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Influence of Structural Parameters on Moisture Management Properties of Terry Towel

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Abstract

Towel is basically a fabric which is used for wiping the body. Towels can be of many types like hand towels, bathing towels, golf towels and baby towels. The main characteristics of the towels is that it should have good moisture management properties. The moisture management properties of the towels can have increased by pile structure. The main objective of this work is to study of the factor which influence the moisture properties of the terry towels based on 100% cotton fibres. Wicking, water absorption, moisture management, dry rate and tensile properties are studied in this research work. According to the results these properties are influenced by the fabric weight, thickness and pile yarn twist

Keywords: Towels, pile, pile height, twist

1. Introduction

Towels are one of the most used textile structure of terry woven fabrics in water related usages [1]. Terry towels are used by the peoples globally in various places including bathroom, sports, swimming pool, kitchen etc. with different absorption characteristics [2].The users prefer that ready-made bathrobes and towels be comfortable and fresh, made of a light and soft structure, remain dry as they quickly transfer the water and sweat accumulated on the body, and be hygienic and naturally formed [3].

Terry towel is a fabric with loops on the surface either one or two sides of the fabric that can absorb huge amount of water compared to conventional structure (planar woven fabric with warp and weft yarns). Terry fabric or fabric with loop piles can be produced using both weaving and knitting technology [4,5]. Generally, three different yarn components are involved in the production of pile fabrics namely weft, ground and pile warp yarns.The absorptive capacity of terry fabrics predominantly depends upon the material (fibre type, yarn type, yarn twist, etc.) and structural parameters (pile height and warp-weft density) [6].Therefore comfort, an important property for the textile products, is also an important need for terry fabrics in water-related usage[7-8]. However, the comfort properties of terry fabrics such as towels should be specific. The comfort parameters of air permeability, water vapor permeability, liquid transfer velocity, drying time, and water absorption will stand out in such products[9-10].

2. Material and Methods

It could be seen from the Figure1 that the fabric construction of all the three terry towels are almost similar with same base fabric construction. The variation in the position of face pile and back pile ends causes a small difference in the structure which will not be having any effect in the change of properties.The structural properties of terry towels are shown in Table1

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2.1 Basic Structural Parameters

Table1 Basicstructural parameters of terry towels

Sample	Yarn linear density			EPI	PPI	Crimp (%)		Pile warp TPI	Fabric thickness	Pile density	Pile height	Terry ratio	Density
	Ground warp	Pile warp	Weft			Warp	Weft						
S1 V	10	17	12	68	40	8	15	15.76	2.81	226	3.5	4.56	400
S2 G	21/2	20/2	17	64	40	4.2	11	9.03	1.72	208	4.68	3.45	415
S3 MC	21/2	14	17	64	42	7.9	11	15.91	2.73	235	4.61	4.94	461

Figure 1 (a) S1   Figure 1 (b) S2   Figure 1 (c) S3

Figure 1 Terry towels

3. Results & discussion

3.1 Wicking behaviour

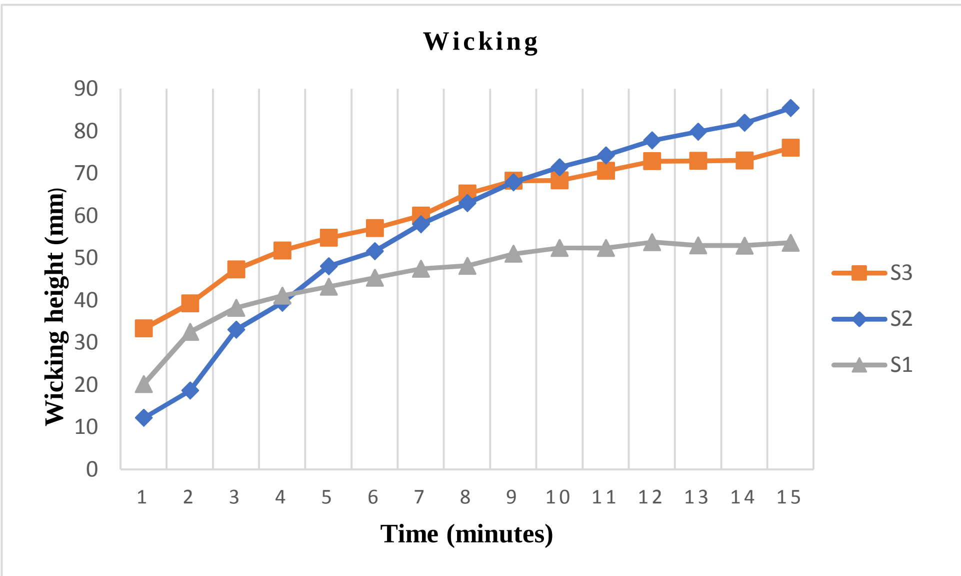

Figure2 Effect of time on wicking height for terry towels

Figure 2 shows the effect of time on wicking height for different terry towels. The initial rise in the wicking height for the S2 sample is lower than the other samples. It is rising rapidly over the time and even after 15 minutes of time it has not reached the saturation level while the other samples already reached to the saturation level. This can be due to the S2 pile which is made of doubled yarn, which supports more capillary flow. S2 samples also have lower crimp as shown in Table 1. Lower crimp also supports wicking because capillary flow is not interrupted by the bending of yarn. One more factor which contributes to the higher wicking is pile height. Increasing pile height increased the wicking height. The capillary forces that act upon the capillary spaces in the fabric structure causes wicking. All these factors improve the wicking behaviour of S2 sample.S1 shows the lowest wicking behaviour that can be due to the poor loop shape factor and higher yarn twist. Higher terry ratio and higher pile density with higher loop shape factor together contributes for higher wicking behaviour of S3 than S1.

3.2 Water absorption behaviour

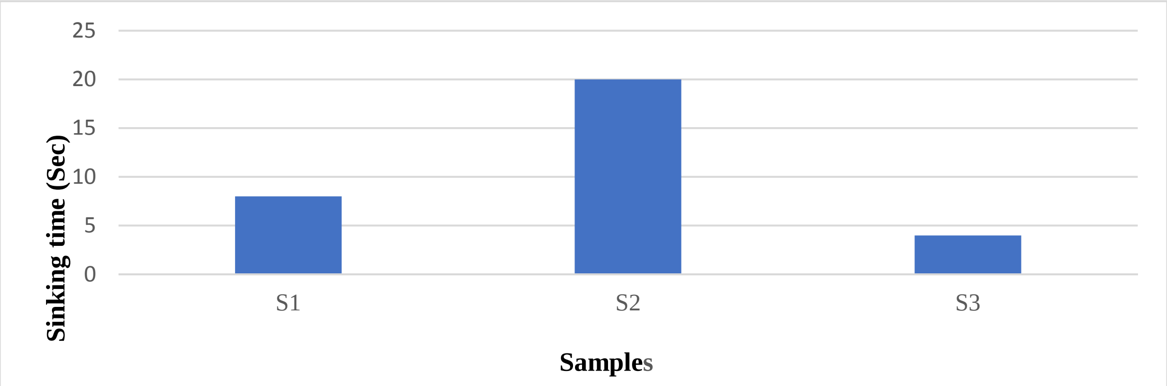

Figure 3 Sinking behaviour of different terry towels

As per BS EN 14697 standard, the recommend minimum level of sinking time should be atleast 15 second. According to the Figure 2, S1 andS3 confirms well to this standard. But S2 has higher sinking time due to the finish applied on the surface of the towel. The sinking time of the same has improved a lot after washing (from 486 seconds to 21 seconds). So, it is expected that the sinking time would improve in the further washing. In S3 sample, terry ratio and pile density is more than S1 which makes more surface area to be exposed to water and enables quick absorption. Also, the fabric weight for S3 sample is more than all which is also a reason for lower sinking time.

3.3 Moisture management properties

Table 2 Moisture management results

Parameters	S1	S2	S3
Wetting time top(sec)	9.14	8.94	5.22
Wetting time bottom (sec)	8.81	5.44	3.91
Top absorption rate(%/sec)	92.92	27.32	37.30
Bottom absorption rate(%/ sec)	50.56	15.60	23.56
Top max. wetted radius(mm)	7.50	11.67	5.00
Bottom max. wetted radius(mm)	5.00	5.00	5.00
Top spreading speed(mm/sec)	0.58	1.16	1.82
Bottom spreading speed(mm/sec)	0.79	1.07	1.46
Accumulative one -way transport index(%)	247.33	933.13	621.09
OMMC	0.33	0.54	0.59

Wetting time is higher for S1 because of higher fabric thickness and poor loop shape factor. S3 has lesser wetting time due to higher terry ratio, higher pile density and good loop shape factor. S2 having more wetting time than S3 due to presence of doubled yarn in ground and pile warp.

Absorption rate is higher for S1 due the bulkiness of the fabric compared to others. S2 is have lesser absorption rate due to lesser thickness and lower terry ratio. S2 pile is made of doubled yarn, which supports more capillary flow and hence the wettedradius is higher. Spreading speed will be directly proportional to the wicking rate which is higher for S3 and S2. One-way transportation capability for S1 is lesser compared to other due to its bulkiness and poor wicking behaviour. Since if fabric is bulkier, more air space will hinder the moisture flow and more water will be held at the top surface of the fabric itself. Since S3 and S2 has good moisture management properties, they have higher OMMC than S1 V.

3.4 Drying rate

Since S1 has more water retaining capacity due to its bulkiness and also it has poor wicking behaviour it shows poor drying rate. Poor loop shape factor also take part in poor drying rate as the loop forms more tortuous and exposes only smaller portion of the surface area to the surrounding atmosphere. S2 and S3 having good drying rate due to good wicking behaviour and good loop shape factor.

Table 1 Drying rate of terry towels

Parameters	S1	S2	S3
Test time (min)	20.03	20.03	20.03
Total water (g)	1.01	1.02	1.01
Dry water (g)	0.03	0.06	0.07
Dry percent (%)	2.48	5.43	6.62
Dry rate (%/min)	0.12	0.27	0.33
Performance1(µg/min inch2)	0.03	0.08	0.09
Performancr 2(µg/min inch2)	27.45	26.77	26.23

3.5 Tensile properties of terry towel

Breaking Strength (N) Extension (%)

In all the case breaking strength in warp wise is greater than the weft wise direction due to higher EPI and lesser crimp in warp direction. S2 and S3 is having higher strength because the warp yarn is two plied yarn and also the warp crimp% is lesser reasonably. S1 has lower strength due to the usage of rotor yarn in the ground warp.

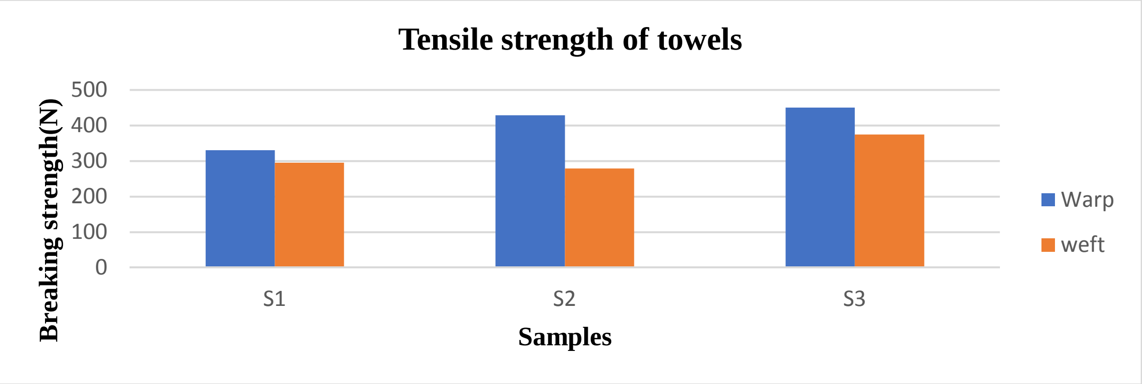

Figure 4 Breaking strength of warp and weft of towels

Extension is higher in weft direction for all due to higher weft crimp% so that decrimping zone is higher. S1 extension% is higher than others due to higher crimp%, higher terry ratio and also influenced by yarn properties.

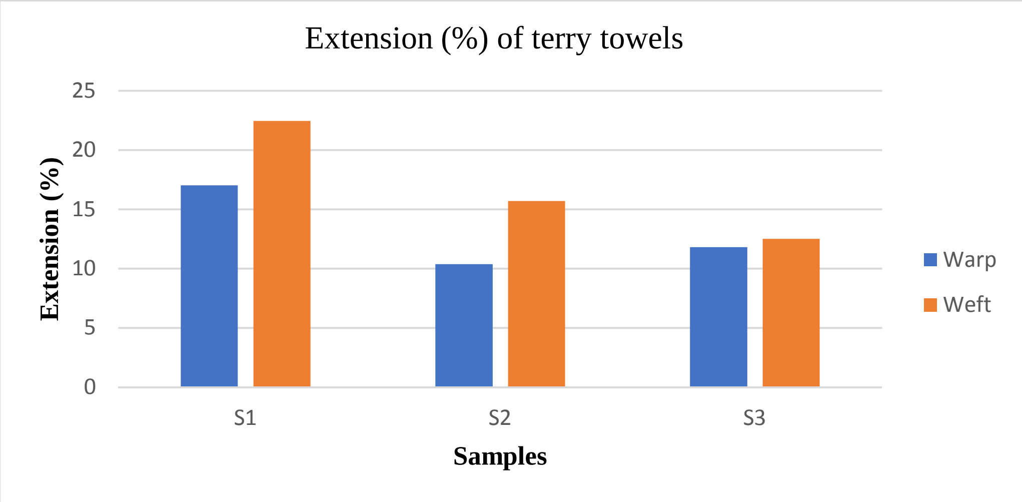

Figure 1Extension(%) of warp and weft of different towels

4. CONCLUSION

It is evident from the experimental results that the moisture management properties of terry towels depend on its structural parameters such as terry ratio, pile height, pile density, yarn type, yarn count, twist in yarn, threads per inch, thickness and areal density.

From the results it is concluded that S3 terry towel has the better towelling properties than S2 which is again better than S1. It is discussed further as follows:

I. S3 is the heavier fabric than all having more threads per inch, higher terry ratio and higher pile density which all helps in good towelling property. S1 has comparatively lower moisture management property due to poor loop shape factor and usage of rotor yarn as ground warp in the fabric construction.
II. Wicking behaviour was best resulted in S2 and S3 due to the good loop shape factor. The initial rise in the wicking height in S2 is less than others but it was rising rapidly over a time and time of attaining saturation is also more for this.
III. Sinking time was observed less in S1 and S2 which was attributed by the terry ratio and pile density. Due to surface finish applied over S2, it has higher sinking time which is expected to be reduced after washing
IV. From the moisture management tester results S3 and S2 has good moisture management properties, since they have higher OMMC than S1. This is due to higher spreading speed, higher accumulative transportation index and lesser wetting time.
V. S2 and S3 having good drying rate than S1 since it retains more water within them and takes more time to dry. This is due to the bulkiness of the fabric and loop shape factor.

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