

Study of Bedding Fabrics and their Influence on Thermal Comfort and Sleep

Authors: Dr. V. RAMESH BABU, S. SURESH KUMAR, R. AMITHA, A. ROHITH KUMAR

Associate Professor, Textile Technology, Kumaraguru College Of Technology, Tamil Nadu, India

Final Year B. Tech Textile Technology, Kumaraguru College Of Technology, Tamil Nadu, India

ABSTRACT

Bed linen is the material laid above the mattress of a bed that serves various purposes such as hygiene, warmth, protection of the mattress and also has a decorative effect in the room. According to several studies, the type of bed linen used for our sleep has a direct effect on our health; in other words, sleep quality is the ultimate performance indicator of bed linen cloth. The bed sheets used in home and hospital bedding are made of cotton or polyester cotton blende fabrics, which seems to date from the past centuries. Depending on the end use, cost factor, durability of the textiles, comfort and aesthetic properties, the fibre choice is made from natural fibre, regenerated cellulosic fibres and synthetic fibres . The major requirement of a fabric sheet is to be comfortable, nice touch and durable to wear and easy care Hence, home and hospital textiles need to ensure the comfort and hygienic level of the human and needs to be engineered with specific comfort properties. This article focuses on to make new textile materials that could help in reducing the discomfort experienced by the human. The relationship between bed linen properties and sleep quality has also been put forth.

Key Words: *Bed linen, Durability of the textiles, Natural fibre, Regenerated cellulosic fibres, Synthetic fibres, Comfort properties.*

1.INTRODUCTION

Bedding, also known as bedclothes or bed linen, is the materials laid above the mattress of a bed for hygiene, warmth, protection of the mattress, and decorative effect. Bedding is the removable and washable portion of a human sleeping environment. Multiple sets of bedding for each bed are often washed in rotation and/or changed seasonally to improve sleep comfort at varying room temperatures. The major requirement for bed linen is to be comfortable, easy to take care of and durable. Softening is an essential step, required in the field of home textiles, including bed linens, to improve fabric properties making the fabric soft, smooth, and flexible. Fabrics produced from 100% linen and their blends with cotton and viscose have been studied for handle and comfort properties. Linen fabrics produce excellent aesthetic and drape properties. Linen fabrics are found to be tougher than cotton and other blends. However, linen offers the highest tensile resilience and the lowest friction coefficient under low stress-loading conditions. Yarn made from cotton, lyocell, Modal and viscose were used with different combination to produce the woven fabric of plain weave structure and the fabric thus produced is bleached and its physical properties like air permeability drape, tearing strength, water vapor permeability, electro static charge, tensile strength, low stress mechanical properties and total handle value has been studied.

Most bed linen materials usually fall within the categories of cotton, silk or linen and all are natural fibres which are breathable, thus helping to regulate body temperature.” But they do have specific functions which can be decided by your personal preference here we are going to find the right bed linen fabrics for our body temperature. The main some of the things we need to find out while researching the right fabric.

2.Parameters of bedding materials

- Thread counts or GSM
- Breathability
- Materials
- Thermal comfortable properties of fabric

2.1 THREAD COUNT

The GSM (g/m²) of the fabric, also referred to as the areal density of the fabric, also plays an important role i.e. higher GSM means that the bed sheet is plusher and more comfortable. Thread count refers to the total number of threads woven into the bedsheet or the pillow or duvet cover. The higher the thread count, the softer and finer the fabric of the bed linen. Meanwhile, GSM or the grams per square meter measurement stands for the weight of the fabric woven into per meter of your quilts. A higher GSM indicates a plusher, more comfortable quilt.

2.2 BREATHABILITY

Breathability is defined as the ability of a fabric to allow perspiration, evaporated by the body, to escape (diffuse) to the outside (termed moisture vapour transmission), thereby allowing complete comfort. Bed linen is either printed or dyed. This makes it important to check whether the process is chemical free and the bed linen is good for your skin. The material and weave of the fabric also determines how breathable it is i.e. whether it remains cool or heats up against your skin.

2.3 MATERIALS

The material you choose plays an important role in whether or not the bed linen is comfortable for you. Some of the common and popular materials are,

2.3.a Cotton

Cotton is the most popular fabric used to make sheets and other bedding and for good reason. It's durable, breathable, soft, easy to care for, and generally quite affordable. You'll find several different types of cotton, however. Some terms refer to the origin of the cotton fibers themselves, while other terms refer to the style of weaving or methods of treating cotton fabric. Here are some of the most common:

2.3.b Linen

Linen is made of fibers from the stems of flax plants. Linen sheets, pillowcases, and duvet covers are durable, hypoallergenic, breathable, moisture-wicking, and grow softer and stronger with use. A natural fibre, linen bedding is as easy to care for as cotton bedding if you don't mind a few wrinkles.

2.3.c Tencel

Tencel is a brand name for fabric made out of eucalyptus tree wood pulp. It's soft, very durable, and naturally antimicrobial. Tencel is generally considered an environmentally friendly fabric, as its production requires less water, energy, and chemicals than does cotton.

While Tencel is fairly cool, it's not quite as breathable as cotton, and it can have a slightly clammy feel.

2.3.d Blends

There are lots of blended fabrics available, most including some form of cotton. Cotton/polyester is the most common, but you'll also find cotton/bamboo, cotton/rayon, and nylon/polyester. Blended fabrics are usually inexpensive, durable, and wrinkle-resistant, making them a good choice for children's bedding. The complexity of applications has increased with research and developments in the area of bed linen materials. It is observed that for many products, ideal set of physical and chemical properties would not be possible to achieve from one fibre alone. Hence, blending of two or three fibres having differing physical and chemical properties for the desired product becomes essential.

S.NO	WARP	WEFT
A	COTTON	COTTON
B	COTTON	MODAL
C	COTTON	LYOCELL
D	COTTON	VISCOSE
E	COTTON	POLYESTER

3.WEAVE:

The weave of your bed linen also contributes to its softness, comfort, and looks. The two most common forms of weaving are sateen and percale.

3.1 Flannel weave

Flannel weave comprises a napped finish on one or both sides, creating the “fuzzy and soft feel that is characteristic of this fabric. Flannel sheets are ideal for winter because the fuzzy weave holds in body heat, and creates a warm, fluffy and cozy feel.

3.2 Jersey weave

Jersey weave includes a knit fabric rather than woven. It’s knit in the same way as tshirts are. These are soft and comfortable, but can shrink.

3.3 Sateen weave

Sateen weave makes bed linen smooth with a subtle sheen. Due to its unique weaving pattern, it produces a satiny and sumptuous finish.

3.4 Percale weave

Percale weave offers the crisp feel you get in your shirts with a matte finish. The simple weaving method it involves gives bed linen an even texture for better comfort.

3.5 Jacquard weave

Jacquard weave is a more elaborate form of weave containing a slightly raised area of embroidery which can be felt under the hand. This is used to weave the designs into the bedsheets.

3.6 Microfiber weave

Microfiber weave is a tighter weave made up of man-made fiber. The thick weave makes the bed linen water-resistant and hypoallergenic. This is especially good for people with allergies and sensitive skin.

3.7 Damask weave

Damask weave is intricately detailed so that the woven pattern is visible on both sides. This is generally used to create bed linen which is reversible and decorative.

4 Manufacturing Process

Some manufacturers spin the bales of cotton delivered to the manufacturer. Others purchase the yarn already spun on spools. This section will describe the process of making 100% sheeting from bales of cotton delivered to the plant which are not yet spun.

4.1 Procuring the cotton

Bales of cotton weighing about 480 lb (217.9 kg) are purchased and shipped to the sheeting manufacturer.

4.1.a Blending

Bales are laid out side by side in a blending area. The bales are opened by a Uniflock machine that removes a portion of cotton from the top of each bale. Next, the machine beats the cotton together, removing impurities and initiating the blending process. The fibers are then blown through tubes to a mixing unit where the blending continues.

4.1.b Carding

Once blended, the fibers move through tubes to a carding machine, which aligns and orients the fibers in the same direction. Cylinders with millions of teeth pull and straighten the fibers and continue to remove impurities.

4.1.c Drawing, Testing, and roving

Here, the cotton fibers are further blended together and straightened as many strands of fibers are drawn together into one strand by a roving frame. The frame twists the fibers slightly and winds a cotton roving onto bobbins.

4.1.d Spinning

The roving's are spun on a ring spinner, drawing the cotton into a single small strand and twisting it as it spins. The yarn is then wound onto bobbins and the bobbins are placed onto winders that wind the thread onto section beams that will eventually fit onto a loom for weaving.

4.1.e Warping a section beam

It takes between 2,000-5,000 warp (lengthwise yarns) to make up a single width of sheet. Thus, the warping beam, which holds all of the yarns, is very large and cannot be loaded at once. So 500-600 ends of yarn from spools are pulled onto a single section beam, thus warping it. Later, several section beams will be loaded onto the large warping beam, each contributing a portion of the warp.

4.1.f Slashing

Each section beam goes through a slasher—a machine that coats the yarn with starch or sizing to protect the ends and makes the yarn easier to weave.

4.1.g Warping the beam

Once coated with sizing, several section beams are loaded onto a single large loom beam. As many as 6,000 yarns are automatically tied onto old yarns by a machine called a knotter in just a few minutes. The knots are pulled through the machine and the weaving can begin.

4.1.h Weaving

The weaving, in which the weft or filler threads interlock with the warp or vertical threads, is done on high-speed automatic air jet looms. The filler threads are transported across the warp threads at a rate of 500 insertions per minute, meaning that a filler thread runs across the warp thread about every one-tenth of a second. It takes about 90 insertions to weave an inch of sheeting. Thus, about 5.5 in (14 cm) of sheeting is woven per minute—10 yd (9.14 m) per hour are woven. Typically, 8,000 yd (7,312 m) of sheeting is woven on a loom and wound up in rolls and shipped for further processing.

4.1.i Cleaning and bleaching

The fabric, called greige, is grey in color. It is further finished by singeing—a process in which bits of yarn are burned off of the surface. Then, the sheeting is ready to be bleached. This is done in three steps. First, it is desized by bathing it in water and soaps that removes contaminants. Next, caustic chemicals are applied to get rid of dirt and remnants of debris found in cotton yarn. The caustic is washed out and concentrated bleaches (chlorine and/or hydrogen peroxide) are applied to dissipate the grey color. Now whitened, the sheeting is rolled into a rope and put into a dryer which takes the moisture out prior to dyeing.

4.1.j Dyeing

All sheeting is dyed. Even sheeting sold as white must be dyed to become a truly white sheet. In order to give the gray-colored sheets color, pigments are applied to the sheeting in color vats that use large rollers to press the dyestuff into the material. Once dyed, the sheeting is steamed to set the color. Next, a resin is applied to the sheeting to control shrinkage. The sheeting is rolled onto huge rolls and is ready to be cut and sewn.

4.1.k Cutting and sewing

Automatic cutting equipment pulls the cloth off the rolls as it automatically cuts the sheeting to the requisite length. The rolls are transferred to a sewing machine that sews top and bottom hems.

4.1.l Packaging

The sewn sheet is either folded by 1 3 hand or machine. Machine-folded sheets are ejected, shrink wrapped, and individually packaged for sale.

5.SLEEP QUALITY

Determination of bed linen properties affecting sleep quality	The bed linen properties preferred are fiber type, feel, color, drape, style, lusture, stretch, compress, wrinkle, design and print
Determination of the relationship between bed linen quality and sleep quality	Majority of the population considered that the quality of bed linen fabrics directly affects their quality of sleep, which proves the hypothesis
Subjective assessment of bed linen fabric based on selected bed linen properties	The fabrics were rated on the scale 0-5 with 0 being the poor quality and 5 being the excellent quality .
etermination of the weightage and the ranking of bed linen properties According to the \$100 test, the judges have to spend a total of \$100 of virtual m etermination of the weightage and the ranking of bed linen properties According to the \$100 test, the judges have to spend a total of \$100 of virtual m etermination of the weightage and the ranking of bed linen properties According to the \$100 test, the judges have to spend a total of \$100 of virtual m etermination of the weightage and the ranking of bed linen properties According to the \$100 test, the judges have to spend a total of \$100 of virtual m etermination of the weightage and the ranking of bed linen properties According to the \$100 test, the judges have to spend a total of \$100 of virtual m Determination of weightage and the ranking of bed linen properties	The weightage of each individual property contributing to sleep quality was determined. Though the feel factor was chosen as the most preferred factor for quality sleep
Determination of correlation between subjective and objective bed linen sleep quality index	The correlation coefficient obtained for subjective and objective BLSQI was 0.95

6. FACTORS INFLUENCING THERMAL COMFORT

6.1. Air temperature

This is the temperature of the air surrounding the body. It is usually given in degrees Celsius (°C).

6.2. Radiant temperature

- Thermal radiation is the heat that radiates from a warm object. Radiant heat may be present if there are heat sources in an environment.
- Radiant temperature has a greater influence than air temperature on how we lose or gain heat to the environment.

Examples of radiant heat sources include: the sun; fire; electric fires; ovens; kiln walls; cookers; dryers; hot surfaces and machinery, molten metals etc.

6.3 Air velocity

This describes the speed of air moving across the employee and may help cool them if the air is cooler than the environment.

6.4 Relative humidity

Relative humidity is the ratio between the actual amount of water vapour in the air and the maximum amount of water vapour that the air can hold at that air temperature.

7. CONCLUSION

Fabrics produced from 100% linen and their blends with cotton and viscose have been studied for handle and comfort properties. Linen fabrics produce excellent aesthetic and drape properties. Linen fabrics are found to be tougher than cotton and other blends. However, linen offers the highest tensile resilience and the lowest friction coefficient under low stress-loading conditions. In this research work yarn made from cotton, lyocell, Modal and viscose were used with different combination to produce the woven fabric of plain weave structure. The fabric thus produced is bleached and its physical properties like air permeability drape, tearing strength, water vapor permeability, electro static charge, tensile strength, low stress mechanical properties and total handle value has been tested. The findings of test results have been tabulated and the optimization of results has been done to find the best combination yarn to produce the bed linen fabrics.

The hypothesis that the sleep quality is directly proportional to bed linen quality was proved. While evaluating bed linen quality through subjective assessment, most people prioritized the fiber and the feel of the bed linen, rather than the colour or other properties associated with aesthetics.

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