

# Investigation of Selected Utility Properties of Woven Fabrics Made of Soybean Protein Fibres

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## Abstract

*Soybean Protein Fibres (SPF) are man-made fibres manufactured from the proteins contained in soybeans. They are biodegradable fibres derived from renewable sources, friendly for people and the environment. Within the framework of the work presented, selected utility properties of fabrics containing SPFs were investigated. The scope of the investigation included determination of mechanical properties, drapeability, water-vapour permeability and liquid moisture transport. The investigations carried out allowed to evaluate the utility value of fabrics made with the use of SPFs and to compare the fabric 100% made of SPFs with ones with weft yarns other than from SPFs. The research showed that fabrics with SPFs are suitable for clothing products, which may be a very good alternative to the currently available clothing made from fabrics containing standard natural and chemical fibres.*

**Key words:** soybean protein fibres (SPF), moisture transport, bending stiffness, physiological comfort.

## ■ Introduction

Soybean Protein Fibres (SPF) are man-made fibres manufactured from proteins contained in soybeans. They are considered as the only vegetable protein fibres in the world. Fibres are wet spun from deaerated spinning dope composed of soybean protein and polyvinyl alcohol dissolved in distilled water, followed by the adding of borax or boric acid and mixing at a temperature between 40 and 98 °C [1]. The share of components can be different, for instance, high-wet strength fibres containing 5-23% of a soybean protein isolate from oiled soybean cake and 77-95% of polyvinyl alcohol were developed by Guanqi Li in

China [1, 2]. Taking the above into consideration, SPFs can be considered as a synthetic composite fibre composed of polyvinyl alcohol (PVAL) and soybean proteins in different shares [1]. Their morphology is typical for synthetic fibres. According to the literature, SPFs are biodegradable fibres derived from renewable sources, friendly for people and the environment [1, 3]. It is justified by manufacturers by the fact that SPFs are made from eco-friendly raw material. In addition, the raw material comes from soybean, a plant of massive source and rich in nutrition. Therefore, SPFs are biodegradable and can go back to the earth. They contain 16 amino-acids that have a positive effect on human health [4]. Soybean protein fibres have many of the good qualities of natural fibres, and also have some of the mechanical performances of synthetic fibres [5]. The luxurious appearance, health-care function, good dye-ability and comfort-related properties can be considered as the most important advantages of SPFs. Soybean protein fibres have been investigated by many researchers.

Investigations [3] confirmed that fabrics knitted from SPFs and their mixtures with various fibres give higher bursting strength and better pill-resistance than bamboo and cotton fabrics. Yilmaz et al. [3] stated that the micro-holes in the cross-section and high amorphous regions of soybean fibres improve the water absorption capacity of fabrics. They also stated that the fabric drape values of soybean fabrics decrease when blended with other fibres.

Zupin and Dmitrovski [6] investigated woven fabrics containing SPF, bamboo and PLA yarns in the weft direction. They measured fabrics of different weaves in the range of their mechanical properties: breaking force and elongation at break, as well as properties measured by means of the KES (Kawabata Evaluation System). Results from the KES showed that fabrics with SPF yarn in the weft are the most extensible and flexible, while those with cotton and bamboo in weft have higher tensile resilience than fabrics with PLA and SPF in weft [4].

Matusiak et al. [7] investigated the basic, structural, mechanical and UV-protective properties of SPF woven fabrics. They tested the woven fabrics at different stages of processing: grey fabrics, washed and bleached. On the basis of the investigation carried out, they stated that the thermal insulation properties of fabrics made of soybean fibres are comparable to those of cotton fabrics of similar structure and that the UV protection of bleached fabric made of the soybean fibres is much better than that of bleached cotton fabric of similar structure. Matusiak et al. [8] also investigated the dyeing ability of fabrics made of SPFs. They applied different dyes: Cibacron Gelb LS-R (yellow), Cibacron Scharlach (red) and Cibacron Blau LS – 3R (blue) to dye SPF woven fabrics. Investigations showed that the dyeing process was performed without any problems and that colours of the fabrics were clear, intense and durable. The dyeing properties of SPF knitted fabric with different kinds of dyes were

tested, and are compared and described on the SWICOFIL webpage [4]. The test results indicate that the dyeing property with neutral dyes is relatively poor for soybean protein fibres. The application of neutral dyes must therefore be performed with caution. Weak-acid dyes, reactive dyes and substantive dyes are suitable for SPFs. The dyeing fastness on soybean protein fibres is similar to that on wool with different dyes [4].

Soybean protein fibres are applied in different textile products and are characterised by the lustre of silk and a soft hand. Fabrics made of SPF are smooth, soft and gentle, as well as being considered comfortable. Due to this fact fabrics made of soybean protein fibres are used in different apparel goods, especially those worn near human skin, such as underwear, t-shirts, pullovers and beddings, on the world market, and they are becoming more and more popular.

In scientific works published till now, attention has been focussed on the properties of fibres, as well as on their chemical composition, biodegradation, technology and dyeing performance [1, 5]. The investigations have also concerned fabrics made of soybean protein fibres, in the majority, in blends with other natural or man-made fibres. From the point of view of application of SPF fabrics in clothing, the crucial role is played by the comfort-related properties and healthy features of SPFs. Researchers reported that fabrics made of SPFs and their blends are permeable to air and water-vapour. The amino-acids contained in SPFs can nourish human skin during usage of clothing made of them [1-5]. The comfort related properties of fabrics, woven or knitted, depend on many factors, among which the structure of fabrics is very important. In the structure of woven fabrics, the weave as well as the density of the warp and weft influence the porosity of the fabric, which is a crucial feature from the point of view of the thermal resistance and water-vapour permeability [9-13]. In order to assess the effect of the application of soybean protein fibres on the comfort-related properties of fabrics, it is necessary to compare the properties of SPF fabrics with those of fabrics of identical or very similar structure but made of other fibres. In the aspect of thermo-physiological comfort of clothing usage, the following properties of fabrics and clothing are regarded as the most important [14, 15]:

- thermal resistance,
- water-vapour resistance,
- air permeability.

Thermal resistance is a decisive factor influencing the ability of fabrics to protect the human organism against excessive heat loss or overheating. The thermal resistance of textile materials can be determined by different methods such as the "skin" model", the Alambeta, Permetest, and Thermo Labo II [9, 14-18]. The air permeability of fabrics and clothing directly influences gas exchange between a human being and the surroundings and, in the same way, the physiological comfort of the clothing user. The permeability of fabrics to air is expressed by the velocity of air passing through the sample in the direction perpendicular to the sample at predetermined conditions: surface area, pressure drop and time [19].

Water-vapour resistance is connected with the diffusion of water-vapour molecules through the pores in textile materials [20]. It determines the permeability of fabric to water-vapour. The water-vapour permeability of textile materials supports moisture transfer from human body skin through the textile layer into the environment. Water-vapour resistance is usually determined by the "skin model" and Permetest.

Water-vapour permeability is not sufficient to fully characterise textile materials from the point of view of moisture transport. It concerns only the transport of moisture in the form of vapour. In the majority of cases, especially during intensive physical activity, liquid moisture transport is equally important as a water-vapour transport. Liquid moisture flow through textile materials prevents perspiration from remaining next to the skin, due to which it is necessary to characterise materials in two aspects: the transfer of moisture in the form of vapour and in the form of liquid.

The parameters characterising textile materials in the range of their liquid moisture transport ability can be measured by means of a Moisture Management Tester. It is applied to evaluate, in a complex way, textile materials from the point of view of their ability to transport liquid moisture. The device measures the dynamic liquid transport properties of textiles in three aspects [21]:

- absorption rate – moisture absorbing time for inner and outer surfaces of the fabric,

- one-way transport capability – one-way transfer of liquid moisture from the inner to outer surface of the fabric,
- spreading/drying rate – speed of liquid moisture spreading on the inner and outer surfaces of the fabric.

The aim of this work was to assess selected properties of woven fabrics containing soybean protein fibres. Measurement was performed in the range of the: bending stiffness, drapeability and properties characterising the ability of the fabrics to transport liquid moisture. The selection of properties for measurement was based on their importance for clothing application and taking into consideration current data available in scientific articles. Generally, the fabrics were measured in a wider range of properties, for instance, the breaking force, elongation at break and thermal insulation properties. However, some properties of SPF fabrics such as tensile properties [1, 3, 6], bursting strength [3], handle-related acc. to KES [6] have been investigated and results presented by other authors. Due to this fact, in the current paper drapeability was measured because it influences the behaviour, especially the draping of clothing while worn. Bending stiffness is also presented because it is a crucial property influencing the draping ability of fabrics. Drapeability is important not only from the point of view of the appearance of clothing during usage, but it should also be taken into consideration during the design of apparel products and the shape of patterns.

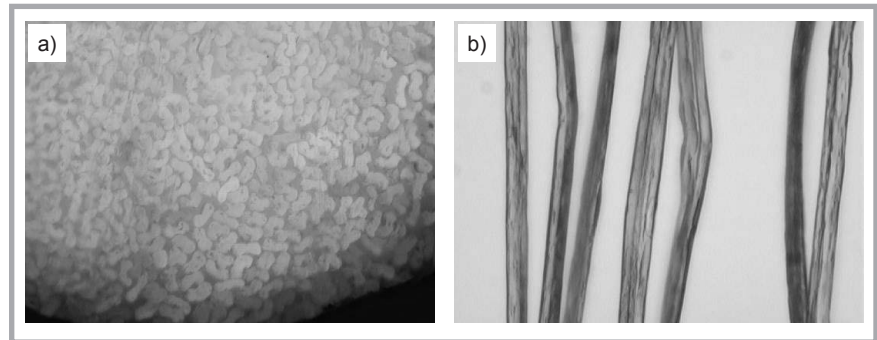
In the paper, the results from the Moisture Management Tester are also presented. The instrument provided information concerning the moisture transport through and across the fabrics, which is the most important novelty of the investigations presented. The Moisture Management Tester is a relatively new testing instrument. Till now the properties of measurement of woven fabrics containing SPFs by means of the MMT have not been published. Moreover, the MMT applied in the investigations presented is the only one installed in Poland. Till now the MMT has not been applied in the measurement of clothing fabrics in our country. The water absorption and air permeability of SPF fabrics have been measured by Yilmaz et al. [3]. However, the investigations concerned knitted fabrics.

## Materials and methods

Within the framework of the work presented, selected utility and comfort-related properties of fabrics containing SPF were investigated. Measurements were performed for 4 variants of plain woven fabrics containing soybean protein fibres. All fabric variants were manufactured on the basis of the same warp – 18.5 tex ring spun yarn made of soybean protein fibres. Microscopic pictures of SPF yarn (cross-section and longitudinal view) from a biological microscope are presented in **Figure 1**.

In each variant different types of yarns were introduced in the weft direction. The following weft yarns were applied: 18.5 tex made of SPF, 20 tex cotton, 20 tex viscose as well as 200 dtex/194 Dacron Coolmax yarn. The last weft yarn is made of polyester profiled fibres, designed to ensure the moisture management properties of fabrics. Coolmax® is a technology patented by DuPont. The fibres manufactured using Coolmax technology are tetra-channel or hexa-channel, produced specially for the improvement of the wicking capability and moisture vapour permeability of fabrics made of them. COOLMAX polyester fibres are characterised by a significantly increased external surface area in comparison to the fibres with a standard round shape of the cross-section. This special shape of fibres creates a transport system that pulls moisture away from the skin to the outer layer of the fabric. Then it dries much faster than other fabrics and ensures the evaporative cooling of the human being [22].

As mentioned earlier, the structure of woven fabrics such as the weave, and the density of warp and weft influences the properties of fabrics. It is obvious that at different weave or thread densities, the values of particular mechanical, utility and comfort-related properties are quite different. In the experiment fabrics of the same weave and thread density were designed. The fabrics differ from each other only in the range of the raw material. It was done in such a way to analyse the influence of the share of SPFs in the fabric structure on the selected properties of the fabrics mentioned earlier. Such a plan of experiment also allowed the comparison of fabrics containing 100% of SPFs with those of an identical structure with SPFs in the warp and other fibres: cotton, viscose and Dacron Coolmax in the weft.



**Figure 1.** Microscopic picture of SPF yarn: a) cross-section, b) longitudinal view.

**Table 1.** Basic properties of the fabrics investigated. **Note:** SPF – soybean protein fibre, CO – cotton, V – viscose, DC – Dacron Coolmax.

Parameter	Unit	Value			
		SPF	SPF/V	SPF/DC	SPF/CO
Weave	–	Plain			
Warp	–	18.5 tex SPF			
Warp density	cm <sup>-1</sup>	29	30	31	27
Weft density	cm <sup>-1</sup>	23	23	22	23
Mass per square metre	g m <sup>-2</sup>	110	113	109	107
Warp crimp	%	1.8	1.4	0.8	2.0
Weft crimp	%	29.0	29.8	20.8	22.8
Thickness	mm	0.26	0.25	0.24	0.28

Cotton and viscose yarns were selected because they are very often applied in lightweight fabrics for summer clothing. This kind of fabric structure (lightweight for summer clothing) was designed and manufactured within the framework of the experiment. Additionally, Dacron Coolmax yarn was applied in order to compare the moisture transport properties of the SPF fabric with those of fabric containing the so-called moisture management yarn in the weft. Taking into account the potential application of the SPF fabric investigated as a fabric for summer clothing, investigation of its liquid moisture transport ability is very important from the point of view of the physiological comfort of clothing (shirt, dress, etc.) made of SPF fabric.

The fabrics were manufactured on a Picanol weaving machine in industrial conditions. All fabric variants were finished in the same way, in industrial conditions. The finishing process included desizing, washing, rinsing and drying. Basic properties of the fabrics investigated are presented in **Table 1**.

The fabrics were measured in the range of their chosen utility and comfort-related properties. The following properties were assessed:

- bending stiffness,
- drapeability,

- liquid moisture transport performance.

Bending stiffness is defined as the resistance to elastic deformation caused by the action of bending moments. The bending stiffness of the fabrics was assessed by means of Peirce's method using a Cantilever stiffness tester [23]. The measurements were carried out in the warp and weft directions (10 replications for each direction). The bending stiffness for a given direction is calculated from the following **Equation (1)**:

$$B = m_p c^3 g \quad (1)$$

where:

- $B$  – bending stiffness, in Nm,
- $m_p$  – mass per square metre, in kg/m<sup>2</sup>,
- $c$  – bending length, in m,
- $g$  – ground acceleration, 9.81 m/s<sup>2</sup>.

Next, on the basis of the results for the warp and weft directions, the total bending stiffness of the fabric is calculated according to the **Equation (2)**:

$$B_{total} = \sqrt{B_{warp} \times B_{weft}} \quad (2)$$

where:

- $B_{total}$  – total bending stiffness of fabric, in Nm,
- $B_{warp}$  – bending stiffness in warp direction, in Nm,
- $B_{weft}$  – bending stiffness in weft direction, in Nm.

**Table 2.** Results of measurement of the bending stiffness and drapability of the fabrics investigated.

Variant	$E_{warp}$ , Nm	$E_{weft}$ , Nm	$E_{total}$ , Nm	K, %
SPF	0.000050	0.000004	0.000014	51.03
SPF/V	0.000030	0.000002	0.000008	55.81
SPF/DC	0.000036	0.000004	0.000012	55.50
SPF/CO	0.000028	0.000005	0.000012	47.37

**Table 3.** Results from the Moisture Management Tester M290.

Variant	WT T	WT B	AR T	AR B	SS T	SS B	R	OMMC
	s	s	%/s	%/s	mm/s	mm/s	%	-
SPF	2.04 (0.072)	2.12 (0.051)	69.57 (2.281)	72.208 (1.756)	8.02 (0.181)	8.01 (0.201)	-19.97 (8.969)	0.46 (0.014)
SPF/V	2.34 (0.066)	2.45 (0.078)	70.38 (0.713)	71.018 (1.233)	6.20 (0.089)	6.08 (0.073)	-37.28 (5.969)	0.43 (0.009)
SPF/DC	2.60 (0.256)	2.70 (0.3652)	37.92 (15.94)	37.344 (9.595)	6.57 (1.224)	6.20 (1.117)	17.68 (40.15)	0.40 (0.401)
SPF/CO	3.80 (0.806)	4.31 (1.421)	25.54 (13.21)	38.80 (14.31)	3.77 (1.203)	3.68 (1.170)	60.53 (101.9)	0.38 (0.036)

**Table 4.** Results of one way ANOVA for parameters determined by the Moisture Management Tester. **Note:**  $MS_{effect}$  – mean square of effect expressing between-group variability,  $MS_{error}$  – mean square of error expressing within-group variability,  $df$  – degree of freedom,  $F$  – variable of  $F$  distribution.

Dependant variable	$df_{effect}$	$MS_{effect}$	$Df_{error}$	$MS_{error}$	F	P
WT T	3	2,974	16	0.182	16.332	3,978 E-05
WT B	3	4,722	16	0,540	8,740	0,001
AR T	3	2566,069	16	108,476	23,656	4,007 E-06
AR B	3	2311,891	16	74,911	30,86193	6,916 E-07
MR T	3	1,667	16	2,500	0,667	0,585
MR R	3	0	16	-	-	-
SS T	3	15,579	16	0,747	20,864	8,915 E-06
SS B	3	15,815	16	0,665	23,773	3,881 E-06
R	3	9424,658	16	3029,775	3,111	0,056
OMMC	3	0,005	16	0,001	7,247	0,003

Drape is one of the parameters characterising the appearance of textile products [24]. Especially, it is very important for clothing goods because it influences the aesthetic effect of clothing, in particular its fitting to the user's body. Physically, drapability is an effect of the interaction between the fabric mass and its bending stiffness.

The drapability of the fabrics was measured using a Fabric Drape Tester [23]. In this method, measurement of the multi-directional drapability is represented by drape coefficient  $K$ . It is calculated from the following Equation (3):

$$K = \frac{\pi r^2 - S}{\pi(r^2 - r_1^2)} \cdot 100 \quad (3)$$

where:

$K$  – drape coefficient, in %.

$S$  – area under the draped sample, in  $m^2$

$r$  – radius of the sample, in  $m$ ,

$r_1$  – radius of the support disk, in  $m$ .

For each fabric variant 3 repetitions of measurement were performed.

Parameters characterising the liquid moisture transport of the fabrics were determined using a Moisture Management Tester – model M290 by SDL Atlas. The measurements were performed according to the device manual based on the AATCC Method 195 – 2011 [2]. The samples for measurement were cut into 80 mm x 80 mm squares, with 5 repetitions for each fabric variant. Values of the following parameters were determined:

- WT T – wetting time of top surface, in s,
- WT B – wetting time of bottom surface, in s,
- TAR – absorption rate of top surface, %/s,
- BAR – absorption rate of bottom surface, %/s,
- $MWR_{top}$  – maximum wetted radius for top surface, mm,

- $MWR_{bottom}$  – maximum wetted radius for bottom surface, mm,
- TSS – spreading speed on top surface, mm/s,
- BSS – spreading speed on bottom surface, mm/s,
- R – accumulative one-way transport index,
- OMMC – Overall Moisture Management Capacity.

## Results and discussion

Results of measurement of the bending stiffness and drapability of the fabrics investigated are presented in Table 2.

On the basis of the results presented in Table 2, it was stated that the fabrics investigated differ from each other in the range of their bending stiffness. Generally, the bending stiffness in the warp direction is several times higher than that in the weft direction, which is a result of the significantly higher density of the warp in comparison to that of the weft. The highest bending stiffness in the warp direction was noted for the fabric variant containing SPF yarns in both the warp and weft. The lowest bending stiffness in the warp direction occurred for the fabric variant with cotton yarn in the weft. In turn, in the weft direction the fabric with cotton yarn in the weft is characterised by the highest stiffness.

It is difficult to explain the differences between particular fabric variants in the range of their bending stiffness in the warp and weft direction. It is a result of different factors. The thread density and mechanical properties of fibres and threads applied in the warp and weft as well as the twist of yarns can be responsible for the bending stiffness of the fabrics investigated. However, data concerning the stiffness of fibres, their linear density and the twist of yarns were not fully available to the authors.

The total bending stiffness is calculated from the bending stiffness in the warp and weft directions according to Equation (2). The highest total bending stiffness was noted for fabric made of SPFs in both directions: warp and weft. The lowest total bending stiffness occurred for fabric with viscose fibres in the weft.

The drapability of the fabrics investigated is at a similar level. In 3 cases the val-

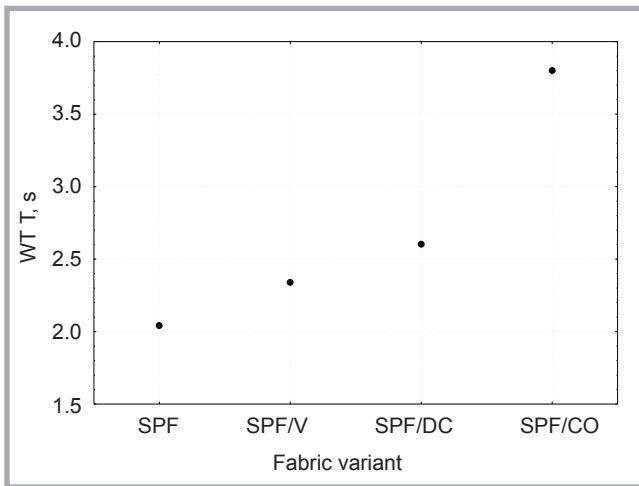


Figure 2. Wetting time for top surface.

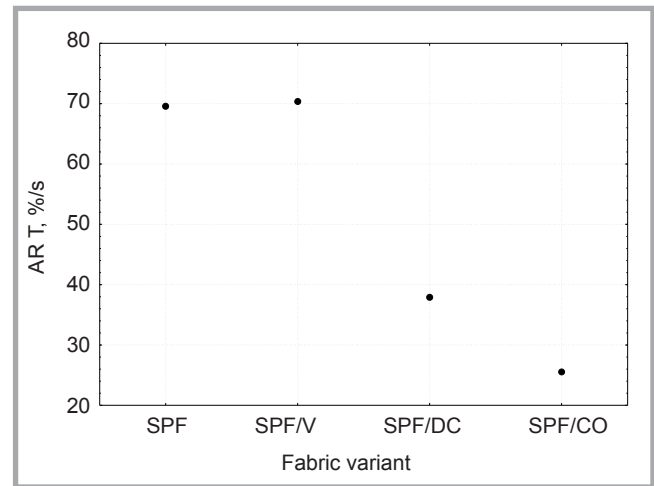


Figure 3. Absorption rate for top surface.

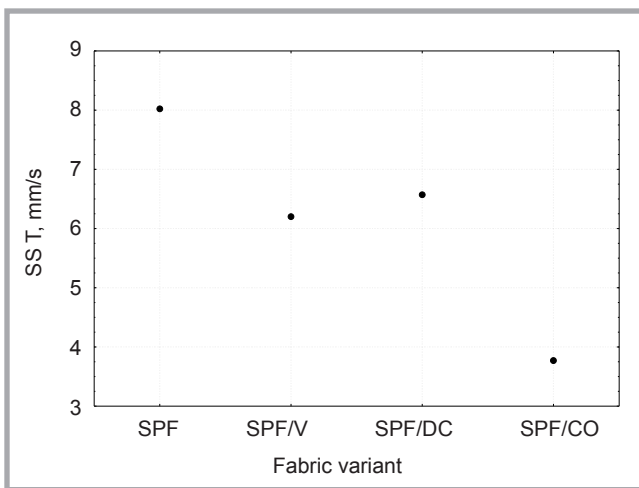


Figure 4. Spreading speed for bottom surface.

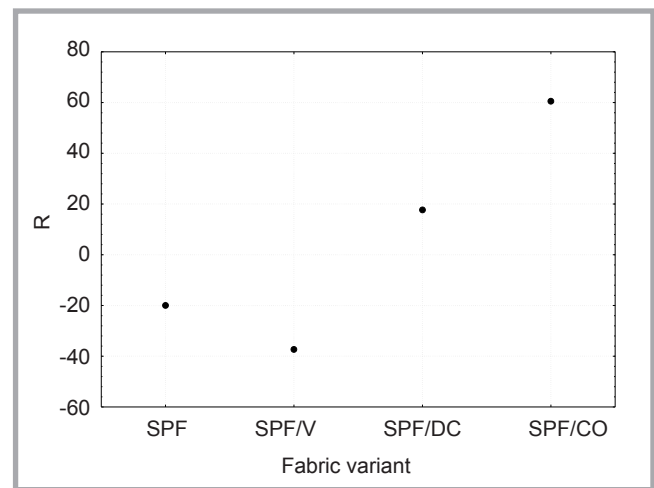


Figure 5. Accumulative one-way transport index.

ue of the drape coefficient is higher than 50%. The lowest value of the drape coefficient occurred for the fabric containing cotton yarn in the weft. It was also observed that in all cases the drapeability in the weft direction was visibly better than in the warp direction, resulting from the lower density of the weft in comparison to that of the warp.

Results from the Moisture Management Tester are presented in **Table 3**, which presents mean values from 5 measurements and the standard deviation of the results (in brackets)

The fabrics investigated differ from each other in the range of parameters determined by the Moisture Management Tester. In order to assess the significance of the relationships between the kind of weft yarn and liquid moisture transport parameters, statistical analysis – ANOVA was performed.

Results of the statistical analysis are presented in **Table 4**, in which the effects statistically significant at the level of significance  $p = 0.05$  are emphasised in bold italics.

The results of the ANOVA confirm that there is a statistically significant influence of the kind of weft yarn on the majority of parameters characterising the liquid moisture transport properties of the fabrics investigated (**Figure 2**).

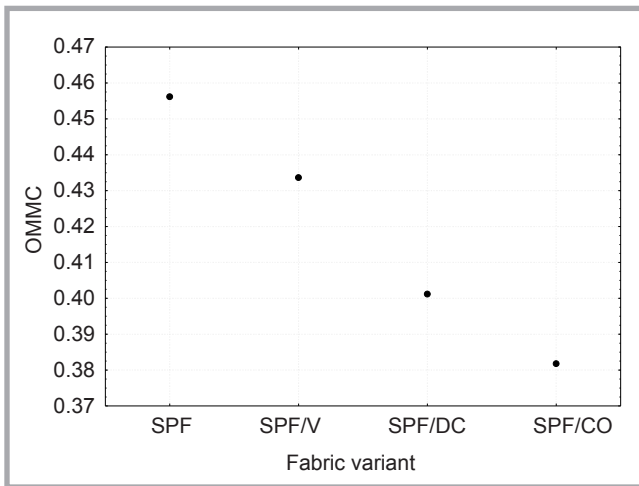
The shortest wetting time was observed for the fabric containing 100% of SPFs, and the longest for fabrics made of SPFs and cotton. A shorter wetting time means a better ability to transport liquid moisture. Results showed that the fabrics made of soybean protein fibres are better from the point of view of wetting than the other fabric variants. The wetting time for 100% SPF fabric was shorter even than for the fabric containing Dacron

Collomax yarn in the weft, despite that fact that Coolmax fibres are considered moisture managing.

The same relationship was also observed for the bottom surface. Generally, the values of parameters measured for the top and bottom surfaces of the fabrics investigated are similar, due to the fact that the fabrics are very thin, and hence liquid moisture is easily transferred from the top to the bottom surface. Additionally, the fabrics are made in plain weave, with both sides of the fabric being identical.

**Figure 3** presents the absorption rate for the top surface of the fabrics investigated.

The highest absorption rate for the top surface occurred for the fabric variants made of SPFs in both directions and for those containing viscose yarn in the weft. The lowest value of the absorption rate



**Figure 6.** Overall Moisture Management Capacity (OMMC).

was noted for the fabric variant made of SPFs and cotton. The fabric containing Dacron Coolmax yarn in the weft is characterised by an absorption rate higher than for the SPF/CO fabric but almost twice lower than for the fabrics containing SPFs and viscose fibres.

The following figure (*Figure 4*) presents the spreading speed for the top surface of the fabrics.

The values (*Table 3*) of the spreading speed for the top and bottom surfaces also confirm the best liquid moisture transport performance of the fabric containing SPFs in both directions in comparison to the rest of the fabrics investigated. For both surfaces: top and bottom, the fabric containing Dacron Coolmax yarn in the weft shows the second best performance in the spreading of liquid moisture.

Values of the accumulative one-way transport index  $R$  of the fabrics investigated are presented in *Figure 5*. A fabric with a high accumulative one-way transport index keeps the skin of the wearer dry due to the transporting of perspiration towards the outer side of the fabric away from the skin. Two fabric variants: SPF and SPF/V are characterised by negative values of the  $R$  index, while two others: SPF/DC and SPF/CO – by positive, but not too high, values of the  $R$  parameter. According to the classification proposed in the MMT manual [20] the fabrics represent poor quality in the aspect of the transfer of liquid moisture from the inner to outer side of the fabric.

Statistical analysis showed that the kind of weft yarn does not influence the value of the  $R$  parameter in a statistically significant way.

*Figure 6* presents the influence of the kind of weft yarn on the Overall Moisture Management Capacity. The OMMC is calculated on the basis of the absorption rate for the bottom surface, the spreading speed for the bottom surface and the one-way transport capability. The value of the OMMC can be in the range from 0 to 1. The higher the value of the OMMC, the better the ability of the fabric to manage liquid moisture.

In the case of the fabrics investigated, the highest value of the OMMC parameter was observed for the fabric containing SPFs in both directions, followed by the fabric with viscose yarn in the weft. Against expectations, the fabric variant containing moisture management fibres (Dacron Coolmax) in the weft was assessed only a little better than the fabric with cotton yarn in the weft. According to the grading rules [20], the fabrics containing SPFs and viscose fibres in the weft were classified as good from the point of view of the Overall Moisture Management Capacity, whereas those with cotton and Dacron Coolmax yarns in the weft were classified as poor.

### ■ Summing up

Soybean protein fibres and their products are present on the market. However, scientific publications in the area of SPFs concern mostly their manufacturing process and properties. In our opinion, information about textile products made of SPFs and their utility properties and performance are insufficient.

The aim of the work presented was to assess the quality of woven fabrics containing soybean protein fibres as well as the usefulness of SPF fabrics for cloth-

ing applications. In order to do so, fabric 100% made of Soybean Protein Fibres was compared with ones made on the basis of SPF warp yarn and with different yarns in the weft. A comparison was made in the range of selected properties which have not been the subject of publications till now. Additionally, the properties of the woven fabrics investigated are important from the point of view of the application of SPF fabrics in apparel products, especially in summer clothing.

Cotton and viscose yarns were introduced in the weft because fibres thereof (cotton and viscose) are the most popular in clothing applications, especially for the summer season. Additionally, technically advanced polyester yarn – Dacron Coolmax was introduced as the weft in order to assess fabrics containing SPFs in the aspect of their ability of liquid moisture transport.

The results obtained showed that the utility and comfort-related properties of the woven fabrics containing SPFs investigated are good. Additionally, it was seen that in many cases the quality of the fabrics containing 100% of SPFs is equal or even better than that of the fabrics of the same structure containing other fibres such as cotton, viscose and Dacron Coolmax in the weft. Especially, the ability of liquid moisture transport of the fabrics 100% made of SPFs was significantly better than that of fabrics with cotton, viscose and Dacron Coolmax yarns in the weft.

The investigations performed confirmed that SPFs and their textile products can be a good alternative to fibres commonly applied in clothing products. The designers and manufacturers of clothing, especially of shirts and dresses, can consider fabrics made of SPFs as an interesting material from the point of view of both appearance and performance. It can also help designers and manufactures to broaden their offer and, at the same time, improve their competitiveness on the market.

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Since 02.07.1996 the **Laboratory** has had the accreditation certificate of the Polish Centre for Accreditation No AB 065.

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- crush tester (RCT, CMT, CCT, ECT, FCT), SCT, Taber and Lorentzen&Wettré (bending 2-point method) Lorentzen&Wettré (bending 4-point method) and stiffness rezonanse method), Scott-Bond (internal bond strength), etc.,
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