International Journal of Aquatic Science
ISSN: 2008-8019
Vol 12, Issue 02, 2021

Effect Of Unconventional Fibres On Fabric Handle Properties – A Review

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Abstract: Unconventional fibres are gaining a huge importance nowadays as most of them are eco friendly in nature and are seen as effective substitutes for synthetic fibres. Although many of these fibres were existing even before synthetic fibres emerged, they are not used profoundly in apparels due to complicated production techniques and these fibres have lesser pliability and so is used by blending with cotton, jute, wool, etc.,. However with new production techniques and user friendly process and more concentration on making eco friendly products has resulted in exploring these fibres for making apparels. Some of these fibres have excellent properties: Flax fibre is soft, lustrous and flexible, Hemp fibre has superior strength and durability, also possesses good comfort and absorbancy. Similarly bamboo and soya protein fibres have excellent anti bacterial properties and are extremely soft in nature. Based on these properties it is to be believed that these fibres when made into fabric and apparels will make it easier to wear and can be good substitutes for the synthetic fibres. However there is one property of these fibres that should be noted when these fibres are made into fabrics and then garments and that is the handle property of the fabrics made out of these fibres. Handle is measured subjectively and objective evaluation is also done using Kawabata evaluation system and FAST. Unfortunately there is very little literature available which expresses the handle of these unconventional fibres using objective evaluation. Hence in this paper, the research findings available related to handle evaluation of unconventional fibres are reviewed. The grouping of the available literature for handle properties of unconventional fibres is carried out in this paper so that it will help the researchers in the future.

Keywords: Handle, KES-F, Unconventional fibres, Bamboo, Soya protein fibre (SPF), Hemp, Ramie, Total hand value

1. INTRODUCTION

1.1 Unconventional fibres:

Unconventional fibres are the ones that are not used commonly. They have lesser pliability (1). A conventional fibre is the one that is commonly used by convention. The synthetic fibres, wool, silk and cotton are the fibres in this category. The synthetic fibres are the last ones to get added to this list (2). Some fibres like linen were conventionally used in Europe but not used in India and hence a fibre being conventional varies between countries. However the above mentioned fibres are mostly used in the world. Unconventional fibres are the one that is obtained from a natural source and it is eco friendly in nature. These fibres are not extensively used and are forgotten although these were very conventional in those days. One main reason is their lower handle properties. Fabric hand is a fundamental aspect, which

determines the success or failure of many new products (3). The list of fibres includes all the plant and animal natural fibres or produced from natural source which are not used extensively. Some of the unconventional fibres are linen, hemp, ramie, nettle, flax, angora, kenaf, abaca, coir, banana, bamboo and soya protein fibre.
These fibres have different fields of application. They are used for making apparels and furnishings, ropes, twines, fishing nets, paper and boards, non woven fabrics, geotextiles, horticultural production materials, building materials and composites (1). Almost these fibres are used in all the fields were conventional fibres are used however it is the apparel sector that utilizes textiles to the highest limit and of course the main reason attributed to clothing being one of the basic necessities of life has very less usage of these fibres. Conventional fibres including synthetics have replaced these fibres to a very large extent. As today's focus is on eco friendliness and natural renewable products, it is required that these fibres are extensively used in apparel sector.
All these unconventional fibres are sometimes blended with conventional fibres like cotton, silk, synthetics, etc., or used in union with conventional fibres so that the best properties of both conventional and unconventional fibres can be obtained in the fabric.

1.1.2 Properties of unconventional fibres:
Before deciding the use of these fibres as apparels, it is essential to see if these fibres have required properties for using in apparels. Few literatures are available confirming their use as apparel. Some of them are listed here. Bamboo and soya fibres are becoming a very good substitute for other natural and artificial fibres in making apparel because of their excellent characteristics like biodegradability. Bamboo, which is a regenerated cellulosic fibre has excellent characteristics like sustainability and exceptional softness similar to silk. These fibres have strong durability, stability and tenacity. They possess high antibacterial and high moisture absorption properties. Garments made out of bamboo make people feel extremely cool and comfortable in humid conditions. The breathability is higher for these fibres and it may be due to the numerous micro gaps and holes present in the fibre (4). Soya protein fibre (SPF) is the only plant protein fibre (5) that is available and it has the combination of the physical properties of synthetic fibres and superior properties of natural fibres. These fibres are produced by wet spinning and it has similar look as silk fibres but considerably cheaper. Fabrics made out of SPF are very soft, smooth and has better moisture transmission (6) than a cotton fabric. SPF also has good antibacterial properties.

Hemp is biodegradable and eco-friendly fiber with highest tenacity in natural fiber. It is antibacterial and antifungus in nature. Linen fabrics produce excellent aesthetic and draping properties. Ramie is one of the strongest vegetable fibre that possesses highest strength and length, good durability and absorbancy with excellent lusture. Similarly all the other unconventional fibres like banana, angora, etc., have lot of unique properties which make them an excellent choice for use as apparels. So based on these properties, one can justify the usage of these fibres in apparels. However we need to consider the low stress mechanical properties of the fabrics made out of these fibres for effective use as apparels. So handle properties of these fabrics should be good for it to be comfortable to wear.

1.2 Handle properties:
Although all these fibres have excellent properties, they should also have a very good handle. So we should know what handle means before proceeding further.

Hand is the judgment made by the person about the surface properties of the fabric and it depends on place, season, fashion, area and personal preferences. The fabric's physical properties determine the sense in the fingers when someone touches the fabric. Hence the physical properties of fabrics can be used to come to a judgement. For example, in describing the strength of a fabric, no one relies on personal judgment since numerical data of strength tests give excellent evaluation of the material.

There are various properties of fabric that plays a major role in handle and they are fabric's resilience, compression, stiffness, friction with respect to surface, thermal characteristics and elasticity. Hand or handle has been defined by various researchers and it was subjectively evaluated till Kawabata proposed an objective evaluation with the conception about hand by the hypotheses that hand of a fabric can be completely expressed by the physical property of a fabric ignoring the important and variable human contribution to the assessment of fabric aesthetics.

Fabric assessment for hand is carried out in two ways: Subjective and Objective assessment. There are lot of subjective evaluations done however it is the objective assessment that has superseded the former. Objective assessment helps in understanding the relation between fabric hand and mechanical properties of a fabric in an objective manner. Objective measurements are done by using Kawabata Evaluation system (KES-F), FAST, Phabrometer (7), etc.,. and out of these methods KES-F and FAST are extensively used. Before we review the literature of handle properties of different unconventional fibres, we will see how the objective evaluation method works and for that let us review the KES-F system for example.

1.2.1 Kawabata evaluation system (KES-F):

KES-F established the relationships between the fabric hand and its mechanical properties by selecting some of the most important fabric characteristics in affecting fabric hand. All the six properties are (a) tensile property (b) bending property (c) surface property (d) shearing property (e) compressional property and (f) weight and thickness. Data from the mechanical properties were put into a transform formula to determine the fabric 'total hand value' which was designed to reflect the subjective hand as closely as possible. 16 low stress mechanical properties are measured and then the primary hand and total hand value are calculated for the fabrics.

The fabric's extensibility, tensile energy, linearity, tensile resilience, shear stiffness, hysteresis at 0.5° shear angle, 5° shear angle, bending rigidity, hysteresis of bending moment, compressional energy, compressional resilience, coefficient of friction, mean deviation of coefficient of friction, geometrical roughness, fabric thickness and weight per unit area are measured using the KES-F evaluation and these properties will be discussed in detail during the review of the work done on handle in the later stages of this paper.

Primary hand expressions and their meanings

KOSHI : Stiffness/firmness
SHARI : Crispness
HARI : Anti-drape stiffness/hardness
FUKURAMI : Fullness/softness
NUMERI : Smoothness

1.2.2 Factors affecting fabric hand:

The various factors affecting fabric hand are given below in Fig 1:

International Journal of Aquatic Science
ISSN: 2008-8019
Vol 12, Issue 02, 2021

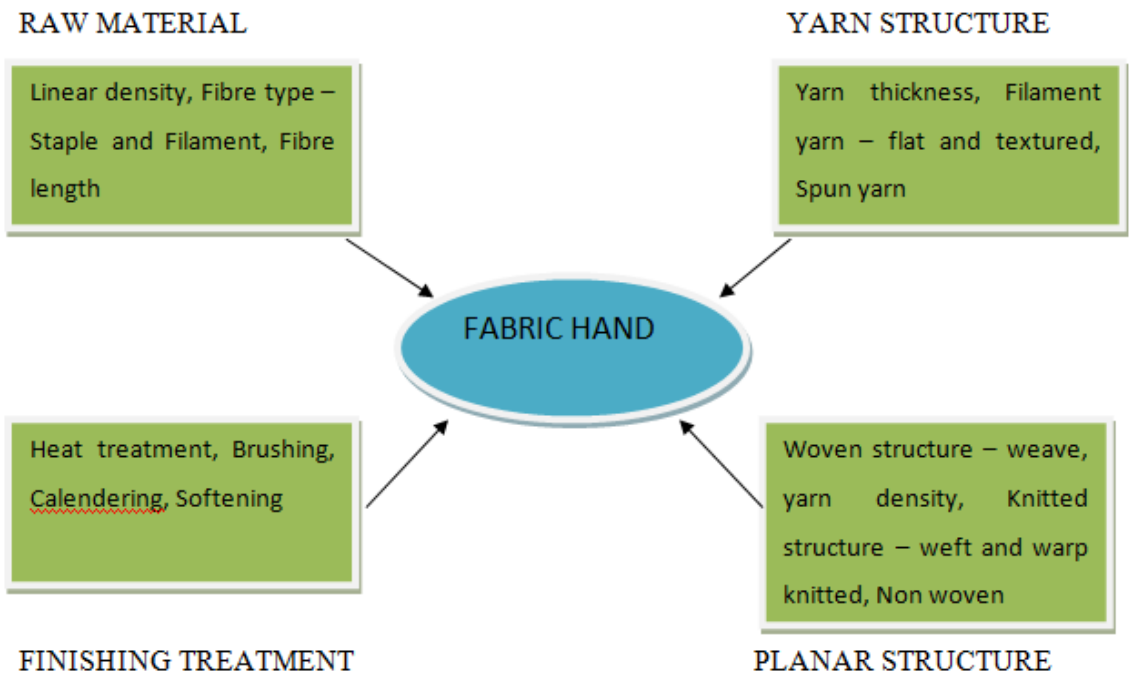

Fig. 1 Factors affecting fabric hand

In the case of fabrics, the fabric handle is affected by the type of finishing treatments, the composition of fibres, structure of yarn and planar structure (8). Just to give an example, let us see the following factors: The properties of a nonwoven is different from woven or knitted cloths as there is no yarn as a constituent in nonwovens. In the case of nonwovens, it is a series of webs of individual fibres needle punched or joined together by various other means to form a fabric with the surface characteristics ranging between harsh and soft. (9).
In the case of fabric finishing, huge changes occur with respect to properties of the fabric. The finishing process is carried out in a sequence but the reactions are interactive and the total effect of a sequence of operations is not the sum of the individual operations. There is an interaction between fabric construction and finishing such that the effect of finishing on fabric properties will depend on both the finishing route and the construction of the loom-state fabric (10).
With the help of various finishes, new value added products can be produced from the same unfinished woven or knitted fabric. Light brushing gives peach-skin type fabric woven from microfibres. By calendering you get flatter surface and also many chemical treatments (softening compounds, resins) can affect to the fabric hand. The differences in types of fabrics and the availability of various finishes leads to various end use combinations, thereby making fabric selection as a very complex task (11).

2. HANDLE OF FABRIC FROM UNCONVENTIONAL FIBRES REVIEW:

The study of handle properties of the fabrics made from unconventional fibres is mainly done using objective assessment of Kawabata evaluation system (KESF). In this section, we will see the various papers that have highlighted the handle properties of fabric made out of unconventional fibres. We will see in the order of each unconventional fibre and various blends or union associated with the fibre.

2.1 Bamboo and Soya protein fibre (SPF) fabric:
Most of the studies are done on the union fabric with cotton as warp and bamboo or soya as weft. Handle evaluation by KES systems showed that the flexibility and extensibility were highest when the soya protein fibres yarns were used as weft (5) and the tensile resilience was lower for fabrics of SPF weft yarns than the fabrics with bamboo and cotton weft yarns. Multivariate statistical analysis was performed and there existed a very high positive correlation between extensibility and tensile work, and between bending and shear. A negative correlation was reported between fabric shear properties and thickness, and bending properties.

2.2 Bamboo and hemp union fabric:
In another study, the raw bamboo fabric was compared (12) with hemp and it showed that the raw bamboo fabric is stiff and shari, but not good in fullness and softness. The study also focused on the characteristics of raw bamboo fabric's fullness and massiness, elasticity and elongation, hardness and shari.

2.3 Bamboo viscose blended fabric:
A study carried out in China for characterisation of handle and for health care applications showed that 100% regenerated bamboo viscose fabric and cotton/bamboo viscose blend (60/40) had better hand value than 100% cotton and 100% viscose yarn (13).

2.4 Kenaf fabric:
Extensive work has been done in checking the handle properties of kenaf fabric (14) by blending it with cotton. Different blend compositions were carried out like 10/90 kenaf cotton and upto 50/50 kenaf cotton. It was found that the type of spinning whether it was ring spun or rotors spun had an effect on the hand value and also as the proposition of kenaf increased, both bending rigidity and shear stiffness increased. The bending rigidity of fabrics with 50% kenaf was about 4 times greater than that of the fabrics with 10% kenaf. Surface properties also showed the same trend, the higher the kenaf content, the rougher the fabrics were. The chemical treatment with NaOH did not have any impact on the hand value compared to the blend composition.
Another study carried out in China (15) used kenaf fibres which were treated by a modified chemical degumming method was blended with 70% pima cotton and compared with fabrics made from 100% cotton yarns. The findings indicated that 100% cotton fabric was flexible and recoverable after deformation than the blended fabrics, however the surface properties were contradictory with what Zhang (15) reported as this study showed that the measured surface properties were similar to the surface properties of 100% cotton fabric.

2.5 Bast fabrics with liquid ammonia/cross linking treatment:
The effect of liquid ammonia/cross linking treatment on hand feeling of bast fabrics were studied (16) and it showed that tensile resilience and compressional resilience increased by the liquid ammonia treatment, especially surface properties of hamp, ramie and flax fabrics exhibited significant improvement. Also the bending, shearing and surface properties improved as well. The tensile and compressional properties were also better than the bast fabrics treated only by crosslinking.

2.6 Hansan Ramie:

The effect of sizing on the physical and mechanical characteristics of Hansan ramie (17) was studied. The wrinkle recovery angle was gradually reduced when the sizing concentration increased. Sizing affected the bending and shear properties majorly. Primary hand value showed that ramie became stiffer after sizing.

2.7 Linen:

Handle properties of Linen was extensively analysed (18). 12 samples of linen cotton and linen viscose union fabrics were made at different compositions and were compared with hand values of 100% cotton sample. With respect to shari and fukurami, the fabrics made of linen had very high primary hand. Interestingly, the 100% cotton fabric had a lesser total hand value than the linen blended fabrics. The other reason for more hand value of linen blends can be due to addition of viscose and cotton which aid in improving the surface properties.

2.8 Banana, Nettle and other unconventional fibres:

It is found that the banana fibres are little stiffer and create a pricky sensation while wearing. However due to their anti-crumple nature, they are used in dress materials. Although, the surface characteristics are rough, the fabric has a nice sheen and at times, it is being used for making barongs and wedding gowns (18). The finer yarns lead to better texture and is based on the quality of fibre used. However no study on handle properties of the fabrics made out of these fibres have come out. Similarly other fibres like sisal, coir, nettle, abaca, angora also do not have any research findings on their handle properties.

3. CONCLUSION

The various research papers have been reviewed to understand the unconventional fibres usage as apparel with respect to their handle properties measured objectively. It is found that subjective evaluations have been done for all these fibres and some of the fibres like sisal, coir, nettle have not found any apparel application based on the subjective evaluation. For every fibre type, there is very little literature available to confirm the use as a fibre for apparel based on their handle properties. In the case of bamboo and soya protein fibre, it is found that the studies that have been carried out were either 100% of bamboo fabric or cotton in warp and bamboo and SPF in weft. It is essential to see how bamboo and SPF aid to better low stress mechanical properties when used as blends. Handle properties of kenaf fibre made fabrics showed a decrease when the kenaf content increased in the blend with cotton. Surface modifications improved the handle properties of bast fibres. Linen fibres have been studied for handle and it showed that they have better hand values when combined with cotton or viscose. So these papers show that hand values get better when they are in union with conventional fibres or when they are blended with them. Although hemp, SPF, bamboo are all considered to be soft in nature and with good use in apparels it would still be a daunting task to get a great usage of these fibres in apparel front as 100% composition without any blends or union with conventional fibres. Subjective evaluation of banana, sisal, coir and abaca are all against their usage of apparels but it has to be further studied to see any chemical modifications like enzyme treatment may make them effective in being an apparel. So to conclude pretty much, it is to be noted that there is scope for more analysis of handle properties of 100% unconventional fibre made fabrics or blends or union fabric to come out

with concrete results of these fibres outperforming the conventional ones as an apparel based on their handle properties barring the other properties required to be an apparel.

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