

# ISOLATES APPLICATION OF MULTI-FUNCTIONAL FINISHES ON DENIM GARMENTS

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**Abstract:** *The main aim of this research is to apply the functional finishes to denim garments to enhance the value of the garment. The fabric selected for the research is 100% cotton with the construction of 2/1 Right Hand Twill. The selected fabric was made into garments (A-line frock) and subjected to de-sizing and enzyme washing and then the garments were treated with two different synthetic scents sweet citrus and rose oils to induce fragrance. The garments were also tested for the efficacy of anti-microbial, anti-fungal, UV protection, stain repellency and mosquito repellency finishes. The results have proven very good sense of functional finishes on to the garments in conjunction with a sweet fragrance. Two different methods – dip dry and micro encapsulation methods were chosen for the study and the fastness property of the finishes were compared. The treated garments were evaluated using AATCC standards.*

**Keywords:** *fragrance finish, anti-microbial finish, anti-fungal finish, A-line frock and enzyme washing.*

## 1. Introduction

Denim garments has an evergreen demand among the consumers globally, as it is the only fabric that can be worn during any season and it is both fashion and performance driven as well. Traditionally denim was made as 14 -16 ounce twill woven fabric using cotton ring spun indigo dyed yarn [1, 8]. Recently many variations and adaptations of denim have been introduced in the market that are woven, knitted and dyed. Apart from the innovations in fabrication of denim, value added finishing to garments such as fragrance finish, anti-microbial finish, anti-fungal adds up more value to the product in the current market scenario.

Over the years, many different denim fabric treatments have been introduced, including pre-washed, stone-washed, sandblasted, and vintage but hardly any attempt has been made for a functional finish. In order to impart the required functional properties to fabric, it is customary to

subject the material to different type of physical and chemical treatments. Enzymatic treatment can replace a number of mechanical and chemical operations, which have been applied to improve the comfort and quality of fabrics [2, 3]. The inherent properties of the textile fibres provide room for the growth of micro-organisms [4]. The increasing awareness for hygienic lifestyle, effects of global warming are raising necessity and expectation in consumers for a wide range of textile products finished with antimicrobial properties, UV protection, stain release etc. [5, 7]. In addition, the structure of the substrates, the chemical processes may also induce the growth of microbes. Humid and warm environment still aggravate the problem. Infestation by microbes cause cross infection by pathogens and development odor where the fabric is worn next to skin. The staining and loss of the performance properties of textile substrates are the results of microbial attack [7]. Imparting various finishes in a single fabric may result in incompatibility of chemicals, and hence instead of going for various chemicals and finishes, a single finish which satisfies multi functional properties can be imparted [10]. With this context, the manufactured denim garments were treated with bio-washing using cellulase enzymes. The garments are then treated with a combination of sweet spring citrus oil and rose oil by two different methods like direct method and micro encapsulation. This imparts a pleasant, new-clothing odor which can mask unpleasant odors and is similar in action to a deodorant. The scents of lavender, rose, citrus or vanilla were encapsulated into fabrics which proved a good way to meet important psychological and emotional needs [11]. Then the treated fabric samples are tested for multifunctional activities like antimicrobial, antifungal, stain repellent and mosquito repellency. Then the results of the two samples are compared and contrasted for good efficiency.

## 2. Materials and Methods

### 2.1. Development of Fabric

Light weight cotton denim fabric was manufactured with the following specification

Table 1: Fabric particulars of 100% Cotton denim fabric

Fabric structure	2/1 right hand twill
Ends/inch	124
Picks/inch	70
Warp count	30s ring
Weft count	30s ring
Weight/sq. yard	5.5 oz

using indigo blue dyed yarn in the warp and undyed yarn in the weft.

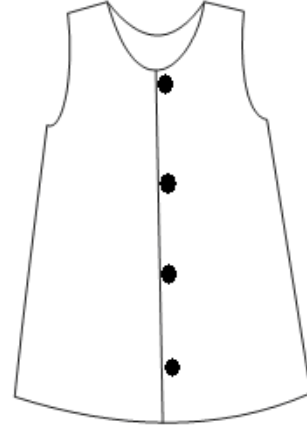


Fig. 1: 2-D Design of an A-Line Frock

### 2.2 .Garment Making

The garment selected for the study was kids wear for the age group 3 - 5 years (girls). The style feature of the garment was an A-line frock with full front open two-piece placket, round necked, sleeveless frock as shown in the Fig. 1.

The patterns for the frock was drafted based on a set of standardized body measurements and a

marker plan was developed in order to reduce the wastage of the fabric. The marker was placed on the developed cotton denim fabric. The fabric was cut and the garments were constructed. Single needle lock stitch machine was used for the construction.

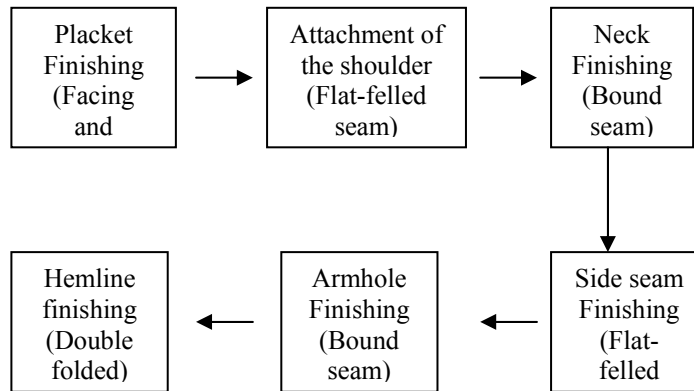


Fig. 2: Garment Construction Sequence

### Method of Desizing:

The A-line frocks developed were subjected to Enzymatic desizing process for removal of size particles. The recipe for desizing the frocks is

given in the Table 2. The process was carried out as per the recommendation of the industry.

The desized garments were washed and rinsed twice after the process.

## 2.4. Enzyme Bio-wash

Bio-wash is a technique involving the use of enzyme to produce soft denim. Enzyme permits accurate control of the process leading to consistent quality of garments in terms of fading, surface smoothness, strength etc. the cellulase enzyme used in the present study was obtained from the commercial available source (S&A impex, Tirupur)

## 2.5 Application of Multi-functional Finishes to the Denim Frocks

The chemicals selected to incorporate multi-functional finish to the denim garments were Sweet spring citrus and rose oil. The odour of the citrus will keep us fresh and gives energy; rose will reduce the tension, fatigue and negative thoughts. The finishing was carried out using two different methods and the same was compared for the efficacy.

### 2.5.1 Direct Finishing Method

In this method the garments which are finished with enzyme is dipped into the bath containing sweet spring citrus and rose oil for half an hour at room temperature. Then the garment is dried in the room temperature. This method is called as dip dry method.

### 2.5.2 Micro Encapsulation Method

The Core material used was sweet spring citrus and rose oil in equal proportion and the wall material selected was sodium alginate. Microcapsules containing Sweet spring citrus and

Rose oil were formed by the addition of 3%

Table 2: Recipe of Enzymatic Desizing

Particulars	Process parameters
Non-ionic wetting agent	0.5 gm/l
Bio-Tempasel (Desizing Enzyme)	0.5 gm/l
Temperature	65-70° C
Time	20 minutes
M:L ratio	1:20

Table 3: Finishing Garments with Enzyme

Particulars	Process parameters
Enzyme used	cellulase enzyme
pH	5- 5.5
Temperature	55-60°C
Time	30 minutes
M:L ratio	1:15

sodium alginate followed by spraying into the calcium chloride solution by means of a sprayer. The droplets were retained in the calcium chloride solution for 15 minutes for hardening of the capsules. The microcapsules were obtained by decantation and repeated washing with isopropyl alcohol followed by drying at 45 °C for 12 hours.

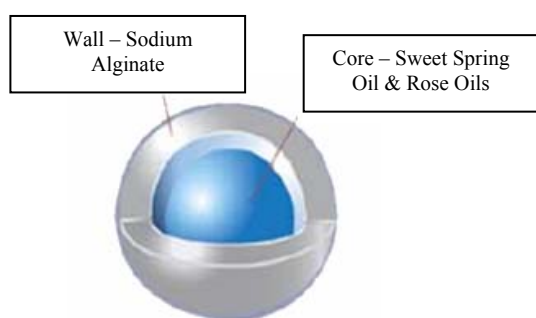


Fig. 3: Microencapsulated Covering Oil

Table 4: Direct Finishing with Sweet Spring Citrus and Rose Oil

Particulars	Process parameters
Chemical used	50% sweet spring citrus and 50% rose oil
M:L ratio	1:5
Wetting agent	1%
pH	6
Temperature	room temperature
Time	30 minutes



Table 5: Microencapsulated Sweet Spring Citrus and Rose Oil

Particulars	Process Parameters
Chemical used	Microencapsulated sweet spring citrus and rose oil
M:L ratio	1:20
Citric acid	8%
Time	30 minutes
Temperature	50°C
Dried	80°C
Drying time	5 minutes in oven
Curing temperature	120 °C
Curing time	2 minutes

In this method the denim garment is dipped into the bath containing microencapsulated sweet spring citrus and rose oil. Then the garment is dried at 80°C temperature and cured at 120 ° C temperatures.

## 2.6 Functional Analysis

### 2.6.1 Antibacterial test - Quantitative Bacterial Reduction Test (AATCC Test Method 100 - 2004)

The Test Organism used was Escherichia coli ATCC 11229 and Staphylococcus aureus ATCC 6538. Initial inoculum is E. coli –  $2.7 \times 10^9$  cfu/ml and S. aureus –  $2.6 \times 10^9$  cfu/ml.

About 5.0 cm diameter of the treated fabric was taken and it was immersed in sterile AATCC broth with 0.1 ml inoculums of each culture (Staphylococcus aureus and Escherichia coli) and left overnight at 37 °C in shaker. Control was also maintained with untreated fabric. AATCC broth with the fabric was taken for appropriate dilutions. The broth was spread plated on AATCC agar plates. The plates were incubated at 37°C for 24 hrs. After incubation results were interpreted. The percentage reduction of bacteria after incubation was calculated by the following formula

$$R (\%) = (B - A) \times 100 / B$$

Where A is the number of bacteria colonies from treated specimen after inoculation over 24 hr contact period and B is the number of bacteria colonies from untreated control specimen

### 2.6.2 Analysis of Antifungal Activity by Qualitative Method (AATCC 30)

An inoculum of 1.0ml was evenly distributed over the surface of the agar. The fabric discs were pre wetted (not rubbed or squeezed) in water containing 0.05% of a non-ionic wetting agent (triton X- 100) and placed on the agar surface. The inoculum of 0.2 ml was distributed evenly over each disc by means of a sterile pipette. All the specimens are allowed to incubate at a temperature of 28°C for seven days.

At the end of the incubation period the percentage of the surface area of the disc covered with the growth of the fungus was reported by observing visually and using a microscopic (40X) and interpreted as follows:

1. No growth (If present, the size of the growth free zone in mm was reported)
2. Microscopic growth (visible only under the microscope)
3. Macroscopic growth (visible to the naked eye)

### 2.6.3 Ultraviolet Protection Factor Determination

The ultraviolet protection of a fabric is expressed by the Ultraviolet Protection Factor, (UPF). The UPF evaluates the reduction in the amount of the UV radiation that passes through the fabric to the skin. For example, when a fabric has an UPF of 20, only 1/20<sup>th</sup> of UV radiation reaches the skin. The AATCC (183-1999) Transmittance or Blocking of Erythemally weighted Ultraviolet Radiation through fabrics using Shimadzu UV/V is Spectrophotometer.

### 2.6.4 Analysis of Stain Release using AATCC 130-2000

Staining of fabrics is the most common problem influencing the Fabric maintenance. Hence the Fabrics were subjected to different stains and then tested for their stain releasing property. Fabrics were stained with three types of vegetable stains and vegetable oils. The stain release was rated after one home laundering tumble-dry cycle (HLTD)

### 2.6.5 Assessment of Mosquito Repellency Activity

The mosquito repellency efficiency of the finished fabric was tested using the modified excito chamber method. Anopheles mosquitoes were identified based on morphologic keys and they were collected during the evening hours. All mosquitoes were starved of blood and sugar of 4 hours before the tests.

uniform across the clamped width. Uniform and equal tension was achieved by attaching an auxiliary clamp to the bottom of the specimen and at the point below the lower clamp of the testing machine. The lower clamp was tightened and auxiliary clamp was removed. The machine was operated to break the specimen. The breaking force was read from the testing machine indicating mechanism.

Table 6: Quantitative Bacterial Reduction Test

S.No	Type of Bacteria	Bacterial reduction (in %)	
		Direct method	Micro encapsulation method
1.	Staphylococcus aureus	>99.99	100
2.	Escherichia coli	99.42	>99.99

## 2.7 Physical Testing

### 2.7.1. Abrasion Resistance

The design of the instrument makes use of the principle of two simple harmonic motions working at right angles. The instrument can be used for getting circular or linear motion. The pressure of Abrasion and type of abrading can be changed.

The abrasion property was tested with the help of Martindale Abrasion Tester. Initially, the fabric samples were prepared and then weighed. Then fabrics were abraded for 50 cycles, after which the fabrics were weighed, then the differences in the two weights i.e. fabric before abrading and after abrading was calculated and finally the percentage weight loss was calculated.

### 2.7.2 Tensile Strength (Grab Test – ASTM D 5034-95 2001)

A tensile testing machine was used to determine the breaking strength and elongation of most textile fabrics. The specimens were conditioned to moisture at equilibrium as directed in ASTM D 1776. This test was performed either wet or dry and samples were cut in both the warp and weft directions. The specimen was mounted in the clamp of the testing machine. Care was taken that the specimen was centrally located and the long dimension was as nearly parallel as possible to the direction of force application. It was made sure that the tension on the specimen was

### 2.7.3 Tear Strength (ASTM D 1424-96)

The tearing strength of the treated and untreated fabric was measured by the tongue (slip rip) procedure-using constant – rate – of – extension tensile testing machine. The specimens were conditioned in the standard atmosphere at a temperature of  $21 \pm 1$  °C ( $70 \pm 2$  °F) and  $65 \pm 2\%$  relative humidity. A rectangular specimen was cut in the center of a short edge to form a two – tongued (trouser shaped) specimen, in which one tongue of the specimen was gripped in the upper jaw and the other tongue was gripped in the lower jaw of the tensile testing machine. The separation of the jaws was continuously increased to apply a force to propagate the tear. At the same time the force developed was recorded. The force to continue the tear was calculated from autographic chart recorders and microprocessor data collection systems.

## 3. Results and Discussion

### Assessment of Functional Properties

#### 3.1.1 Antibacterial Assessment by Quantitative Bacterial Reduction Test (AATCC Test Method 100 - 2004)

The finished cotton denim is then assessed by the quantitative bacterial reduction test (AATCC test method 100 - 2004). The finished fabric reduces the bacteria in the flake. Both the finished fabric reduces the bacteria in the flake. From the Table 6 the fabric shows more or less the same

reduction level of bacteria. It is proven that the finished fabric not only inhibits the growth of bacteria but also reduces the bacterial activity

### Analysis of Antifungal activity by Qualitative Method (AATCC 30) Against

#### *Aspergillus Niger* (AATCC 6275)

The antifungal activity of the finished fabric is analyzed by the qualitative method (AATCC 30). The finished cotton denim fabric inhibits the growth of the fungi completely. Both the finished fabric has 100% antifungal activity. Table 5 shows the result of the antifungal activity by qualitative method of the finished fabric.

### 3.1.2 Determination of Ultraviolet Protection Factor

UV protection of the finished fabric is determined by the AATC-183-1998. Cotton denim fabric has excellent UV protection category. Both the fabric has same percentage of Ultraviolet protection. The finished fabric not only has antimicrobial activity but also has excellent UV protection which is necessary for a kids wear.

### 3.1.4. Analysis of Stain Release using AATCC 130-2000

Fabrics were stained with five different types of vegetable stains. The stain release was rated after one home laundering tumble-dry cycle (HLTD). The stain release property of the finished fabric is determined by AATC 130-2000. The stain such as vegetable stain, soil and saffron are released completely in the tumble wash from both the finished fabrics. The stain such as vegetable oil and pickle are not completely removed. Apart from the antimicrobial, UV protection activity the finished fabric also has stain release property.

Table 7: Analysis of Antifungal Activity by Qualitative Method

S. No.	Antifungal activity (Mycelial reduction - %)	
	Direct method	Micro encapsulation method
1.	98	100



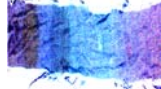

Table 8: UV Protection Factor Determination

UV factors	Methods	
	Direct	Micro Encapsulation
Average % UV blocked	97.5	98.0
UPF range for classification category	40 – 50+	40 – 50+
UV Protection category	Excellent	Excellent

Table 9: Rating of Stain Release

S. No	Type of Stains	Methods	
		Direct	Micro Encapsulation
1.	Vegetable	5	5
2.	Soil	5	5
3.	Pickle	1	3
4.	Saffron	5	5
5.	Vegetable oil	2	4

Table 10: Stained Fabric Samples

S.No	Fabric condition	Direct method	Micro Encapsulation method
1.	Stained samples		
2.	After wash effect		

**3.1.5. Assessment of Mosquito repellency activity**

Assessment of mosquito repellency activity of the finished fabric is carried in the Excito chamber. Table 11 shows that The cotton denim fabric finished using direct method showed 92%

of mosquito repellency whereas the fabric finished using Micro encapsulation have shown 96% of repellency. From this it may also have anti-insect repellency. So this type of finished fabric is also recommended for the home textiles.

Table 11: Repellency of Mosquito

S.No.	Mosquito repellency factors	Finishing Methods	
		Direct	Micro encapsulation
1.	No. of specimen Exposed	25	25
2.	No. of specimen in the cage	2	1
3.	No. of specimen Escaped	14	15
4.	No. of specimen Dead	9	9
5.	Mosquito Repellency in %	92	96

**3.2 Wash Durability Assessment for Direct and Microencapsulate Finished Garments**

The finished garments were washed forty times and the fabric was tested for its fastness properties. From the above table it is clear that the durability of the finish is retained only upto 20 washes in case of direct finished fabric, where as it is retained to 46% and 28% in Micro encapsulation method for S.aures and E.coli respectively. The fastness property of the functional finish is more in case of Micro encapsulation method than in direct method.

**3.3 Assessment of Physical Properties of Finished and Unfinished Garments**

The fabrics from the garments finished by direct method and encapsulated finish were tested for its physical properties to compare within the both and with that of the original unfinished fabric. From the above table it is more obvious that there are only negligible variations in the physical properties of the fabric after finishing. The garment finished in the direct finishing method is highly affected in the abrasion resistance and tensile strength. The garment finished by Micro encapsulation method shows less deviation in the physical properties.

Table 12: Wash Durability Test of Anti-bacterial Activity

No. of washes	Antibacterial activity in Bacterial reduction %			
	Ordinary finishing method		Micro encapsulation finishing method	
	S.aureus	E.coli	S.aureus	E.coli
0	>99.99	99.42	100	>99.99
5	87	77	98	96
10	63	62	87	81
15	59	28	83	72
20	41	18	71	58
25	24	0	65	42
30	0	0	46	28



#### 4. Conclusion

The combination of perfume oils (sweet spring citrus oil and rose oil) used in the present study has successfully resulted in multifunctional activities such as Antimicrobial, Antifungal, UV protection, Stain repellence, Mosquito Repellence and Fragrance as well. As denim apparels are worn by the consumers for an extended period of time, this attempt of applying multi-functional finishes to denim garments will pave a new way to denim industry in satisfying the needs and requirements of their customers. The results have proven that the finish applied to the light weight denim fabric has proved only negligible changes its normal physical and functional properties. The wash durability test concludes that the functional activities are retained for more washes in Micro encapsulation than ordinary finishes. Hence, the studies have also proved that the garment subjected to micro encapsulated finish have proven the best durability of functional finish than the direct finishing method. The present investigations have formed the fundamental aspects in Denim Finishing, which is found to be rare in denim industries. Hence, from this research it is clearly evident that there is wide scope and opportunities for commercialization of this technology by the denim industries to develop value added denim products.



Dr. T. Ramachandran has completed his under B.Tech, M.Tech and Ph.D in Textile Engineering from PSG College of Technology. He is having 25 years of teaching and research experience at PSG College of

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