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Full Length Research Paper

Nanoencapsulaed Finishes For Physical and Comfort Properties for Durable 100% Cotton Denim Fabrics

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The garments are more susceptible to wear and tear. It is important to take into account the impact of stress and strain. The following requirements need to be satisfied to obtain maximum benefits out of the herbal finish. To enhance the efficiency of physical properties, comfort properties of 100 percent cotton denim fabrics, finishing with herbal Nanoencapsulated method was done. The properties were analyzed and compared between before wash and after 10, 20 and 30 washes respectively followed by ENISO 20645 standard method. The Nanoencapsulated finished fabrics showed good durable physical and comfort properties. This study concludes that The Fabric count (Ne) in the warp direction and weft direction was increased after the application of the finishes. There was no reduction noticed after washing. The Fabric weight (g/m^2) and the Fabric thickness (mm) were considerably decreased in the finished and the washed sample. The drapabilty of the sample was found increased after washes, along with air permeability increase during washing out of starch and other material from the pores, which resulted in wearing comfort. The maximum crease recovery was noticed in finished samples. Further the stiffness was found predominantly reduced after washing. In turn the above characters enhanced the wearing capacity of the denim fabric free from dermatitis.

Keywords: Comfort properties, Cotton, ENISO 20645, Herbal finish, Nanoencapsulated, Physical properties

INTRODUCTION

Today, in order to protect the environment; the consumers have had a change in their mindset, and have turned towards eco-friendly clothing. Herbal remedies are safer than the corresponding pharmaceutical drugs, also called botanical medicine or Phytomedicine refers to the use of seeds, berries, roots, leaves, bark, or flowers of any plant for medicinal purposes. view Jose (2005).Many efforts have been made to discover new antimicrobial compounds from various kinds of sources such as micro-organisms, animals and plants. One such resource is folk medicine. Systematic screening of these may result in the discovery of novel effective compounds; denote Tomoko et al (2002).

One of the amazing things about denim is that it's been around forever and is still growing in popularity. Antimicrobial fabrics can foster microbial growth in one of two ways. Either passively by inhibiting the growth of micro-organisms through inherent surface structure without the use of agents – linen for example displays such characteristics, as well as lamb wool. Or actively using antimicrobial agents to either kill or inhibit the growth of any microbe present such as in treated denim fabrics, as denoted by Shirley technologies Ltd (2004).The other attraction of 100 % cotton denim fabric is that it is easy to take care of, it does not need starching or ironing after each wash unlike other fabric materials, denote Pujari et al, (2010).

Nanotechnology is an emerging and highly interdisciplinary field based on the ability to manipulate structural materials on the level of individual atoms and molecules, say Anita et al (2010). In today's industrial era, textile is the major industry which markets a range of nanotechnology finished products to the consumers. Textile products are the most popular materials which maintain comfort, easy care, health and hygiene while ensuring protection against mechanical, thermal, chemical and biological attacks on humans, denote Rajendran et al (2009).The objectives of this study are to finish the selected herbal combination on the 100 % cotton denim fabric, To evaluate the physical properties and comfort properties of herbal finished fabric before wash and after 10, 20 and 30 washes respectively.

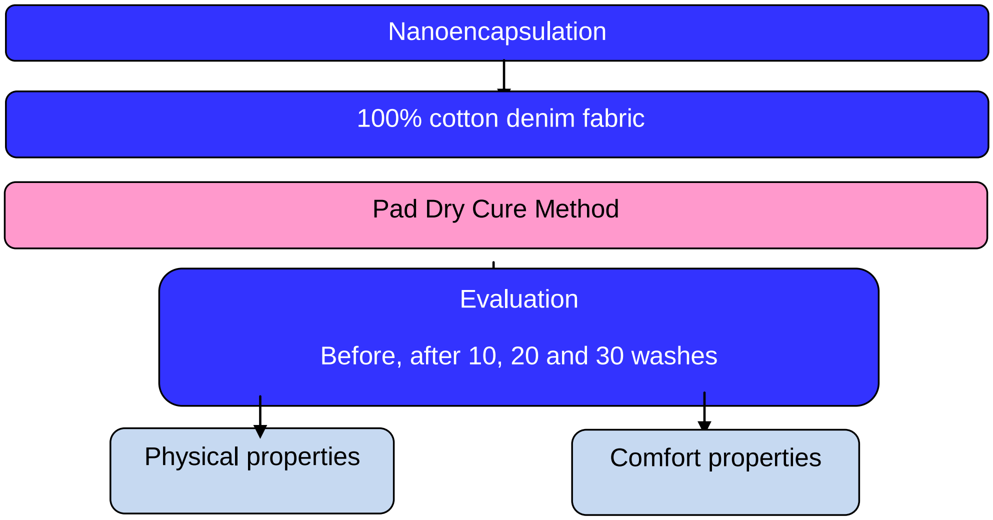

Figure 1: Nanoencapsulation of special finishes and evaluation

MATERIALS AND METHODS

The fabric was sourced from the market with respect to the expected quality requirements. The fabric chosen was 100% Cotton denim fabric (GSM-219.4 g/ m^2, and twill weave) for the application of nanoencapsulation finish. The three herbs used and the best herbal combination was selected to be 1:3:2 of *Ricinus communis, Senna auriculata* and *Euphorbia hirta.* Figure 1.

The herbal extraction was nanoencapsulated and applied on 100% cotton denim fabric, by pad dry cure method, this was evaluated after 10, 20 and 30 washes. The evaluation was done such as, **Geometrical properties-**The geometric properties such as Fabric count, Fabric weight and Fabric thickness were analyzed and **Comfort properties-**The comfort property was determined using the following three tests Drape coefficient test, Air permeability test and crease recovery angle test and Stiffness to fabric.

Nanoencapsulation

Finishing of selected fabric by pad dry cure method

Recipe

Denim fabric	-	4 Meter (100% Cotton)
Nanocapsules	-	2%
Binder (Citric acid)	-	8%
Temperature	-	55˚C
Time	-	30 minutes

The basic process was that the nanocapsules were compounded at a particular ratio and padded on the fabric .The nanocapsules were attached to the fabric with binder. By evaporating water during the drying process in a tenter, it allows only the required ingredients to combine with the fabric.

The Compounded solution consisted of 2% of the nanocapsules with binder citric acid 8% and normal textile chemicals were added, such as softener and anti-static electricity agent and kept in a bath. The fabric was dipped into the compounded solution using a roller. The fabric was sent through a mangler to squeeze the dipped chemicals out of the bath at a certain ratio by the pickup rate when the fabric was passed between the rollers. The heat dryer dried the fabric with heat for evaporating water and maintaining its width. The encapsulation worked inside the fabric, filling the spaces between the fibers with an ultra thin film of polymer creating a permanent barrier that was breathable, yet impermeable to both water and wind.

Wash durability test

The greatest influence was made by washing. During the whole washing cycle, garments were affected by the entire complex of different factors such as a washing solution, abrasion, creasing, heat, various chemicals etc, says Juciene et al (2006). The dip micro encapsulation and Nanoencapsulation finished fabrics were analyzed for wash durability by subjecting the samples to washing by industrial machines and testing. The washed fabrics were assessed by **ENISO 20645** test method.

Geometrical properties

Fabric count

The fabric count was the number of warp and weft yarns per unit distance while the fabric was held without tension and free folds and wrinkles. The number of warp threads/inch was called ends/inch. The threads of weft were called picks and the number of weft threads per inch was called picks/inch. Therefore, a fabric may be described in terms of ends and picks pointed by Angappan and Gopalakrishnan (2010).

Use of counting glass (pick glass)

The counting glass was a small magnifying glass in a stand over a square exactly one inch each way. The number of ends and picks per inch should be counted in five different places and the mean value is calculated .

Fabric weight (ISO 3801: 1977)

The specimen of known area was dissected into warp and weft threads over paper of a color suitable for showing up fragments of yarn from the fabric being tested. When the dissection of the specimen was completed, the non-fibrous matter from the two sets of threads was removed separately by a method described in ISO/TR5090, taking care that no loss of fiber occurred during the process. The threads were and brought into equilibrium in the standard atmosphere for testing, from the dry side by exposing them freely to that atmosphere. The mass of the two sets of threads was determined separately to get an accuracy reset of 0.1%.

From the conditioned masses of warp and weft, free from added matter, and the known area of the specimens dissected, mass per unit area of warp, and weft of fabric was calculated, and each expressed in grams per square meter. The same procedure was repeated for five samples and the mean values were calculated.

Fabric thickness (IS 7702: 1975)

The principle of measuring fabric thickness in B.S.2544:1954: states that essentially, the determination of the thickness of a compressible material such as a textile fabric consists of the precise measurement of the distance between two parallel plates as a pressure foot and the other as the anvil, says Jewel Raul (2009).

The pressure foot and the reference plate were cleaned. The pressure foot shaft was checked for free movement. With the pressure foot so loaded as to exert the appropriate specified pressure on the reference plate, the thickness gauge was set to zero. The pressure foot was raised and the sample was positioned without tension on the reference plate, such that no part of the area to be measured was near the selvedge. The area chosen for the test was ensured that it was free from creases. No attempt to flatten out any creases was made, as it was likely to affect the result. The pressure foot was gently lowered onto the sample; the gauge readings were noted down after 30 seconds. Similarly, the thickness was determined at five places on the sample chosen, containing different warp and weft threads.

Comfort properties

Drape coefficient (%) (IS-8357/1977)

The drape tester was placed firmly on a level table. The light was switched on. The specimen holder was removed from the bayonet socket and a cut fabric specimen was placed between the plates. The stub of the specimen holder assembly was held, and briskly moved up and down ten times, and tested on the table each time, for a moment. A square of ammonia process paper on the base of the instrument was placed flat. The stub of the specimen holder was inserted in the socket on the threaded bolt, pressed upwards and turned counter clockwise to lock the holder in position. Looking along the level of the base board, the height of the drooping edge of the drape specimen was adjusted, so that the lowermost edge was just above the paper without touching it. The setting knob of the timer was adjusted for the required time of exposure. At the end of the exposure time, the ammonia paper was removed, and placed in a developing box containing a few millimeters of strong ammonia solution. When the latent was developed, the paper was removed. The paper was conditioned to moisture equilibrium in standard atmosphere. The drape pattern was cut out with a pair of scissors and its mass determined in gram weight, exact to two decimal places.

Mass per unit area of the paper was determined, by cutting a known area of the original paper and weighing. The specimen was reversed and the drape pattern obtained with the other surface upwards.

The following formula was used to calculate the percentage of drape coefficient.

Drape co-efficient (F %) = W/w-a / A-a *100

Where, mass of drape pattern (gms) = w

Mass/unit area of the paper = W

Area of circle of 12.5 cm diameter = a

Area of circle of 25 cm diameter = A

Drape was the ability of a fabric to fall under its own weight into wavy folds of different nature. Fabric drape can be evaluated objectively as well as subjectively. The same procedure was repeated for five samples and the mean value was calculated.

Table 1: Nomenclature

S. No	Fabric samples	Fabric samples	Abbreviations
1.	ND	Nanoencapsulated sample (finished sample)	100% cotton
2.	ND10	Nanoencapsulated Sample after 10 washes (washed sample)	100% cotton
3 .	ND20	Nanoencapsulated Sample after 20 washes (washed sample)	100% cotton
4.	ND30	Nanoencapsulated Sample after 30 washes (washed sample)	100% cotton

Air permeability test (IS 11056: 1984)

Air Permeability Test (IS 11056: 1984) was based on the measurement of the rate of flow of air through a given area of fabric by a given pressure drop across the fabric denotes Indian standard, 1985.A portion of the conditioned specimen was mounted between the clamp and the circular orifice with sufficient tension to eliminate wrinkles, if any and care taken to ensure that the fabric was not distorted. The suction fan or other means to force air through the fabric was started; the rate of the flow of air was adjusted till a pressure drop of one centimeter water across the fabric was indicated. The rate of air flow was noted in cm^3 /s. The test was repeated at different places. The same procedure was repeated for five samples and the mean value was calculated.

Crease recovery angle (IS 4681: 1981)

The testing equipment was leveled with the help of leveling screws and the spirit level. Level the testing equipment with the help of leveling screws and spirit level. The specimen was folded end to end in half, with its edges gripped in a line with the help of tweezers, no more than 5 mm from the ends the folded specimen was placed on the plate of the loading device and load was applied gently without delay. The load was removed after 5 minutes. The removal of the load should be done in 0.5 seconds. Half of the specimens were folded face to face and the other half back to back. In order to mount, the one limb of the specimen was placed in the clamp of the instrument and the other held by the tweezers, in such a manner to ensure that there was hardly any disturbance. The specimen was thus held for at last one minute before the angle was measured. While the specimen was held by the clamps, adjustments were made such that the suspended limp of the specimen is always in a vertical position or horizontal position depending upon the type of instrument used. The reading of the crease recovery angle was taken after 5 minutes after the load was removed.

The angle of recovery was measured for all the warp way and weft way specimens folded face to face and back to back in the same way. The same procedure was repeated for five samples and the mean value was calculated.

Stiffness to fabric (IS 6490:1971)

Method for determination of stiffness of fabrics as denoted by Indian standard, 1971 the tester was placed on a table or bench so that horizontal platform and inclined reference line were at eye level of the operator. The platform was adjusted, with the help of a spirit level so that it was horizontal.

One of the specimens was placed on the platform with the scale on top of it lengthwise and the zero of scale coinciding with the leading edge of the specimen. The scale was held in the horizontal plane, the specimen was pushed, and the scale slowly and steadily moved, when the leading edge projected beyond the edge of the platform. An increasing part of the specimen would overhang and start bending under its own weight. If the specimen had a tendency to twist, a reference point was taken at the center of the leading edge. The specimen which twisted more than 45 degree was not measured. The length of the overhanging portion was noted from the scale to the nearest millimeter. five readings from each specimen was taken, with each side up, first at one end and then at the other. Similarly, at least five test specimens for each warp way and weft way was tested. The weight per unit area of the fabric was determined, according to IS: 1964-197I and expressed in terms of milligrams per square centimeter. Alternatively the weight per unit area could be determined by weight of all the warp way and weft way test specimens together, after completion of stiffness test. The same procedure was repeated for five samples and the mean value was calculated (table 1).

RESULT AND DISCUSSION

Evaluation of physical Properties

The Figure 2 clearly depict the fabric count of Nanoen-

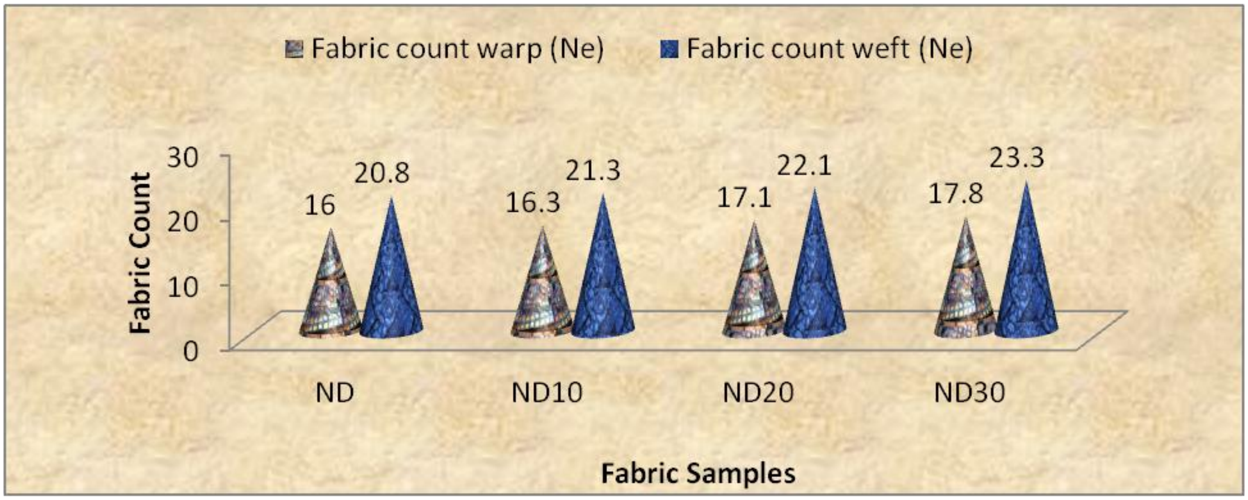

Figure 2: Fabric count (Ne) of nanoencapsulated finished fabrics. Fabric count Warp and Weft (Ne)

Table 2: Fabric weight (g/m^2) `and Fabric thickness (mm) of nanoencapsulated finished fabrics

S. No	Fabric samples	Fabric weight(g/m^2)`	% Loss or gain	Fabric Thickness (mm)	% Loss or gain
1	ND	**219.3**	-	**0.55**	-
2	ND10	217.6	-0.775	0.52	-5.45
3	ND20	215.5	-1.732	0.50	-9.09
4	ND30	210.8	-3.875	0.48	-12.72

Table 3: Drape co-efficient (%) of nanoencapsulated finished fabrics

S. No	Fabric samples	Mean	% loss or gain
1	ND	67.3	-
2	ND10	68	10.40
3	ND20	68.6	1.93
4	ND30	**69**	2.52

capsulated finished fabrics in warp and weft direction on 100% cotton denim material

Figure 2 show the fabric count in warp and weft direction. There was increase in fabric count in sample ND30 (11.25 %) in warp direction and in weft direction (12.01 %) which may be due to shrinkage after washing. Hence it could be concluded that fabric count increased after washing the finished and washed samples. It was because of the slight shrinkage in the fabric which was 100% cotton.

Fabric weight (g/m^2) and Fabric Thickness (mm)

The following Table 2 depict the fabric weight (g/m^2) and fabric Thickness (mm) by Nanoencapsulated method of finishing on 100% cotton denim material.
Nanoencapsulated samples was found in sample ND, which was 219.3(g/m^2) and 0.55(mm). The maximum

values in samples ND10 decreased by 0.77 % and 5.45 %, ND20 by 1.73 % and 9.09 % and ND30 by 3.87 % and 12.72 % respectively. Hence it could be concluded that the fabric thickness and fabric weight decreased in the finished and washed samples.

Evaluation of comfort properties

Drape co-efficient (%)

The following Table 3 and Figure 3 show the Drape co-efficient (%) of Nanoencapsulated method of finishing on 100% cotton denim material.
Figure 3 and Table 2 represent the drape coefficient of

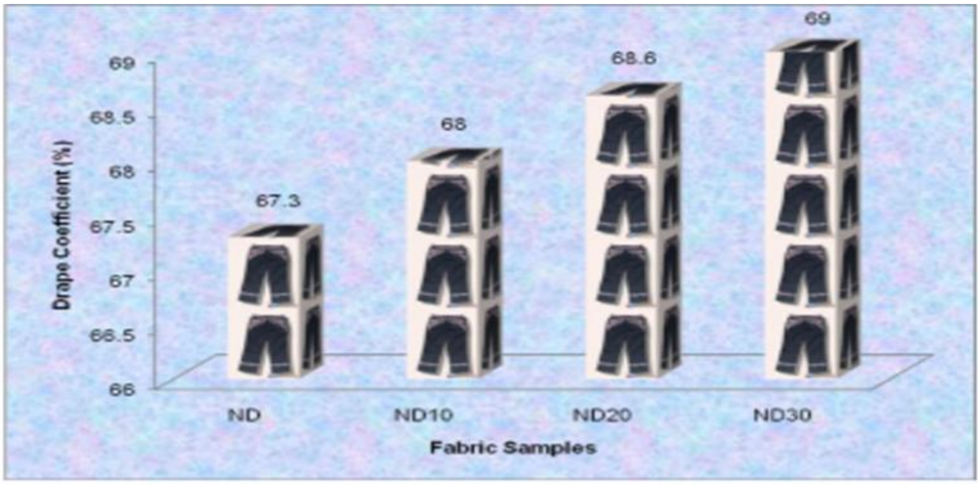

Figure 3: Drape coefficient (in %)

Table 4: Air permeability (m^3/ cm^2/sec)

S. No	Fabric samples	Mean	% loss or gain
1	ND	22.9	-
2	ND10	30.8	34.4
3	ND20	34.4	50.2
4	ND30	**37.5**	63.75

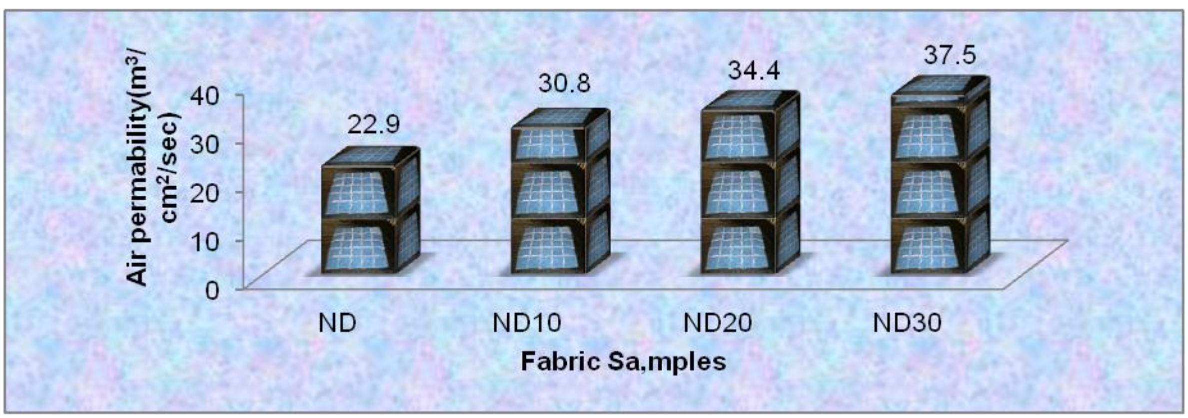

Figure 4: Air permeability (m^3/ cm^2/sec)

the Nanoencapsulated samples that exhibited maximum value in ND30 which was 69 %, followed by samples ND20 of 1.93 % and ND10 of 10.4 %. Hence it could be concluded that drapability increased in washing over unfinished sample.

Air permeability (m^3/ cm^2/sec)

The following Table 4 and Figure 4 depict the Air permeability (m^3/ cm^2/sec) of Nanoencapsulated method finished 100% cotton denim material.

Above Table 3 and Figure 4 represent the air permeability (m^3/ cm^2/sec) of sample ND30 was 63.75 %, which was more after twenty washes to 50.2 % ,and ten washes to 34.4,and for sample ND ,the value was 22.9 m^3/ cm^2/sec. Hence it could be concluded that after several washes, the air permeability of the fabric increased because of the removal of starch, finishes from the pores of the fabric.

Crease recovery angle (degrees)

The following Table 5 and Figures 5 depict the Crease recovery angle (degrees) of Nanoencapsulated method of finishing on 100% cotton denim material (D).

Table 4 and Figure 5 depict the Crease recovery angle

Table 5: Crease recovery angle (degrees) of nanoencapsulated finished fabrics

S. No	Fabric samples	Mean	% loss or gain
1	ND	**186**	-
2	ND10	185	-0.537
3	ND20	183	-1.612
4	ND30	181	-2.688

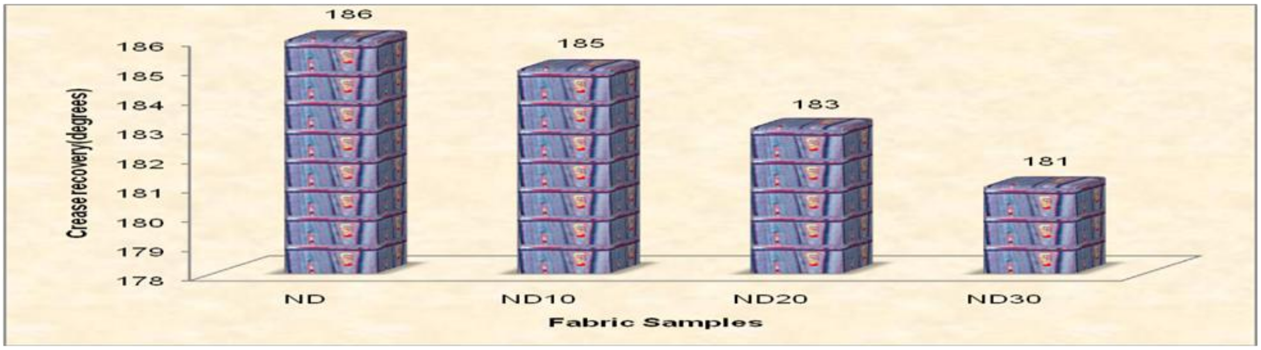

Figure 5: Crease recovery (degrees)

Table 6: Stiffness (mg-cm) of nanoencapsulated finished fabrics

S. No	Fabric samples	Mean	% loss or gain
1	ND	**2126**	-
2	ND10	2105	-0.987
3	ND20	2056	-3.292
4	ND30	2005	-5.691

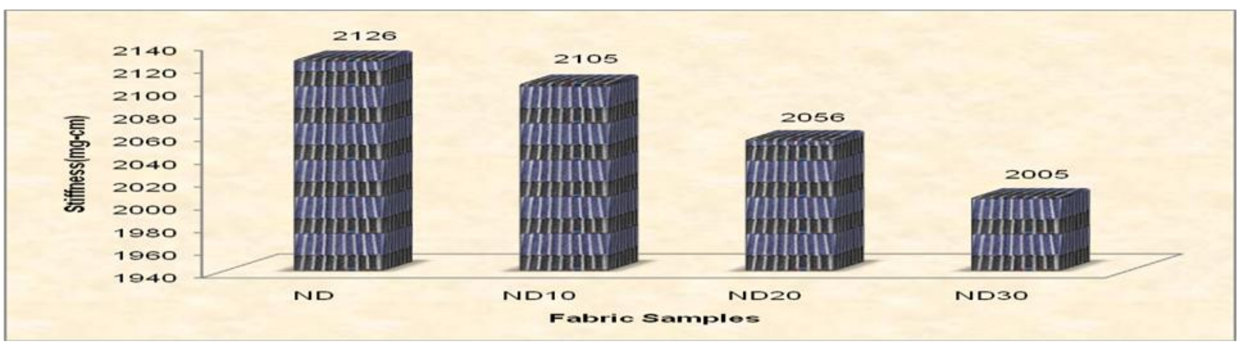

Figure 6: Stiffness (mg-cm)

(degrees) of Nanoencapsulated samples in sample ND with 186^{o}, followed with a decrease in sample ND10 (0.53 %), ND20 (1.61%) and ND30 (2.68 %) over the finished sample. Hence it could be concluded that samples subjected to thirty washes had the minimum Crease recovery over the original sample.

Stiffness (mg-cm)

The Following Table 6 and Figure 6 depict the Stiffness (mg-cm) of Nanoencapsulated method of finishing on 100% cotton denim material.

Table 5 and Figure 6 represent the stiffness of the finished sample ND, which was observed as 2126 (mg-cm).This decreased by 0.98 % in sample ND10, 3.29 % in sample ND20 and 5.69 % in ND30 respectively. Hence it could be concluded that the stiffness reduced predominantly in the fabric subjected to several washes.

CONCLUSION

The eco sensitiveness of the consumer is vastly improving day by day, and the finishing techniques with natural herbal products are gaining momentum. The Fabric count (Ne) in the warp direction and weft direction was increased after the application of the finishes. There was no reduction noticed after washing. The Fabric weight (g/m^2) and the fabric thickness (mm) were considerably decreased in the finished and the washed sample. The possession of drape coefficient (%), Air permeability (m^3/ cm^2/sec) through the fabric, Crease recovery angle (degrees) ,Stiffness (mg-cm) exhibited samples were considered as criterion for the comfort properties. The drapabilty of the sample was found increased after washes, along with air permeability increase during washing out of starch and other material from the pores, which resulted in wearing comfort. The maximum crease recovery was noticed in finished samples. Further the stiffness was found predominantly reduced after washing. After the procedure it was identified by the investigator that the finishing technique by the Nanoencapsulation method in the fabric sample 100% cotton denim fabric possessed all the expected characters like durability of the fabric, increased fabric thickness, weight, drapabilty etc, In turn the above characters enhanced the wearing capacity of the denim fabric free from dermatitis.

REFERENCES

Jose J (2005). Medicinal and aromatic plants,Discovery Publishing House,Delhi, p-162.

Tomoko N, Takashi A, Hiromo T, Yuka I (2002). Antibacterial activity of extracts prepared from tropical and subtropicalplants on methicillin-resistant *Staphylococcusaureus*. J. Health Sci, 48(3): P.p 273–276.

Shirley technologies Ltd, (2004). Denim – created to feel as good as they look, Textile magazine, p:78

Pujari MM, Kulkarni MS, Kadole PV (2010). Bombay to Goa Journey of the denim, Textile review, Vol.5(11), ISSN 0974-2530, Pp. 7-11.

Anita A, Ramachandran T, Rajendran, R, Koushik CV, Mahalakshmi M (2010). Preparation and characterization of zinc oxide nanoparticles and a study of the antimicrobial property of cotton fabric treated with the particles, JTATM, 6(4): Pp.1-2

Rajendran V, Gobi N, Sasipriya K (2009). Functional Nanotextiles, Nano digest, V:P.-32.

Juciene M, Dobilaite V, Kazlauskaite G (2006). Influence of industrial washing on denim properties, Materials science (medziagotyra), ISSN 1392-1320, Vol.12, Issue-4, P-355.

Angappan P, Gopalakrishnan R (2010). Textile testing,SSM Institute of Textile Technology,Kumarapalayam, Pp.271-272.

Jewel Raul (2009). Textile testing, published by APH Publishing Corporation, New Delhi, p.36.