J. Farm Sci., 31(2): (183-187) 2018

RESEARCH PAPER

Effect of treatment and method of application on mechanical properties of Vetiver finished organic cotton fabrics

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(Received: July, 2017 ; Accepted: June, 2018)

Abstract: *Vetiveria zizanioides i*s popularly known as Khas Khas or Khus grass widely grown in Karnataka and other states has been used as one of the important bioresources with variegated functional properties *viz.*, medicinal value, aromatic and antimicrobial properties. Vetiver root powder was extracted by 80 per cent of ethanol and microcapsules were prepared by interfacial polymerization technique using diluted vetiver oil, dicyclohexyl methane 4,4 dilsocyanate, cetyltrimethyle bromide and ethylene diamine. The scoured and bleached organic cotton fabric was treated with Vetiver root extract and Vetiver oil microcapsules through exhaust and pad dry cure method. The treated samples were assessed for mechanical properties *viz.,* cloth count, cloth thickness, cloth weight, cloth crease recovery and cloth stiffness. The results revealed that, the cloth density of treated samples were found to be decreased and reduction was statistically non significant. The treated samples possessed greater crease recovery angle and lesser bending length resulting into more softer, pliable and resistant to crease due to presence of diethyl pathalate compound in the vetiver root and oil. The vetiver microcapsules treated sample by pad dry cure method found to be more thicker and heavier than the exhaust method of application. Irrespective of method of application and treatments, the vetiver oil microencapsulated organic cotton fabric by pad dry cure method possessed excellent mechanical properties than other treated fabric samples. Vetiver root powder and oil is most suitable bio source for textile finishing as a crease resistant agent and to improve the mechanical properties of the fabrics due to presence of major compound like diethyl pathalate and cyclohexane.

Key words: Fabric, Microencapsulation, Root extract, Vetiver

Introduction

Vetiveria zizanioides is an aromatic grass and one of the natural resources that has great application for well being of human. *Vetiveria zizanioides* is popularly known as Khus grass in India and is a densely tufted grass found throughout the plains and lower hills of India, particularly on the riverbanks and in rich marshy soil. Two species of *Vetiveria* are found in India, of which *V. zizanioides* is the common source of well known oil of vetiver, which is being used in medicine and in perfumery. A major portion of oil consists of sesquiterpenoids, hydrocarbon and their oxygenated derivatives. Phyto-chemical screening of the powdered leaves exhibited presences of alkaloids, falvonoides, tannins, phenols, terpenoids and saponins. Roots are highly aromatic, antimicrobial, antifungal, UV blocking, mosquito repellent, cooling, haemostatic, expectorant, insomnia, skin diseases and anti oxidant (Mishra *et al.,* 2013).

Ayurvedic literature mentioned that Vetiver plant has been used for various ailments as digestive, carminative stomachic, constipating, haematinic, expectorant, antispasmodic, antiasthmatic, antigout, anthelmintic, antimicrobial and diuretic. The roots are used for cooling the brain and also used in the treatment of ulcers. Vetiver oil owes several beauty benefits and emotional effects. It replenishes moisture in dry and dehydrated skin and has a rejuvenation effect on mature skin, as well as cuts/wounds/irritated and inflamed skin (Lavania 2003). Vetiver is the most versatile, multifarious grass with immense potential properties which are beneficial to human health and clothing too. Use of plant extracts not only provides protection from environmental hazard but also safeguards the environment, prevents pollution and promotes eco-friendly textiles.

Vetiver has traditionally been used as medicinal and aromatic plant in many places of Karnataka particularly in Uttar Kannada district. This bio-resource is mainly used in medicine, aroma therapy and few handicraft centres involved in preparation of different handicrafts. Based on the literature, the source has very good antimicrobial and aromatic property it can be effectively used for finishing health care textiles. Hence, the present study was designed to impart the functional finish on organic cotton fabric using vetiver root extract and vetiver essential oil microcapsules and its effect on mechanical properties.

Material and methods

Organic cotton fabric

Plain hand woven organic cotton fabric interlaced with warp of single yarn (33s) and weft of 2 ply (2/33s) was processed under SRP titled "Quality Evaluation of Organic and Conventional Cotton Apparels", from the Department of Textile and Apparel Designing was procured during the year 2015-16,

College of Community Science, University of Agricultural Sciences, Dharwad.

Vetiver root

Vetiver root (Gulabi variety) was procured from Department of Horticulture, University of Agricultural Sciences, Dharwad. The collected vetiver roots were shade dried and cleaned. The dried and cleaned roots were crushed into fine powder by traditional pounding method and subjected to solvent extraction method. A known quantity vetiver root powder was dissolved in 100ml of diluted ethanol (ethanol: 80 ml and water: 20 ml) kept it for overnight. The solution was centrifuged at 6000 rpm for 30 min at room temperature to get the bio active agents. The centrifuged solution was filtered using Whatsmann No. 1 filter paper and vetiver root extract was collected for textile finishing.

Microencapsulation process

Pure vetiver root essential oil was used for microencapsulation. It is a means of packaging, separating and storing materials in microscopic capsules for later release under controlled conditions. Interfacial polymerization technique was adopted for the preparation of vetiver oil microcapsules.

Interfacial polymerization technique

Interfacial polymerization technique (Rodrigues *et al.*, 2008) was used for preparation of microcapsules.5 ml of Cetyltrimethyle bromide (CTAB) was dissolved in 95 ml of deionised water and stirred at 500 rpm for 15 min. A diluted vetiver oil (Vetiver oil: 2 ml, Coconut oil : 4 ml) and Dicyclohexyl methane 4,4 dilsocyanate (3 ml) solution was mixed properly and added into Cetyltrimethyle bromide solution. After 5 min, ethylene diamine (5 ml) was dissolved in water (5 ml) then added in to core solution and the temperature of solution was maintained at 40 ^{0}C. The solution was stirred at 600-800 rpm for 15-20 minutes. The prepared solution was subjected to filtration using Whatsmann No 1 filter paper. The filtered microcapsules stock was dried under shade and stored in refrigerator for further application.

Application of finishing substrates on organic cotton fabric

The organic cotton fabric was finished with vetiver root extract and vetiver oil microcapsules through exhaust and pad dry cure method. These two methods are purposively selected for finishing the textiles, as these are proven and reliable traditional methods which are simple, productive, low maintenance, cost effective and hence still quite popular.

Exhaust method of finishing

A known amount of scoured and bleached organic cotton fabric was immersed into finishing bath of 1:30 MLR which was prepared by vetiver root extract (8 % owf) and Vetiver oil microcapsules (8 %) separately. The cross linking agent *i.e.,* citric acid (8 % owf) was added in vetiver root extract bath, where as acrylic binder (8 % owf) was used for vetiver oil microcapsules. The material was stirred continuously for 30 minutes and the bath temperature was slowly increased up to 50 ^{0}C. After 30 minutes the fabric was taken out from the bath, squeezed and dried under shade.

Pad dry cure method of finishing

This process comprised of three steps *i.e.,* padding, drying and curing. The fabric was immersed in the finishing solution of 1:10 MLR with vetiver root extract (8 % owf) and vetiver oil microcapsule (8 % owf) along with citric acid (8 % owf) and acrylic binder (8 % owf) separately. The pre wetted fabric was passed between the rollers at a uniform speed and pressure for proper impregnation of vetiver root extract and oil microcapsules. The treated fabric was dried and cured in a curing chamber by maintaining the required temperature and time.

Assessment of mechanical properties of vetiver treated organic cotton fabrics

The vetiver treated organic cotton fabrics were subjected to testing of mechanical properties *viz.,* Cloth count, Cloth thickness, Cloth weight, Cloth stiffness and Cloth crease recovery using standard test procedures.

Results and discussion

Cloth count of vetiver treated organic cotton fabrics

Cloth count of the woven textile material is the number of ends and picks per unit area which is influenced by the yarn count, compactness of the weave and finish applied which influence the mechanical and functional properties of the ultimate cloth. The cloth count of organic cotton fabrics treated with vetiver root extract and oil microcapsules finished by exhaust and pad dry cure methods is reported in the Table 1. Irrespective of source and methods of application, the cloth count of control sample was found to be greater as compared to treated samples. In general, the warp way cloth count of all

Table 1. Cloth count of vetiver finished organic cotton fabrics

Source of application / Method of treatments		Cloth Count (Ne)			
		Exhaust method		Pad dry cure method	
		Warp	Weft	Warp	Weft
Control		72	52	72	52
Vetiver root extract		71	48	71	48
Vetiver oil microcapsules		71	50**	70	49**
Method of application	Variables	S.Em ±		C.D. (1 %)	C.D. (5 %)
Exhaust method	Warp	0.56		2.09	1.55
	Weft	0.66		2.58	1.91
Pad dry cure method	Warp	0.72		2.84	2.11
	Weft	0.67		2.63	1.95

** Significant @ 1 % level, * Significant at 5% level

the samples was found to be greater than the weft way cloth count. However, in warp direction the cloth count of control and treated fabrics was found to be same (70-72) and statistically non significant. Whereas, in weft direction the cloth count of fabric treated with vetiver root extract (48) in both the methods of treatment remained same *i.e.,* 48 threads per inch followed by fabrics treated with microcapsules *i.e.,* 50 and 49 respectively.

In general, irrespective of source and methods of application, the treated organic cotton fabrics possessed significantly lesser number of threads per unit area than control sample. This may be due the absorption and deposition of coating material *viz.*, vetiver root extracts and vetiver microcapsules with binder and cross linking agent fixed within the fabric structure, which resulting in to swelling of yarns thus reducing the cloth count. Gupta (2016) who reported that there was decrease in cloth count fabric treated with *S. cumini* (L.) leaves extract than the control fabric. Similarly Sumithra and Vasugi (2012) also reported that the fabric treated with the combination of herbal extracts of *Ricinus communis, Senna auriculata* and *Euphorbia hirta* in ratio 1 : 3 : 2 was found to be decreased in fabric count compared to control sample.

Cloth thickness of vetiver treated organic cotton fabrics

The thickness of the fabric is one of its basic properties giving information on its warmthness, heaviness or stiffness in use. When a fabric is compressed the space between the fibers/ yarns decreased until they eventually come in contact with one another (Saville, 2009).

In general, the treated samples were found to be significantly thicker than the control sample (0.547). However, in exhaust method, the fabric treated with vetiver root extract was found to be more thicker (0.567) than the oil microencapsulated fabric (0.557). Further, the fabric treated with oil microcapsules through pad dry cure method possessed significantly greater thickness (0.579) than the fabric treated with vetiver root extract (0.564). Among the treated samples fabric possessed greater thickness in combination of microcapsules + pad dry cure method (0.579) followed by vetiver root extract treated fabric through exhaust method (0.567) recorded in the Table 2.

Irrespective of source and methods of application, the treated organic cotton fabrics possessed increased in cloth thickness compare to control sample. This may due to the migration of vetiver root extract and oil microcapsules to fabric surface, adsorption of the same on the surface of fabric, diffusion of finishing substrates inside followed by fixation resulted into increased thickness in the treated samples. The results are in line with the explanation of Annapoorani *et al.* (2016) in their study stated that there was a slight increase in microencapsulated samples than control.

Cloth weight of vetiver finished organic cotton fabric

Fabric mass per unit area is expressed either as grams per square meter or grams per linear meter. The type of fibre, yarn density, weaves type and finishes applied are some factors that contribute to the fabric weight.

Irrespective of methods of application *i.e.,* pad dry cure and exhaust method, the fabric treated with vetiver oil microcapsules possessed significantly greater cloth weight (120.56 and 117.84) than the fabric treated with vetiver root extract *i.e.,* 119.44 and 115.2 respectively. Similarly the greater amount of per cent warp (55.32 & 53.36) and per cent weft (66.16 & 63.68) was recorded in the fabric treated with oil microcapsules than the vetiver root extract treated fabrics (warp: 54.88 & 52.00, weft: 63.06 & 61.52). This may be due to absorption and deposition of vetiver root extract and oil microcapsules as well as finishing agents on the surface of the fabric. Gupta (2016) who reported that there was increase in cloth weight of treated fabric sample than control sample (Table 3).

Cloth stiffness of vetiver finished organic cotton fabrics

Bending length is the length of fabric that will bend under its own weight to a definite extent. The higher the bending length, the stiffer is the fabric and vice versa (Booth, 1996).

The vetiver root extract treated samples with exhaust and pad dry cure method possessed decrease in bending length in both the directions *i.e.,* warp-way (1.14 & 1.13) and weft -way (1.40 & 1.55) compared to fabric treated with oil microcapsules (warp: 1.29 &1.31, weft: 1.42 &1.66) respectively. Among the treated samples with different source and methods of application the fabric treated with vetiver root extract and oil microcapsules exhibited significantly lesser cloth stiffness than the control sample. This may be due to the application of citric acid as cross linking agent and acrylic binder as binder during finishing process makes the fabric more flexible and pliable. The results are in support with the study conducted by Edwin and Nalankilli (2012) who reported that, decrease in bending length in both warp and weft direction after the application of resin cross linking agent. Jaswal *et al.* (2017) who reported that, there was

Table 2. Cloth thickness of vetiver finished organic cotton fabrics

Source of application Method of treatments	Cloth thickness (mm)	
	Exhaust method	Pad dry cure method
Control	0.547	
Vetiver root extract	0.567**	0.564
Vetiver oil microcapsules	0.557	0.579**

Method of application	S.Em ±	C.D. (1 %)	C.D. (5 %)
Exhaust method	0.0047	0.018	0.013
Pad dry cure method	0.0049	0.0192	0.0142

** Significant @ 1 % level, * Significant @ 5% level

Table 3. Cloth weight of vetiver finished organic cotton fabrics

Source of application / Method of treatments	Cloth weight (GSM)					
	Exhaust method			Pad dry cure method		
	Percent Warp(%)	Percent Weft(%)	Cloth Weight	Percent Warp(%)	Percent Weft(%)	Cloth Weight
Control	51.28	56.66	95.36	51.28	56.60	95.36
Vetiver root extract	52	61.52	115.20	54.88	63.06	119.40
Vetiver oil microcapsules	53.36	63.68**	117.84**	55.32	66.16**	120.56**

Method of application	Variables	S.Em. ±	C.D. (1 %)	C.D. (5 %)
Exhaust method	Warp	1.141	4.86	3.48
	Weft	1.168	4.57	3.38
	Cloth Weight	1.451	5.68	4.21
Pad dry cure method	Warp	1.22	5.125	3.70
	Weft	1.15	4.53	3.35
	Cloth Weight	1.83	7.18	5.31

** Significant @ 1 % level, * Significant @ 5% level

no significant variation in stiffness of curry leaves and ginger extract treated fabrics (Table 4).

Cloth crease recovery angle of vetiver finished organic cotton fabrics

The crease recovery is one of the elementary property of fabrics which effects product performance. Crease recovery is the ability of the fabric is determined by measuring the crease recovery angle. As the crease recovery angle increases the fabric bending length decreases. Irrespective of source and application methods, all the treated samples showed significantly greater crease recovery angle than the control sample in both the directions *i.e.,* warp and weft way as presented in the Table 5.

Among the treatments and combinations, the fabric treated with vetiver root extract by exhaust (98.24) and pad dry cure methods (106.69) showed greater recovery angle than the vetiver oil microcapsules treated samples by both exhaust method (85.27) and pad dry cure method (85.93) respectively.

Table 4. Cloth stiffness of vetiver finished organic cotton fabrics

Source of application / Method of treatments	Cloth Stiffness (cm)			
	Exhaust method		Pad dry cure method	
	Warp	Weft	Warp	Weft
Control	1.74	2.19	1.74	2.19
Vetiver root extract	1.13**	1.40**	1.14**	1.55**
Vetiver oil microcapsules	1.29	1.42	1.31	1.66

Method of application	Variables	S.Em. ±	C.D. (1 %)	C.D. (5 %)
Exhaust method	Warp	0.046	0.180	0.133
	Weft	0.04	0.180	0.133
Pad dry cure method	Warp	0.053	0.210	0.155
	Weft	0.045	0.177	0.131

** Significant @ 1 % level, * Significant @ 5% level

However, in all the treated samples weft way recovery angle was found to be greater in the fabric finished with vetiver root extract (104) and vetiver oil microcapsules (94.20) by exhaust method followed by pad dry cure method *i.e.,* 107.2 and 94.20

Table 5. Cloth crease recovery angle of vetiver finished organic cotton fabrics

Source of application / Method of treatments	Cloth recovery angle (degree)					
	Exhaust method			Pad dry cure method		
	Warp	Weft	Cloth crease recovery	Warp	Weft	Cloth crease recovery
Control	77.20	83.2	80.14	76.60	82.00	79.24
Vetiver root extract	92.8	104.00**	98.24**	106.20**	107.20**	106.69**
Vetiver oil microcapsules	77.27	94.20	85.27	78.40	94.20	85.93

Method of application	Variables	S.Em±	C.D. (1 %)	C.D. (5 %)
Exhaust method	Warp	1.28	5.54	3.95
	Weft	2.02	7.42	6.23
	Cloth recovery	1.25	5.43	3.87
Pad dry cure method	Warp	2.44	10.56	7.53
	Weft	2.50	10.80	7.70
	Cloth recovery	1.26	5.48	3.90

** Significant @ 1 % level, * Significant @ 5% level

respectively. The warp way crease recovery angle of all the treated samples registered lesser crease recovery value than the weft way. This may be due to combined effect of organic compound present in the source (diethyl pathalate) and the introduction of cross linking agent imparts dimensional stability and elasticity to the fibrous material and makes it crease resistant. The most commonly used cross linking agents for finishes of cotton fabric are citric acid and resins. The citric acid and resin react with the OH groups of cellulose forming cross links which is durable and hence increase the crease recovery of the fabric. The same results are in line with Shilpi (2017) reported that, cross linking agents improved the crease recovery angle.

Conclusion

The organic cotton fabrics treated with vetiver root extract and vetiver oil microcapsules exhibited significantly thicker, heavier cloth weight and greater crease recovery angle than the control sample. The decreased cloth stiffness was noticed in all the treated samples compared to control sample which indicates that the treated fabrics were found to be more flexible and pliable than the control sample. The treated fabrics has resistant to creasing due to the presence diethyl pathalate in vetiver which is good source of plasticizer can be effectively used in textile finishing to overcome the creasing problem in cotton fabric. Among the source of treatment, the fabrics treated with vetiver microcapsules exhibited better mechanical properties compare to vetiver root extract treated fabrics. Whereas, the fabric finished by pad dry cure method showed improved mechanical properties than the treated fabrics of exhaust method of finishing. Irrespective of method of application and treatments, the vetiver oil microencapsulated organic cotton fabric by pad dry cure method possessed excellent mechanical properties than other fabric samples. It can be concluded that, the vetiver powder and oil can be effectively used as crease resistant agent for cotton fabrics.

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