KEYWORDS: Wheat and Paddy Straw, Date Palm Leaves, Woven, Moulded and Composite, Textures & Epoxy Resin

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INTRODUCTION

India is an agrarian nation where the major part of the arable ground is used for agriculture and diverse crops are cultivated in different regions of the country. The plant waste materials include an orchard and vineyard prunings, vegetable by-products from farming, residual fruits, vegetable residues, and other crop remains after the usable crop is harvested, other plant wastes from canneries, wineries, or other industrial sources (Anon 2015). Plant residues left in the field after harvesting of produce, trimmings and plant parts discarded during pruning operations, weeds, surplus plants from thinning operations lead to tremendous plant waste materials.

Depending on the crops grown, their productivity and cropping intensity, production of crop waste and their use varies in different regions. Agricultural waste management is an element of the environmental rotation in which all matter is recycled to facilitate a chain of interdependent relationship maintaining a bio-network. Through waste management, the plant residues are allocated at the suitable place and time to render as profitable products and control pollution. It is therefore evident that new applications need to be found for agricultural residues. The burning of crop residues in fields is one of the most noteworthy activities of global biomass burning (Streets et

al 2003), and contributes significantly to air pollution. In Asian countries, where more than 1.2 million km of land is used to grow rice, accounts for 60 percent of rice production worldwide.

Plant and Agro-waste, therefore, can be a boon if appropriately utilized. It is capable to provide multi-dimensional products, with a variety of end-uses ensuring employment in various segments (Stout 1960). In Punjab and Haryana, the waste materials from plants and crops available are wheat, corn and paddy straws, leaves, corn dollies, grasses, plant straws, and pruned branches, etc. which were used to make products mainly for domestic consumption. However, these can be utilized more profitably through product diversification and design development. The present study was undertaken to address the issues of plant and Agro-waste utilization for the benefit of mankind. Development of textile textures using agro-waste materials would prove useful since the potential of effectiveness is not fully exploited. Unethical and unthoughtful disposal of the huge amount of agricultural waste is causing multiple hazards through deterioration of the environment and consequently, the public health. Development of textile textures from plant and Agro-waste may partially help in addressing to this problem, in addition to providing self-employment through entrepreneurship development in related products. The objectives of the study have been mentioned below.

- To develop woven and composite textures using plant and agro-waste materials
- To study the physical parameters of the woven and moulded composite textures

METHODOLOGY

Identification and Selection of Plant and Agro-Waste Materials

For the development of moulded composite textures, three types of plant and Agro-waste materials were selected for the study. Two textures for each of three types of selected plant and agro-waste materials (total six textures) were developed through weaving and moulding. Three types of raw materials, i.e. Wheat and paddy straws and date palm leaves, suitable for use in natural form in texture development were selected. The physical properties of three selected straws and leaves studied were thickness, diameter, and length. Three each of woven samples, and woven moulded composite textures were developed.

Procurement of Materials

Wheat and paddy straws were collected from the fields of Punjab, while date palm leaves were collected from roadside wild date palm plants. Paddy and wheat straws and date palm leaves were considered suitable for developing textile textures in their natural form. The resin was procured from Thames Chemicals, Ludhiana (Punjab) for moulding. The spun polyester yarns were procured from Ludhiana market.

METHODS

Woven Samples of the Straws and Leaves

Three samples of straws and leaves were woven in plain weave using 100 per cent spun polyester (2/45 yarn count) yarn as warp (Figure a-d).

Figure 1: (a-d) Type of Raw Materials Used for Woven Samples

Preparation of Raw Materials

The wheat and paddy straw waste materials were collected from the fields of Punjab after harvesting. The date palm leaves were collected from wild date palm plants or bushes growing on the roadside. The upper part of the wheat and paddy straws were selected for weaving. The immature date palm leaves were selected for weaving. The selected straws and leaves were sun-dried and stored in a ventilated room before weaving. Over the century's straws of grasses and cereal crops (wheat, oats, barley, rye, and rice) were used for making straw hats, reticules, baskets, storage containers and a wide range of decorative items. During the 1600s, the straw hat industry provided income for families throughout Europe. It employed hundreds of thousands of people who made plaits, wove hats (similar to panamas) in a cottage craft or a factory setting (Anon 1978).

Preparation of Textures from Straws and Leaves

The thickness of the straws was examined before using them for weaving. To maintain the thickness of coating, wheat straws were split lengthwise before weaving, but paddy straws were used in the original form. Even date palm leaves were split into narrow strips for weaving. Frame looms were used for making woven textures from straws and palm leaves. Polyester yarns in different colors such as white, orange and green were used as warp yarns, and straws were used as weft (Fig 1). All the samples were woven in plain weave.

Physical Properties of Prepared Textures from Straws and Leaves

Properties of woven and moulded composite textures- GSM and thickness were examined

RESULT AND DISCUSSIONS

Development of Woven Textures from Straws and Leaves

Woven samples were prepared by using plain weave. The threading and lifting plan for plain weave has been shown graphically below.

Six samples of straws and leaves were prepared in plain weave using polyester yarn (2/65). Two harness frame loom was used for making samples in plain weave. Polyester yarn used as warp is resistant to sunlight behind the glass. Thus, the woven textures would be suitable for window curtains.

Threading plan of two harness loom for plain weave

Harness 1															
Harness 2															

Lifting plan of plain weave

1, 2, 1, 2, 1, 2 repeat from

Development of Woven and Moulded Composite Textures

Three woven samples of wheat and paddy straws and date palm leaves were used to develop a water and stain resistant texture. The moulded textures were prepared by hand lay-up technique. A calculated amount of resin and hardener (ratio of 50:50 by measure or weight) was thoroughly mixed in a glass jar. The plastic moulds were used to prepare the moulded or coated textures. After keeping the mould on a flat surface a thin layer of the mixture was poured into it. After 5 minutes, the woven textures were set on the mixture. Then, again resin was poured over the woven sample. Care was taken to avoid the formation of the air bubbles. The mould was allowed to set at room temperature for 5-6 hours and the samples were taken out of the mould (Fig 2a-f).

(a) Heat and Mix Resin and Hardener in Lukewarm Water for 3-5 Minutes

(b) Pour the Resin in the Plastic Moulds and Set for 15 Minutes

(c) Place the Woven Straws/Leaves on the Resin Layer and Set for 15-20 Minutes

(d) Pour Resin over Woven Straws and Allow to Set for 3-4 Hours

(e) Set it for 3-4 Hour and Release

Figure 2: (a-e) Process of Making Woven and Moulded Composite Textures**Details of Developed Woven and Moulded Composite Textures**

Total six samples comprising of three each of woven, and woven and moulded composite textures were developed using 2/45 polyester yarns as warp for each of paddy and wheat straws and date palm leaves. Three woven samples were assigned code such as PSP₁, WSP₂ and DPP₃ (Table 1). The Rest of the three samples were woven and moulded with the resin and codes were assigned PSP₄, WSP₅ and DPP₆.

Table 1: Codes Assigned to Developed Textile Textures from Straws and Leaves

Code of Developed Textures	Composition of Warp Yarn	Composition/EPI and PPI Used in Weft Yarn	Type of Weave Used	Images of Woven Samples
PSP ₁	2/45 polyester	Paddy straw EPI=12, PPI=2	Plain weave	
WSP ₂	2/45 polyester	Wheat straw EPI=9, PPI=5	Plain weave	
DPP ₃	2/45 polyester	Date palm leaves EPI=40, PPI=7	Plain weave	
PSP ₄	2/45 polyester	Paddy straw woven and moulded composite textures	Plain weave	
WSP ₅	2/45 polyester	Wheat straw woven and moulded composite textures	Plain weave	

DPP ₆	2/45 polyester	Date palm leaves' woven and moulded composite textures	Plain weave
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Analysis of Physical Properties of the Woven and Moulded Composite Textures

This section included physical properties of the moulded woven textures from the epoxy resin. The physical properties examined were mass weight (GSM) and thickness of the moulded woven textile textures. Data pertaining to physical properties of developed textile textures have been presented in Table 2.

Table 2: Physical Properties of Moulded Composite Textures

Physical Properties	Developed Woven and Moulded Composite Textures		
	Paddy Straw (PSP ₄)	Wheat Straw (WSP ₅)	Date Palm Leaves (DPP ₆)
Weight (GSM) (gm)	21.60	29.45	27.05
Thickness (mm)	8.479	7.630	10.01

Figure 6: Physical Properties of Woven and Moulded Composite Textures

GSM and Thickness

The weight (GSM) of PSP₄, WSP₅ and DPP₆ was 21.60 gm, 29.45 gm and 27.05 gm, respectively (Table 2). Thus, the weight of the moulded woven texture WSP₅ was highest (29.45 gm) among other samples. Thickness of WSP₅ was minimum (7.630 mm), while thickness of DPP₆ was highest (10.01 mm). Thickness of coated textures affected the cost of the end product.

CONCLUSIONS

The woven textures from selected wheat and paddy straws, and date palm leaves coded PSP₁ (paddy straw × polyester), WSP₂ (wheat straw × polyester) and DPP₃ (date palm leaves × polyester) were found suitable for various end-uses such as coaster plates, bags, purses, file cover, mats, small window curtains, baskets, containers and trays. The developed woven and moulded composite samples of wheat and paddy straws, and date palm leaves coded as PSP₄ (paddy straw × polyester), WSP₅ (wheat straw × polyester) and DPP₆ (date palm leaves × polyester) were also considered suitable for similar kind of applications for office table utilities such as coaster plates, paperweights, pen holders, pots, trays and fancy boxes, utilities and wall tiles for interior designing. The composite textures were durable and shock, water and stain resistant.

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