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Functional finishing for the Men's corporate ensemble using innate Jute fabrics: An Ingenious approach towards sustainable Ready-to-wear clothing

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ABSTRACT

Men's corporate Ready-to-wear clothing has always been a conventional segment of attire as far as the choice of fabrics, silhouettes, notions and functionality is concerned. But in the latest fashion eras, advances in the technologies haven't even left this highbound clothing sector untouched. Instead of keeping warm, good looking and comfortable; people nowadays, have a much higher demand on clothing and prefer the clothes to have special properties. Textiles with advanced technology could offer extremities than the conventional textile forms that work as functional performers for the under looked Men's clothing sector. Thus, the present paper aims at achieving the objectives of reinventing the men's clothing wardrobe with the impressions of sustainability and style together. In this work, Men's semi formal waist coats were conceptualized using the forgotten Jute fabrics infused with Fragrance finishes with the use of essential oils as host-guest complexes of ß-cyclodextrin citrate to impart value added finish durability. It came out to be a novel approach to re-surface Jute and Men's formal attire that can be targeted as a big boon for the M2M clothing lines.

Keywords: *Ready-to-wear, silhouettes, highbound, sustainability, host-guest complexes, ß-cyclodextrin citrate, M2M.*

INTRODUCTION

There is no perfect fiber. All fibers have well far and poor characteristics, so blending is the technique to combine fibers which emphasizes the good qualities and minimizes poor qualities of the fibers. Blending also makes the fabric manufacturing process economical.

Jute is a lignocellulosic bast fiber. It is hard and harsh due to the presence of lignin. Due to its harshness, it is difficult to produce apparels and other fancy fabrics to use in our day to day life. Limited work has been done to remove the hardness of the jute fiber [1,2].

It's not easy to turn the jute as soft as cotton but can be taken to an acceptable level to blend with cotton [3,4]. *JUTE ALSO HAS SOME FAVORABLE PROPERTIES LIKE HIGH TENSILE STRENGTH, BULK AND GOOD DYE ABILITY.*

Instead of keeping warm, good looking and comfortable, people nowadays have a much higher demand on clothing and prefer the clothes to have special properties [5]. Textiles with advanced technology could offer much more than the

conventional textile forms, with new wrinkle free, stain resistance, soil resistance and antimicrobial properties as functional performers for textiles. Different kinds of essential oils are added to fabrics to allow the fabrics have various scents and aromatherapy functionality. The addition of fragrance to a textile makes it possible for customers to enjoy a fresh smell and relax themselves [6]. Fragrance finish is the process by which textile materials are treated with the pleasant odours which yields better beneficial effects. The pleasant smells can be created by the essential oils that have pharmacological effects like antibacterial, antifungal, antiviral and mood elevating effects [7]. Fragrances and flavors have been used widely in many fields such as the food, medicine, tobacco, textile, leather, papermaking, cosmetics and so on because of their antibacterial effect, sedative effect and tranquillization. Pure fragrance compounds and essential oils have been used traditionally in folk medicine for a long time. The term aromatherapy was coined in the late 1920s by the French cosmetic chemist R.M. Gattefosse, who noticed the excellent antiseptic properties and skin permeability of essential oils. Fragrances have medicinal value depending upon the type of the fragrance used in the composition. Over the last 50 years; plants are utilized as a potential source of natural aromas in the form of essential oils. Essential oils offer many advantages over synthetic fragrances like these are friendly to skin as well as to the environment. The textiles treated with essential oils are next to the skin, so skin can be benefitted of essential oils as these are retained by the skin for revitalization. Also, the treatments don't affect the wearability and comfort of the textiles. Microencapsulation has become a means of imparting finishes and peculiar properties which were not possible previously and provide the possibility of combining the properties of different types of material as a single entity (e.g. inorganic and organic substances) which is difficult to achieve otherwise using alternative techniques and this has been used successfully for imparting fragrance finishing also. The fragrance application has been commercialized with the use of microcapsules having monotonous but yet impart durability. The first wave of microcapsule inventions for textiles were developed in 1970s and gave a way to the formulation and successful application of microencapsulated dyes, pigments, softeners, antistatic agents and flame retardants for textiles. In the 1990s, the second wave of inventions brought interesting products as thermochromic and photochromic materials, insect repellents, antimicrobials, cosmetics and medical textiles. The wide variety of application techniques of different microcapsules depend on stability of core and wall material, particle size, wall thickness, wall permeability, type and rate of release of core material required, physical properties and overall economics of manufacture. Microcapsules can be applied on the textile by padding, coating, spraying and immersion without altering the feel and color of the textiles. All these require a binder as microcapsules lack any affinity for any fibre substrate to develop a strong binding of microcapsules during wash and wear [8]. Though, this method is widely exploited but also has some disadvantages as it increases the finishing cost substantially and by this method, it is difficult to get continuous and uniform distribution of microcapsules throughout the fabric.

Thus, the other alternative that has gained a lot of interest in the field of functional finishing as fragrance the 'Host–guest' chemistry, where a 'host' is that anchoring compound which has the capability of housing other characteristic compound termed as the 'guest' [9]. In the family of hosts, cyclodextrins are the most promising molecular containers. These compounds are capable of forming inclusion complexes with a wide variety of guests to achieve improved properties of the guests. The major reason of their commercial success includes their cost-effectiveness; alteration in the properties of finished fabric can be dictated by the finisher's end, no excess load on the waste water and biodegradability.

So, β-cyclodextrin is used for binding essential oils on to the fabrics. In the present work, three different fragrances in a blended composition and one derivative of β-cyclodextrin has been used for the fragrance finishing of jute blended fabrics. The essential oils are applied by pad-dry method on jute blended fabrics for imparting fragrance finishes. The stability of the functionalized fabrics was also studied for fragrance finishing.

OBJECTIVES OF PRESENT WORK

In the present work-

1. Jute blended fabrics were finished with essential oils for the achievement of desired effects of fragrance and converted into garments, suitable for corporate wear.
2. In this regard, essential oils were used with host compounds such as β-cyclodextrin citrate.

3. The stability and retention of essential oils was studied in terms of wash durability from jute blended fabrics. In addition, the change in their physical properties and functional performance was also assessed.

METHODS

Materials

Two types of untreated and unprocessed plain woven Jute/Polyester/Viscose blended fabrics taken from 'Store T.I.T &S, Bhiwani had been used as control for the work with 309 G.S.M, EPI & PPI as 85 & 60; 2/31Ne^s (P/V) and 12Ne^s (J/V) as warp and weft for sample 1. The specifications of Sample 2 were- 302 G.S.M, EPI & PPI as 94 & 60; 2/30Ne^s (P/V) and 12Ne^s (J/V) as warp and weft. The properties of the fabrics are listed in Table 1.

Table 1 Fabric Properties for sample jute blended fabrics

Tensile Strength (Sample 1)	Crease recovery (^{0}) (Sample 1)		Drape coefficient (Sample 1)	
	Warp	Weft	Face	Back
9.08cN/tex	236˚	243.3˚	0.55	0.49
Tensile Strength (Sample 2)	Crease recovery (^{0}) (Sample 2)		Drape coefficient (Sample 2)	
	Warp	Weft	Face	Back
8.78 cN/tex	225˚	230˚	0.72	0.56

The chemicals of analytical grade had been used for the work as β-cyclodextrin (host), citric acid, Rosemary oil, Jasmine oil and Peppermint oils, Green acid (pH buffer), Terrytex mode (silicon softener), UCFC (resins) & Magnesium chloride (catalyst) from SD Fine Chem Limited, Tarapur, Mumbai. Ethanol was procured from Haryana Scientific, Rohtak, Haryana. Electronic weighing balance, GSM cutter, Beasley balance, Tensile tester, Crease recovery tester (Shirley), FTIR (Perkin Elimer, T.I.T&S college, Bhiwani), Drape meter were used as the main instruments/Apparatus.

EXPERIMENTAL

Pre-treatment of Jute blended fabrics- Heat Setting is done on Stenter machine for the dimensional stability at the temperature of 160˚C for 80 seconds at the speed of 24 meter/min. After this, Singeing was performed to reduce the harshness and also to avoid pilling and soiling resulting an even surface at burner position 2 (burner was positioned at 45˚ angle) with the flame intensity of 8 mbr at speed of 90-95 m/min. It was followed by an enzyme treatment with commercial Cellulase (Biopolishing); 8gpl solution at the temperature of 60˚c raised upto 70˚C for 30 mins at the pH of 2-3; then in combination with Acitizyme (1gpl) and Green acid (1gpl) at temperature of 45˚C raised up to 80˚C for 45 mins along with cooling and washing holding time of 10 min to remove the left over protruding surface jute fibers (after singeing) that are prickly in nature. Later, Silicon finishing was applied to improve the fabric handle giving pleasing touch using pad (2 dip 2 nip) → dry → cure (at the require conditions (temperature =180˚C, time = 25-30 seconds, pH=7 & speed = 28 meter/min). Calendering was used as the finishing process to make the fabrics smooth at the temperature of 51˚C.

Synthesis and characterization of β-cyclodextrin Citrate (β-CD-CA)

The β-CD-CA was synthesized according to the method [10]. β-cyclodextrin Citrate (β-CD-CA) was prepared using a semidry reaction method. Citric acid (CA) (3.5mmol, 0.68g) was dissolved in water (1.2ml) followed by the addition of β-CD (1.76mmol, 2g) in presence of Sodium Hypophosphite (SHP) (0.5g). The reaction mixture was allowed to react in a circulating air oven at reaction temperatures 100°C for 2 hours. The cured sample was purified by washing with isopropanol using soxhlet for 6 hours in order to remove unreacted components as well as any soluble fragments or by-product, followed by drying at 60°C for 24 hours. FTIR was used for its characterization. Further, its solubility analysis was done in water & ethanol as compared to native β-CD by dissolving different concentrations of β-CD-CA ranging between (10, 20, 30, 40, 50, 60, 70, 80, 90, 100 gpl) in different mediums as water and 50 % ethanol for 10 minutes. Then, the solution was filtered with the help of filter paper. The filter paper was oven dried and weighted with the use of weighting machine. To get accurate results, the filter paper was also weighted before and after the filtration process. Solubility % was determined as: -

$$\text{Solubility \%} = \frac{\text{Initial weight of β-CD-CA in solution} - \text{Final weight of β-CD-CA as residue on filter paper}}{\text{Initial weight of β-CD-CA in solution}} \times 100$$

Application of β-CD-CA on jute blends

β-CD-CA solution was prepared and the samples were immersed in solutions of β-CD Citrate at

64gpl for 2 minutes followed by padding at 1KPa, drying and curing at 190°C for 2 minutes [11]. % weight gain was evaluated as the characterization of the functionalized fabrics.

Application of combination of essential oils (EOs) on β-Cyclodextrin Citrate (β-CD-CA) treated fabrics

Essential oils (EOs) as Peppermint (PO), Jasmine (JO) and Rosemary (RO) were used in combination in the proportion of 95:2.5:2.5% to make an oil solution of 100 ml in 1000 ml of alcohol (10% oil concentration). The combined oil solution was applied on β-CD-CA treated jute blended fabrics using immersion method by dipping the fabrics independently in the oil concentrations for 2 mins followed by air drying at room temperature. The stability of the oil treated fabrics was assessed in terms of their **wash durability** (ISO 105-C03:1989). The native and functionalized jute fabrics were also tested for the changes in the **Tensile strength** (IS:1969-1968), **Crease recovery** (IS:4681-1968) and **Drape Test.**

Design and development of end products

The fragranced functionalized jute blended fabrics were converted into the Men's corporate jackets in their semi formal form that were aimed to acquire the functionality of durable fragrance finishing as an ensemble of Men's formal clothing.

The complete process of the designing and development of the end product is outlined in fig 1.

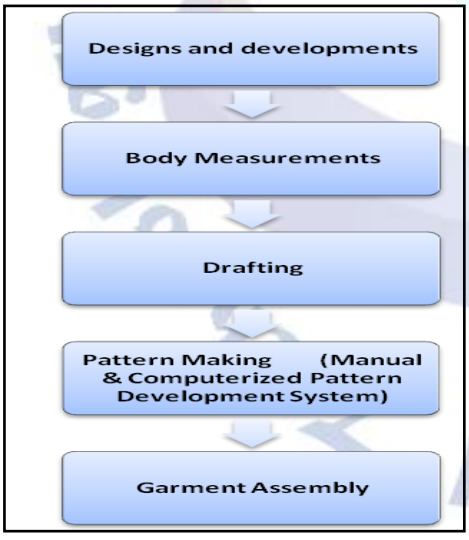


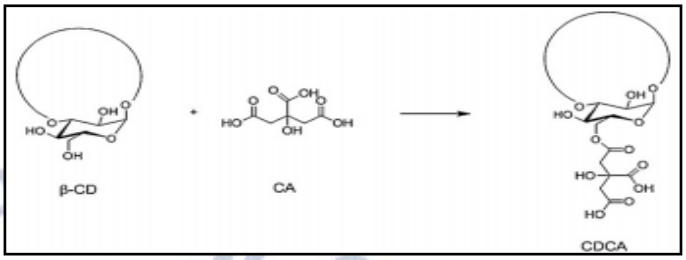
Figure 1. End product development process

RESULTS & DISCUSSIONS

Synthesis and characterization of β-CD-CA

The synthesis of β-CD-CA was carried out according the reaction mechanism shown in Reaction 1. The yield % of the reaction was satisfactory at 62.6 %.

The comparative FTIR spectra were analyzed for the native β-CD, citric acid and β-CD-CA.



Reaction 1 Synthesis of β-Cyclodextrin Citrate (β-CD-CA) [9]

β-CD-CA should a characteristic peak at 1715 (absent in both β-CD and citric acid) indicating C=O Stretching (Strong Ester Peak). The solubility analysis of β-CD-CA had shown that as concentration of β-CD-CA increases from 10gpl to 100gpl, the solubility in water and 50 % ethanol solution decreased gradually. Water was chosen as the final medium for the further work.

Application of combination of essential oils (EOs) on β-Cyclodextrin Citrate (β-CD-CA) treated fabrics-

The jute blended fabrics were treated with the derivatized host under the predetermined variables along with the combination of fragrance oils. The **weight gain** % was assessed as 1.87 (I) % & 2.28 (II) for the samples. The wash durability of the treated fabrics was assessed using the standard procedure. It was observed that there was 8.15% & 8.23% loss in the **tensile strength**, 8.7% & 8.64% increase in **Crease recovery** and 12% & 11% fall in the **drape** of the functionalized jute blends (for Sample 1 and Sample 2 respectively). The **wash durability** was assessed for both the samples for 5 subsequent washes- 4.5% (I) & 4.7% (II) in terms of the % retained weight gain after 5th wash. For the fragrance retention, it was observed that the rosemary component of the oil was the first to leave the host moieties followed by peppermint and Jasmine components. This difference in the fragrance retention of the oil components was due to the difference in their compositions as well as the volatility or vapour pressure. The peppermint was the last o leave the fabric surface due to its proportion in the oil composition. The shelf life of the fragranced fabrics was almost retained for more than a year (obviously with the reducing % stability).

End product development- The fragranced jute fabrics were converted into Semi Formal Men's jackets with the digital design presentation using theme based Storyboards (with Adobe Photoshop 7.0), Pattern Making in 2DPDS (Optitex) and garment making with the marking, cutting and sewing methods (with JUKI-DDL-8300N-31234, SNLS was done (fig.2).

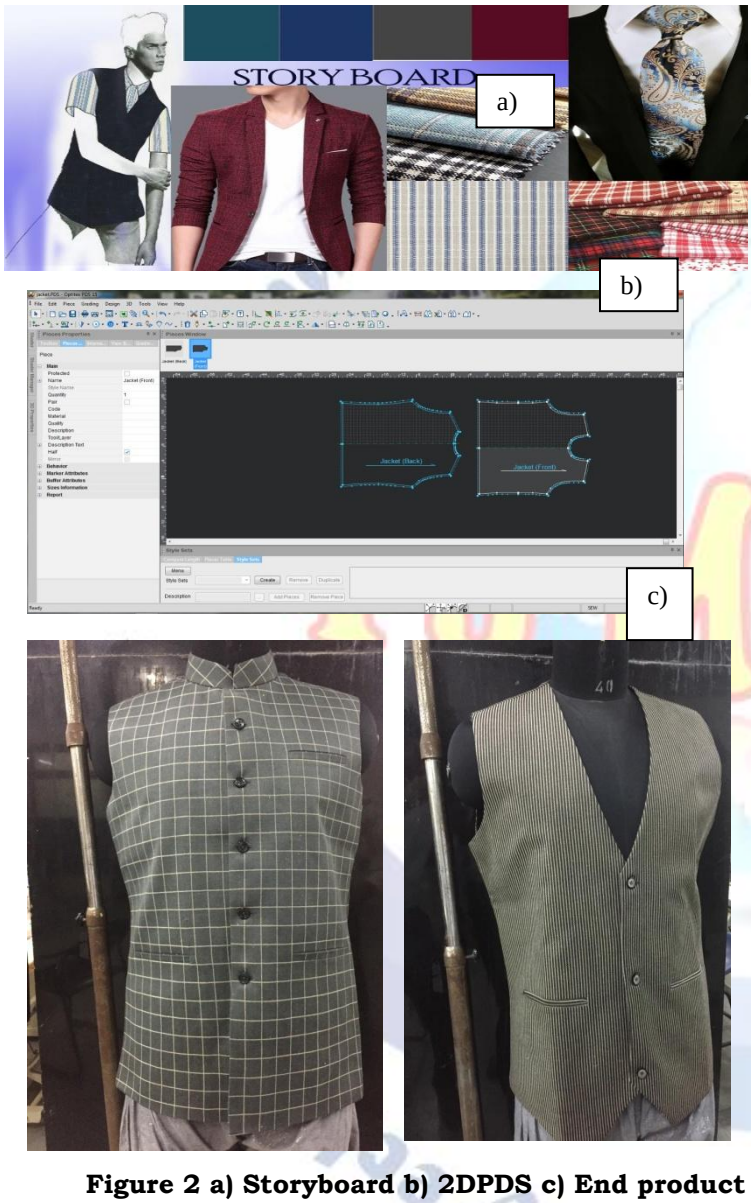


Figure 2 a) Storyboard b) 2DPDS c) End product

CONCLUSIONS- It was concluded that the derivative of β-CD had modified the surface characteristics of jute blended fabrics by reducing the tensile strength, increasing the crease recovery angles (due to the increased fabric stiffness) and also affecting the drape behavior in the acceptable ranges. On the other hand, the functionalized jute fabrics infused with the combinational fragrances have shown much better stability and increased shelf life than the direct fragrance application & also, through the native host. This was due to the better adherence of the derivatized host and inturn the complexation of the guest oils with the host. The fragrance infused textiles can prove to be promising for the Men's clothing sector and have got the ability to revolutionize the Corporate clothing segment.

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