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Hygienic Super Absorbent Terry Towel

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Abstract

In this research work more emphasis was given to improve the absorbency of terry towel along with imparting anti-microbial property to terry towel fabric. The piles which was chosen were given pre-treatment process followed further with various concentration of citric acid and sodium hypophosphite. This treatment with citric acid leads to crosslinking of the interstices in the yarn thus providing more space for the accommodation of more amount of water. This treated fibers creates a hydrophilic networks which not only absorb but retain the huge amount of water within it. This chemical modification which was achieved by hydrophilic group increases the uptake of water within hydroxyl group of cellulose molecule. The whole fabric along with base and piles were treated with different concentration of aloe-Vera gel showed good anti-microbial property.

Keywords:* *Super absorbent fibers; Water retention value; Citric acid; Scoured and bleached

Introduction

In our day to day life the products used by us are not giving that quality and comfort as it is expected so an attempt was made to give the comfort property to the product along with hygiene factor. It has been found that absorbency is a factor playing important role in manufacturing of terry Towel. The transportation of water in this fiber is accompanied by capillary action with swelling action of fibers. This desired need showed the path for the development of superabsorbent fibers which absorb water to 100 times then its own weight further this lead the application of superabsorbent which may be used in various fields such as feminine care products like baby diapers and hospitals disposable.

The primary function [1] of superabsorbent is not to increase absorbent capacity but to immobilize the fluid and prevent it from being squeezed out under pressure. They do not make the fabric feel harsh even at high level. Superabsorbent fabric will absorb many times own weight under pressure and they will retain the absorbed liquid when subjected to pressure. They swell many times as they absorb fluids and they extract moisture from non-aqueous fluids, whether that is gas or liquid.

Absorbency depends mainly [2] on osmotic pressure, ionic impulsion, and elasticity of the polymers. Thus super absorbents are cross linked network of hydrophilic polymers with high capacity for water uptake. The absorbency of superabsorbent depends not only on the nature and density of the hydrophilic group but also on the density of cross linking forming the three-

dimensional network. It is used to lock in wetness and keep it away from the skin which minimizes rash and irritation and provide consumers with comfort, and peace of mind.

This research [3] explores fundamental physics, chemistry, and engineering principles to understand how liquids wet, permit/flow, and reside in the Nanoporous fibrous structure to develop a product which can be used for industrial application and commercial application.

A correlation between [4,5] absorbency [water retention] and structural characteristics of cellulose fibers has been reported by Krassig, IE retention α 1/[crystallinity] -orientation] based on this theory a reduction of crystalline regions and lower degree of orientation of cellulose molecules should be favorable to achieve improved absorbency. The degree of affinity that exists between water molecules and long chain molecules in the fiber determines the uptake of aqueous fluids in the polymer network. This phenomenon is called absorbency and it can be employed mechanically by entraining fluid in the fibrous material. Absorbency follows capillary mechanism in which transportation of fluid to the superabsorbent take place via capillary action and its rate depends upon granular size of the particle, polarity, crosslink distribution, surface energy and particle porosity.

Materials and Methods

Materials

Citric acid and catalyst sodium hypophosphate was available in processing lab of PSSGL, Shirpur fabric**.** It was made available from Ruby cotex, Shirpur (Integrated Textile Park) which was already scoured and bleached. It was produced on Jacquard with 250 gm. Characterization. The absorbency test of the yarn was carried out by few tests like Spray Test, wicking test sinking, and Drop Test in PSSGL Lab, Shirpur. The test of absorbency was carried out according to ASTM961standards.

Testing methods

The standard test methods are followed which are as below:

1) Spray test.
2) Wicking test.
3) Sinking test.
4) Drop test.

Method

Scouring and bleaching was carried out in Ruby mill itself and further it was treated with absorbency increasing agent with the help of Padding mangle. The anti-microbial treatment was applied to terry towel with padding mangle followed by cold wash, hot wash, and cold wash.

The absorbency increasing agent was taken as citric acid, which was applied in the concentration of [2%, 4%, 6% and 8%] and sodium hypophosphate as a catalyst was taken with the concentration 1%, 2%, 3% and 4% with MLR of 1:30. Then the

fabric dipped in a solution of citric acid and sodium Hypo Phosphate was passed through a padding mangle. Further this sample was treated with *Aloe-vera* gel having concentrations of 3%, 6%, 9% and 12%.

Absorbency increasing agent

The absorbency increasing agent was taken as citric acid and sodium hypo phosphate which was applied to scoured and bleached fabric having concentration of 2%, 4%, 6%, 8% and 1%, 2%, 3% and 4% respectively. This citric acid along with catalyst like sodium hypophosphate increases the cross linkage in cotton cellulose.

The test was carried out on terry and the best result was selected, out of this only one concentration i.e. 10% for citric acid was found good, which gave the best result for increasing the absorbency of terry towel.

Application of citric acid

Scoured and bleached terry towel was treated with citric acid with 2, 4, 6, 8% with 90º for 60 min with the help of padding mangle as shown in TABLE 1.

TABLE 1. **Treatment of bleached terry towel.**

1	Terry Towel	Scoured and bleached
2	Citric Acid	2, 4, 6, 8
3	Sodium hypophosphite	1%, 2%, 3%, 4%
4	*Aloe vera* gel	3%, 6%, 9%, 12%

Result and Discussion

For the qualitative assessment of absorbency, cotton samples [yarn and piles] were treated with citric acid and sodium hypophosphate which was used as a mordant which increases the cross linkages in cellulose. Untreated cotton shows less intake of water. For Testing the absorbency of the piles of the terry towel some test were carried out which were like Spray test, wicking test, sinking test and Drop test by using few grams of treated and untreated sample [6-9].

In this work an attempt has been made to study the pile yarn of terry towel with different concentration of citric acid in the presence of catalyst like sodium hypophosphite for making this terry fabric super absorbent. It has been found that the best antimicrobial agent is *Aloe vera* and it has shown the best antimicrobial and anti –fungal properties when treated with various concentrations [10-12].

TABLE 2**. Effect of citric acid on terry towel.**

S. No	Water in ml	Citric acid [%]	Sodium Hypophosphate [%]	Water absorbed	Absorbency [%]
1	50	untreated	untreated	20	40
2	50	2	1	25	50
3	50	4	2	28	56
4	50	6	3	29	58
5	50	8	4	35	70

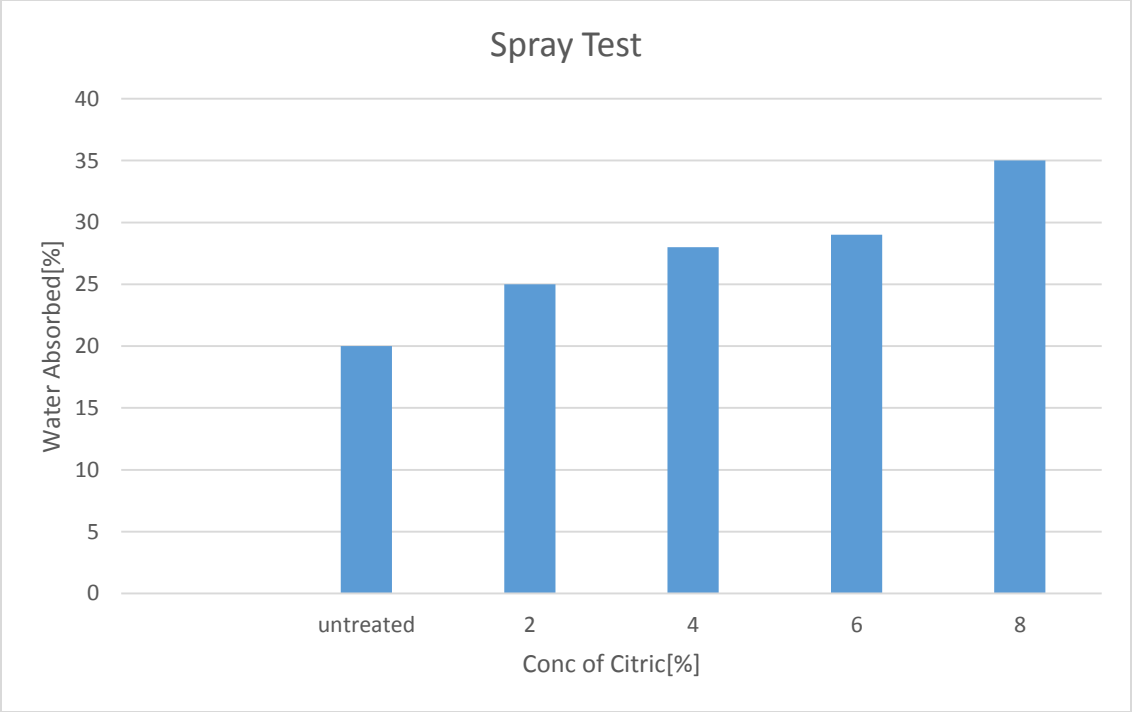

FIG. 1. **Graph showing effect of citric acid on terry towel.**

1. Spray test

As per TABLE 2 and FIG, 1 it was observed that when samples treated with higher concentration of citric acid showed good result of absorbency which was analyzed by spray test. In this method, the sample was fitted in in a ring and was mounted 45 degree on an inclined surface where the water of 50 ml was dropped on its surface. The water was drop in the form of shower throughout the surface which was covered in ring. The amount of water which slide down was collected and recorded. The fabric which absorbed much water was marked as the sample with higher absorbency. The sample which was treated with 8 % concentration of citric acid and 4% concentration of sodium hypophosphate showed good result, this absorption of water may be due the formation of more amount of amorphous region and contraction of crystalline region. It was found that at higher side of concentration of these chemical more rooms are created for the water molecule to stay in the internal structure of the fiber.

2. Wicking test

In this test the sample was cut with dimension of 10 × 2 cm and was put on a wall of beaker having half filled with water containing blue colour. Horizontal strip was marked at the bottom and was dipped in the beaker till this mark. After 5 minutes the water started rising above the marked line which is 2 cm from bottom. The level to which water raised upward was recorded. This raised water was marked and the distance was measured from the marked line till it has been reached in 5 minutes, the results which are obtained are shown below in TABLE 3 and FIG. 2.

TABLE 3. **Wicking test.**

S. No	Citric Acid [%]	Sod. Hypophosphate. [%]	Water Raised [Cm]	Water Raised [%]
1	Untreated	Untreated	4	60
2	2	1	6.8	83
3	4	2	6	80
4	6	3	7.2	92
5	8	4	6.3	88

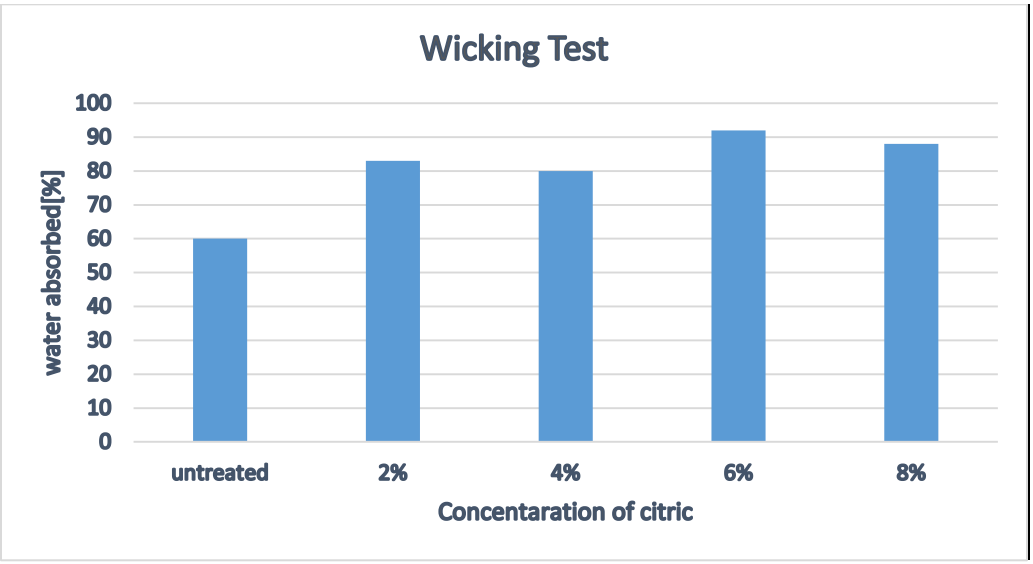

FIG. 2. **Graph showing wicking test.**

It has been observed that the sample which was treated with higher concentration of citric acid showed good results which were observed in the level of water raising in the strip. The sample which was not treated with chemicals like citric acid and sodium hypophosphate does not show any increase in wicking behavior. The sample with 6% concentration of citric acid and 3% concentration of sodium hypophosphate showed good result, increase in wicking property may be due to the reason that there might be formation of capillaries in the internal structure of cotton fibre which make the water molecule to raise up to certain height. Samples treated with 6% concentration raised the level to its maximum value within the stipulated time. Thus we can say that the sample treated with this chemicals increase the absorbency level of cotton piles which are attached to the base fibre.

3. Sinking test

In this test the loops/piles of the terry towel which were treated with citric acid and sodium hypophosphate were cut and put on the surface of the water. The samples which were not treated with chemicals float on the surface for more time whereas the sample which was treated sink to the bottom of the beaker in less time. The sample which goes down to the bottom in less time is showing higher absorbency, this increase in absorbency may be due to more opening of the spaces in the fibre structure which makes the water molecules to rush inside the structure of piles of yarn and make it to sink faster. As shown in TABLE 4 and FIG. 3.

TABLE 4: **Effect of citric acid on terry towel.**

S. No	Citric Acid [%]	Sod. Hypophosphate [%]	Sinking Time [Sec.]
1	Untreated	Untreated	180
2	2	1	46
3	4	2	26
4	6	3	9
5	8	4	12

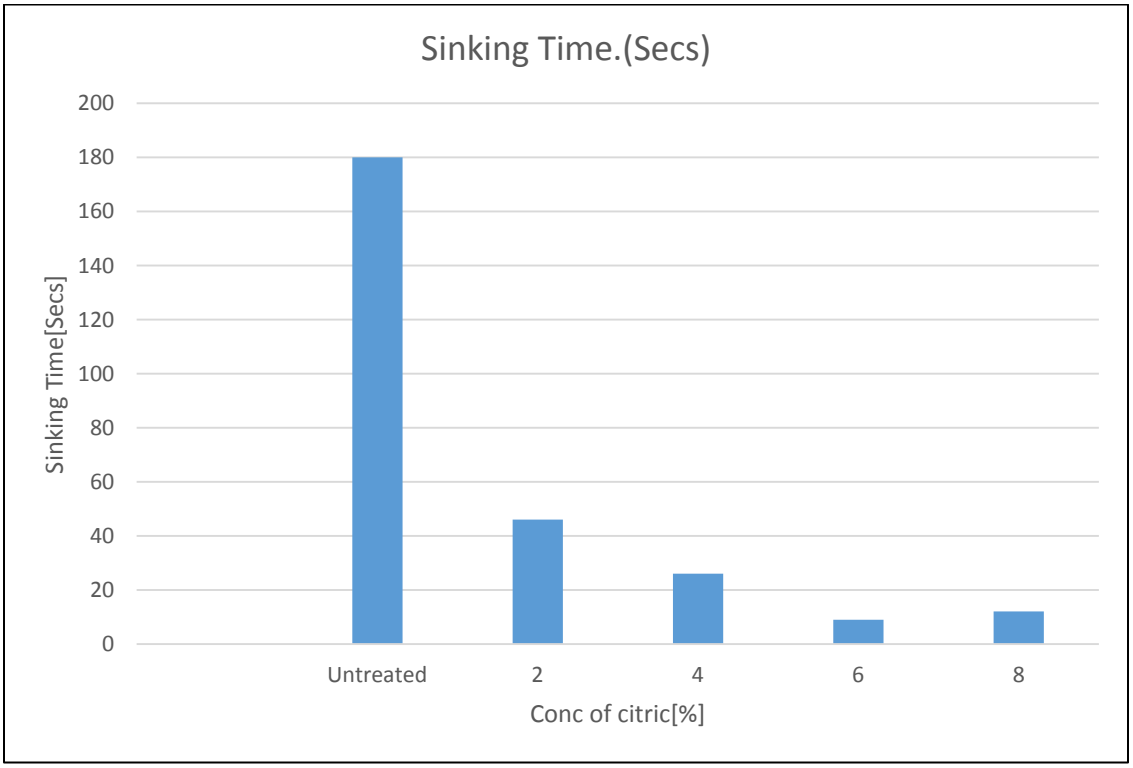

FIG. 3. **Graph showing effect of citric acid on terry towel.**

4. Drop test

In this method drop of water is put from a fixed height with the help of dropper on the surface of the fabric, the time for the water molecules to percolates and pass in the piles of the terry is noted down in seconds. It was found that the samples which were treated with chemical showed good absorbency whereas for untreated sample the absorbency level does not show much difference.

As the chemical makes the opening of the pores on the surface of the yarn and due to this reason the drop of water which was dropped gets absorbed at the faster rate on the treated sample. It represents in TABLE 5 and FIG. 4.

TABLE 5: **Effect of citric on drop test.**

S. No.	Citric Acid [%]	Sod. Hypophosphate [%]	Time [Sec.]
1	Untreated	Untreated.	3
2	2	1	2.2
3	4	2	1.5
4	6	3	1
5	8	4	1.2

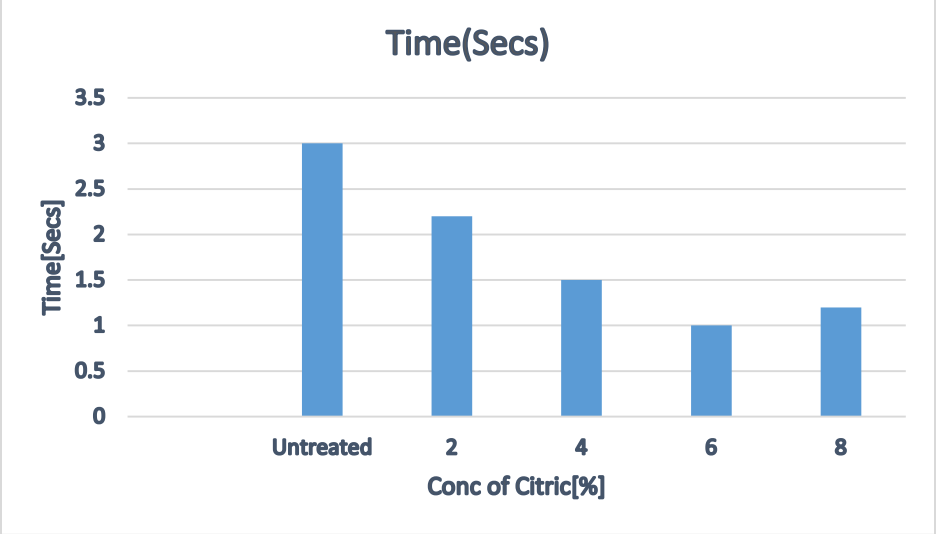

FIG. 4. **Graph showing effect of citric on drop test.**

5. Anti-microbial treatment

It has been found that *Aloe vera* is one of the best anti-microbial agents which restrict the growth of microorganism on the surface of the fabric. This prevention of growth of the microbes not only deteriorates the quality of the fabric but also stop the odor of the fabric which is liberated after some time.

As shown in TABLE 6, this fabric was treated with different concentration of *Aloe vera* with 3%, 6%, 9% and 12% and the samples were given to pharmacy Lab for testing this antimicrobial property. The sample was treated conditioned with culture of *E. coli*. The sample were kept for conditioning in room temperature for seven days and the growth of the microbes were observed under microscope (FIG. 5 and 6).

TABLE 6. **Samples of antimicrobial-treatment.**

S. No	Fabric	Treatment
1	Terry Towel	Untreated
2	Terry Towel [A%, B%, C% and D%]	3%., 6%, 9% and 12%

FIG. 5. **Sample: Untreated and sample A, B, C and D, treated with 35.6%, 9% and 12% conc of *Aloe vera*.**

Formation of colonies

Untreated sample

FIG. 6. **Untreated sample.**

Untreated sample

In this sample there was formation of more colonies found which clarifies that the growth of the microbe's takes place, when does not treat the sample with *Aloe vera* gel. This activity of growth of bacteria increase to higher level and this leads to the formation of more colonies which are cultured with *E. coli* bacteria. This growth not only deteriorates the quality of the fabric, but also foul smell is coming from this fabric which leads to the cause of un-hygienic terry towel.

Sample "A"

FIG. 7. **Sample A.**

Sample A: In this sample, as shown in FIG 7 it was found that it was treated with 3% concentration of *Aloe vera* and this samples showed the good result as compared to other samples. The growth of microbes on these samples was not seen this showed good anti-microbial properties. There is restriction in the formation of the colonies on the terry fabric which may be due to high resistance activity of *Aloe vera.* Thus as per TABLE 7, we can say that at 3% concentration of Aloe-Vera stop the growth of microbes on the fabric.

TABLE 7. **Observation table.**

S. No	**Sample treated with *Aloe vera***	**Occurrence of bacteria**	**Result**
1	Untreated	Found higher colonies formation.	Positive.
2	3%	Not found	Negative
3	6%	Very Less found	Negative
4	9%	Some more found	Negative
5	12%	More no of colonies found.	Positive.

Samples "B","C" and 'D" were also kept for the conditioning and it was found with formation of the colonies on the lower side whereas untreated sample showed growth of bacteria.

Sample "B"

FIG. 8. **Sample-B.**

Sample B: As per FIG. 8, in this Sample "B" there was less formation of bacteria seen; the sample treated with *E.coli* culture start forming colonies after duration of 7 days. The sample was put with drop of water after few days, the necessary condition for the growth of bacteria is moisture and the condition was created in all the samples. It was found less formation of the colonies in this sample and thus we can say that there was little growth of these bacteria seen.

Sample "C"

FIG. 9. **Sample-C.**

Sample C: As per FIG. 9, this sample "C" was treated with 9% concentration of *Aloe vera* and the kept for conditioning for 7 days. This sample showed very less growth but compared to sample "A" and Sample "B" there was some colonies seen. This increase in formation of the colonies is found more sample "c" which may be due less resistance to growth of bacteria as we

increase the concentration of *Aloe-vera*. This raise in growth of bacteria suggests that as the concentration of *Aloe Vera* increases, it does not support the anti-microbial activity and some colonies start forming.

Sample "D"

FIG.10. **Sample D.**

Sample D: There was formation of the colonies in sample "D", as per FIG. 10, this may be due to less resistance to the growth of the bacteria at this higher concentration. In sample "D" there were more colonies formed as compared to sample A, B and C whereas for "untreated" sample showed higher number of colonies. The reason of formation of more colonies in sample D may be due to support of more growth in formation colonies, at this higher concentration of *Aloe vera* does not sustain the ability to restrict the growth of this microbes.

Conclusion

It is sure that in the new era, superabsorbent fibers will occupy an important place. Many researchers are attempting to widen the use of superabsorbent such as for absorbing water in household goods, food products and medical devices. In the above treated sample it was found good antimicrobial property in sample "A" which was treated with 3% concentration of *Aloe vera*. The sample which show good absorbency showed formation of colonies which may be due to the reason that more availability of space and requirement of necessary condition for their bacterial growth which facilitate the formation of colonies. This superabsorbent fibers offer exciting prospects for the development of new textile product both for existing market and completely new markets. This superabsorbent with its cross linked hydrophilic polymers is used primarily in disposable baby diapers but this still are used in adult incontinence as well as in feminine hygiene products. Super absorbent materials are the versatile, natural, biodegradable and renewable ones that have many commercial applications

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