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The properties of weft knitted fabric medical and preventive treatment action using eco-raw materials

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Abstract. A new trend in the world is the clothing production using the new types of ecological raw materials application – milk, pineapple, coconut, hemp, banana, eucalyptus, clams, corn, bamboo, soya, nettle yarn. This makes it possible to create textile materials of new generation with unique antibacterial and antiseptic properties. Such materials have a positive preventive and sometimes therapeutic effect on people, and their health. Eco-raw materials clothing is able to protect the human body from the environment harmful effects: cold, heat, rain, dust, opportunely remove from underclothing layer the steam and gases, sweat; maintain in underclothing layer the necessary microclimate for normal organism functioning. Study of knitwear consumer properties, produced with eco-materials, is an urgent task of the world vector, directed on ecological environmental protection.

This paper presents the research results of hygroscopicity and capillarity weft knitted fabrics, what knitted from different types of eco-raw materials: bamboo yarn, yarn containing soybean and nettle yarn. Character of influence of the liquid raising level changes depending on the experiment time and the knitting structure is revealed.

1. Introduction

Bamboo tree easily grows by itself in areas with good ecology. It does not require any additional farm work, special watering. Bamboo does not require protection from mosquito as spraying the soil and the plant with chemical fertilizers. It has antibacterial properties, prevents increase of harmful microorganisms. Bamboo textile materials are 20 % more breathable than cotton ones and absorb water 60 % better. Such properties are available owing to the great many of natural pores in the fibre. Breathability and hygroscopicity are determined with the degree of porosity of the fibre. Bamboo fibres absorb and evaporate water from the whole surface. If required, bamboo may output excessive heat and vice versa keep the warm in cold season. Thus, moisture and temperature optimal for the body are provided. That's why, bamboo clothes prevent perspiration, the body becomes cool, and there is no unpleasant smell. Moreover, bamboo textile materials protect from UV radiation up to 98 %. It is an ideal material for summer clothing [2, 3].

Soya fibre as well as bamboo one is ecologically raw material. Soya fibre is produced with the latest technology based on processing of plant proteins from soya beans. As well as bamboo, soya beans easily grow and they are insect resistant. There is no need in large number of pesticides, fertilizers and genetically modified objects. Textile materials from soya fibre are very tactile, wearable and easy to look after. They do not require hot water in washing, linear dimensions are not changed in washing, and materials dry very fast. Clothes from soya fibre absorb and evaporate water in a moment [4].

Technology for production of small and great nettle appears not long ago. The nettle grows near the roads, on wastelands, as usual weeds. Certain technology enables us to process the nettle and produce textile materials for clothing. It is proved that nettle clothes helps the customer for certain



ailment: headache, pain in the joints. Clothes from nettle improve blood circulation and have other medical and recreational effect.

Nettle raw material is manufactured in a similar way to flax. Technology for production of nettle yarn is not complicated but rather time-consuming. Classic proceeding includes the following stages: soaking, drying, breaking, shaking, hackling and spinning of fibres [5].

The main factor for using eco-friendly materials in clothing is the fact that all of them are decayed in soil due to microorganisms and do not emit harmful substances to the environment. Processing of such types of fabric on knitting equipment is not well-studied. There is no information about influence of structural properties to physical properties, in particular to hygroscopicity and capillarity [4, 5, 6, 7].

2. Experimental

For the raw material to produce experimental models, the following types of yarn were taken: bamboo yarn (100 %) linear density 40x9 tex, yarn that contains soya bean (50 % soya and 50 % bio-cotton) linear density 25x8 tex and nettle yarn (100 %) that is a knitted ribbon made with rib knitting structure 1+1 - 355 tex. Experimental models are made on plane-knitting machine ‘Brother’ of the 5-th class with plain and rib knitting structures. Density levels of knitting are defined for the machine; it provides standard process of loop formation.

Hygroscopicity and capillarity of experimental models are determined according to standard method. It is commonly known that hygroscopicity of textual materials describes their ability to absorb and evaporate water and water vapour [8]. Experimental results are presented in histogram (Fig. 1).

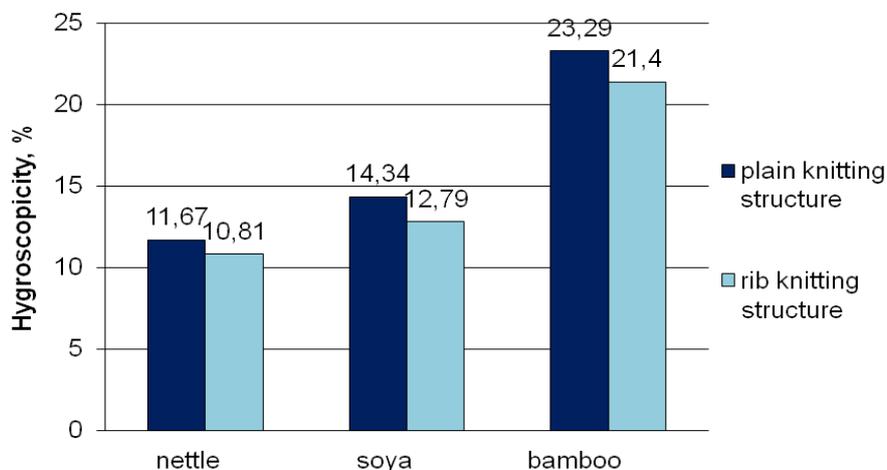


Fig. 1. Hygroscopicity of experimental models

As you see from histogram, bamboos knitted models have max hygroscopicity. For knitted fabric with plain structure this value is 23 %, with rib structure – 21 %. Nettle fabric has min hygroscopicity (plain structure – 12 %, rib structure – 11 %). During experimental survey it is discovered that hygroscopicity depends not only on raw material but also on peculiar features of fabric structure formation. Despite the fact that surface density of fabric models with rib structure is higher, these models illustrate lower level of hygroscopicity. This may be explained by peculiarities of structure formation. Knitted fabric with rib structure has two layers of stitches (purl stitch is located beyond the knit stitch because of elastic properties of yarn) while with plain structure – only one layer. Thus, vapour liquid does not completely penetrate to the internal layer of fabric with rib structure and, as a result, models have lower level of hygroscopicity.

Process of raising the liquid level along the course and wale for the experimental models with plain structure during 60 minute experiment is presented in Fig. 2 and Fig. 3, respectively, for the models

with rib structure 1+1 – in Fig. 4 and Fig. 5, respectively.

Generated diagrams enable us to find out the nature of raising the liquid level depending on duration of experiment. Appropriate equations of regression are obtained.

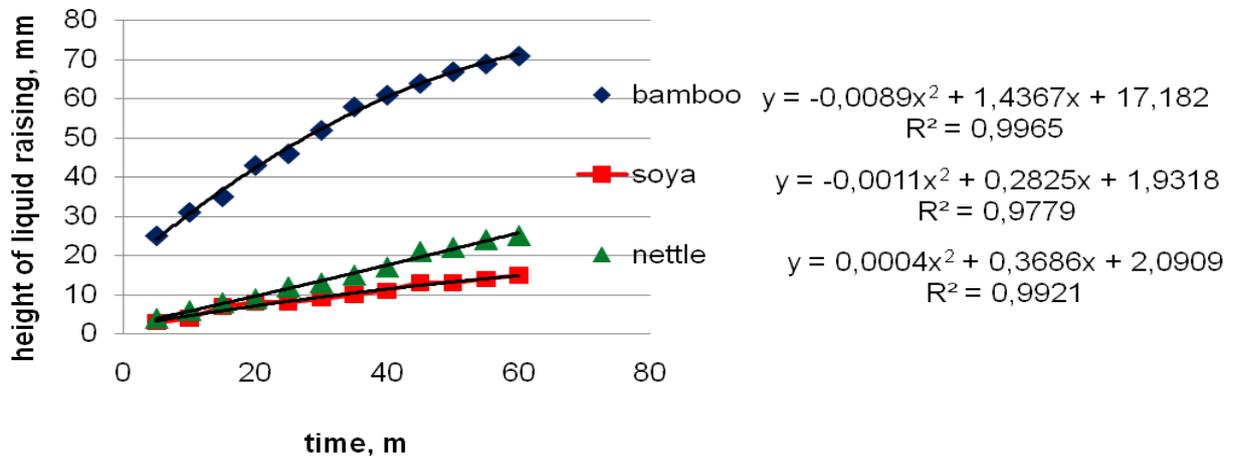


Fig. 2. Diagram of raising the liquid level of experimental models with plain structure along the wale.

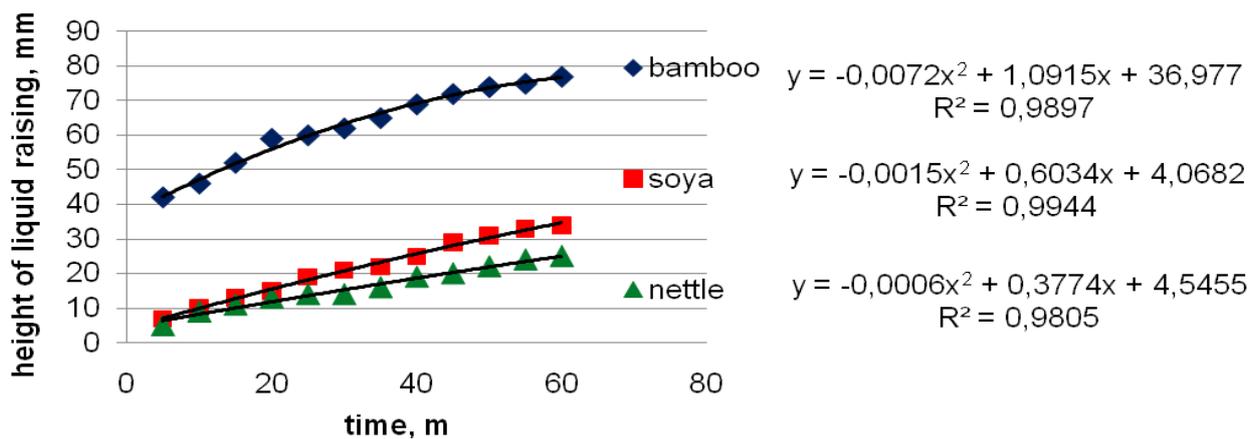


Fig. 3. Diagram of raising the liquid level of experimental models with plain structure along the course.

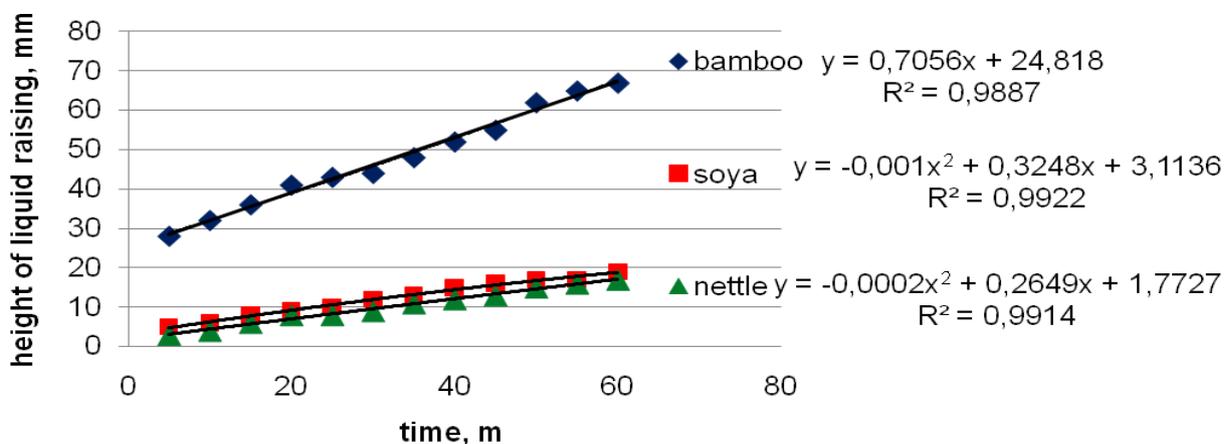


Fig. 4. Diagram of raising the liquid level of experimental models with rib structure 1+1 along the wale.

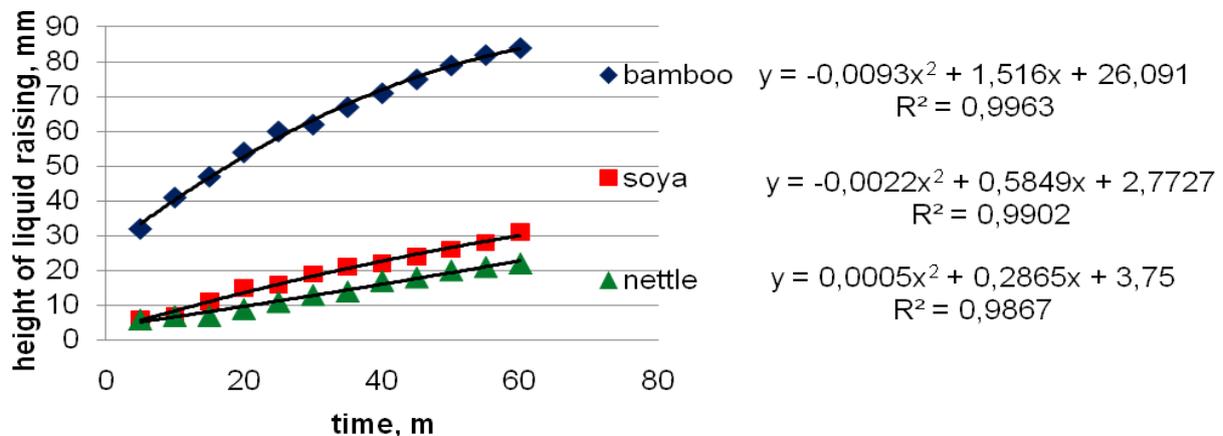


Fig. 5. Diagram of raising the liquid level of experimental models with rib structure 1+1 along the course.

Comparative analysis of influence between raw material type and liquid level shows the following. Max level is observed in the nettle models 460-530 % and along the course in models from soya yarn – 380-420 %. This tendency is observed for both fabrics with plain and rib structure.

Liquid level along the wale rises higher in experimental models with plane structure rather than with rib structure. This may be explained with peculiarities of structure formation. In the rib structure, the purl wales are located beyond the knit ones. It causes difficulties in raising liquid within capillaries.

In contrast, a very different situation is observed along the courses. In models with rib structure liquid level is higher than in models with plain structure. This is due to the larger area of surface contact between models with rib structure and the liquid.

The survey reveals that the rising liquid level depends not only on type of the raw material but also on type of structure.

Capillarity described ability of elementary sample to absorb and transfer moisture to certain height with the help of capillary forces when it is deepened into liquid for the 60 minutes [9, 10]. The survey results are presented in the histograms (Fig. 6-7).

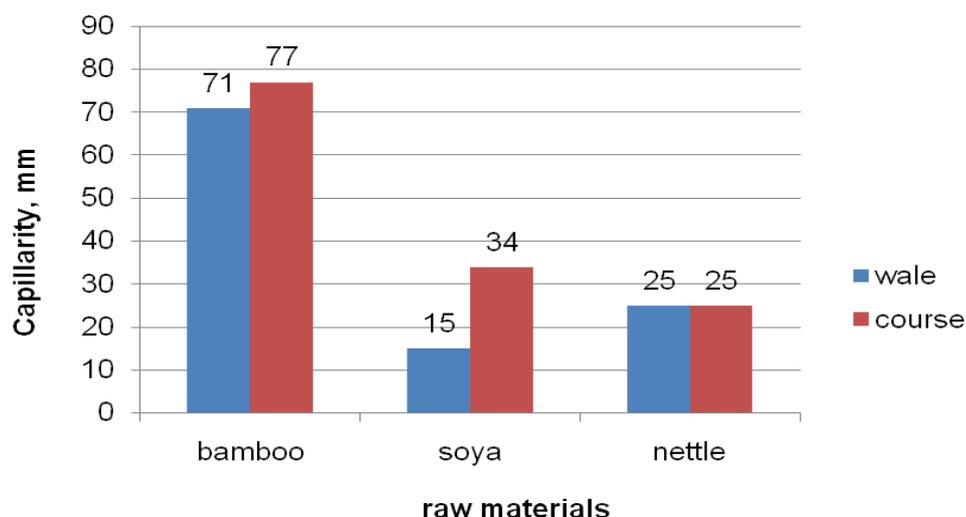


Fig. 6. Capillarity of experimental models with plain structure along the course and wale.

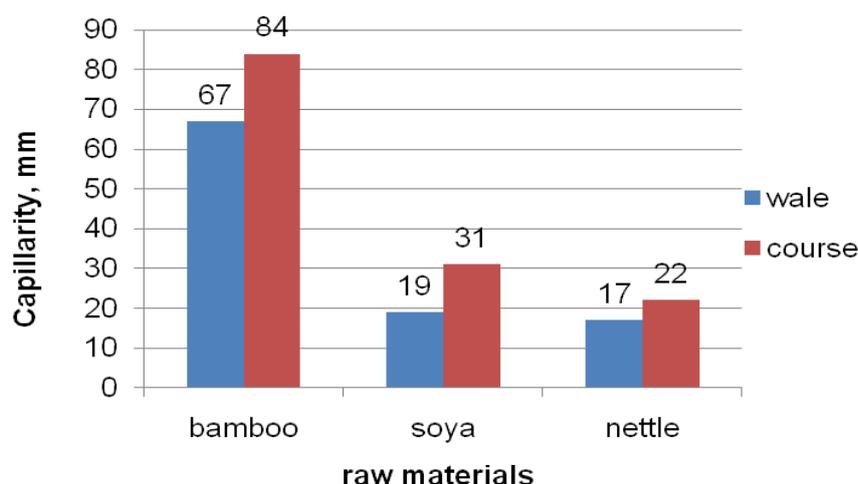


Fig. 7. Capillarity of experimental models with rib structure 1+1 along the course and wale.

As can be seen in the histograms, max capillarity along courses and along wales is observed in the experimental models from bamboo fabric.

Capillarity in experimental models with *plain structure*:

- *along wales* from soya fabric, 78.9 % less in comparison with bamboo models. In nettle fabric models in comparison with bamboo models, capillarity is 64.8 % less.
- *along courses* from soya fabric, 55.8 % less in comparison with bamboo models. In nettle fabric models in comparison with bamboo models, capillarity is 67.5 % less.

Capillarity in experimental models with *rib structure*:

- *along wales* from soya fabric, 71.6 % less in comparison with bamboo models. In nettle fabric models in comparison with bamboo models, capillarity is 74.6 % less.
- *along courses* from soya fabric, 63.1 % less in comparison with bamboo models. In nettle fabric models in comparison with bamboo models, capillarity is 73.8 % less.

Comparative analysis of capillarity of experimental models along courses and wales shows the following. In bamboo models with plain structure, capillarity along courses is 8.5 % higher than along wales. In soya models with plain structure, capillarity along courses is 127 % higher. In nettle models, capillarity is the same (Fig. 6). In models with rib structure 1+1 from bamboo fabric, capillarity along courses is 25.3 % higher, from soya fabric – 63.2 % higher, from nettle fabric – 29.4 % higher (Fig. 7). When comparing capillarity along wales in models with plain and rib structure, the following picture may be observed. Capillarity of models with rib structure along wales for bamboo fabric reduces by 5.6%, for soya fabric – increases by 26.7 %, for nettle fabric as for the bamboo one reduces by 32 % (Figs. 6-7). In experimental bamboo models with plain structure in comparison to the models with rib structure 1+1, capillarity is 9.1 % less along the courses, for models of soya fabric – 8.8 % higher, for nettle fabric – 12 % higher.

3. Results and discussion

The survey reveals that max hygroscopicity is observed in bamboo knitted models (plane structure – 23 %, rib structure – 21 %). Min hygroscopicity is observed in nettle models (plane structure – 12 %, rib structure – 11 %). Hygroscopicity depends on the structure pattern. The highest hygroscopicity is observed in knitted models with plain structure.

The survey reveals that max capillarity is observed in bamboo models (65-85 mm). Though min change in liquid level is observed in nettle models, their capillarity is only 17-25 mm.

Capillarity both along course and along wale depends on the fabric structure formation. Regardless of the type of raw material, higher capillarity is observed along the course. It is explained by direction of loop formation, so this is laterally knitted fabric. As to the type of raw material,

capillarity of models produced from nettle and soya fabrics is practically the same. Capillarity of bamboo models is 2 times higher because of bamboo fibre structure.

4. Conclusions

Knitted fabric obtained from eco-friendly raw materials has positive preventive and sometimes therapeutic effect on human body. Utilization of such materials after their life cycle is environmentally safe. However, when structure formation is generated, it is necessary to consider its influence on hygroscopicity and capillarity. Higher hygroscopicity of textile materials in items with medical and recreational effect may cause growth of pathogenic microflora under the clothing. Information about capillarity of knitted fabric provides an opportunity to evaluate the nature of moisture spreading along the course and wale.

The study reveals the nature of change in liquid level depending on the time of experiment, knitting structure and type of raw material. With results obtained in the study, it is possible to predict hygroscopicity and capillarity of knitted fabric according to selected loop formation and type of raw material.

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