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NATURAL AND MAN-MADE FIBERS AND THEIR ROLE IN CREATION OF PHYSIOLOGICAL STATE OF HUMAN BODY

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Natural fibres including linen and hemp are human friendly in every way. They guarantee high comfort as well as environment protection. Testing of clothes on the human organism is a necessity. New and more sophisticated technologies are being introduced in the textile industry that make production processes more efficient, more productive, allow for introduction of new assortment of textile products and new fibers, improvement of properties of clothes. However, chasing after technological novelties, one cannot forget about the human, because it is a human who is a recipient of the final product. No product should cause a negative effect on human organisms. Each new technology using new modifying chemicals should be evaluated for the safety in direct contact with human skin. The influence of clothes, which were covering transiently the human forearm muscles, on activity of motor units of these muscles was investigated at the INF. The results of electromiographical studies of two groups of people wearing the natural and synthetic apparel shown that temporary covering of tested forearm muscles with synthetic clothes changes the pattern of motor unit activity. The observed fluctuations are the reason of desynchronization in muscle motor units that may lead to higher tendency to fatigue when wearing synthetic garments. Another research concerned influence of different kinds of wear (in given conditions, during the rest or exercise) to the oxidative stress and how the organism defense mechanism change. One of the ways to test the ability of the organism to defense itself against the reactive oxygen species is to determine so called total antioxidant index status (TAS). This parameter informs about total ability of tissues to neutralize exactly determined amount of reactive oxygen species. Due to considerable amounts of man-made fibers in wear and bedding, there are more and more allergies observed among people who use different textile products based on man-made fibers. According to the most recent studies conducted at the Institute of Natural Fibres and Nara Woman's University, Japan, it was found that man-made and natural fibers in clothes have dramatically different physiological effect on human body. This physiological influence is connected with different effect on the level of α -globulin and histamine produced in

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human body in different conditions created by clothes made of different fiber composition.

Keywords: clothing comfort; natural fibers; physiology

INTRODUCTION

Natural fibres including linen and hemp are human friendly in every way. They guarantee high comfort as well as environment protection. Since ages they are a natural human protection against weather conditions giving comfort to the man.

In the presence of increasing environment pollution and chemistry more and more entering our lives man has to make choices almost everyday. More often we prefer healthy “green” food and we move to the suburbs instead of living in the city centers.

Clothing comfort is a complex and hazy subject hard to define in a simple few words. Most of all this is a result of comfort being set of personal individual feelings. However, saying shortly we can call comfort all physiological human body reactions to the conditions related with environment-cloth system. For an everyday consumer a state of comfort is similar to “freedom from pain and from discomfort; a neutral state” [25].

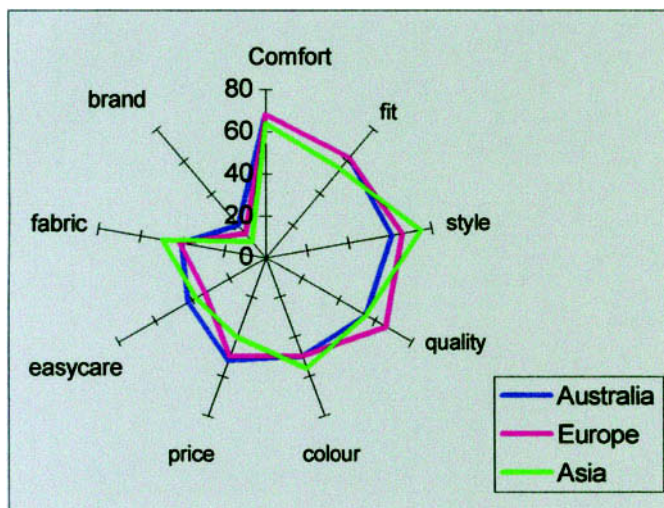
The comfort is very important for the greater part of users. We can see it on the Ryc. 1. It shows some results from a study on the perceptions of the importance of various attributes of clothing worn at the work place, which covered a number of national groups from Europe, Asia and Australia.

The main trends among the national groups are similar. From the nine dimensions listed, comfort, fit, style, color and quality were rated more important than others, which suggests the need for an effective methods for evaluation of the overall wear performance of clothing. The “skin – clothing” system is the key one when talking about comfort formula.

We should consider it as an open system that is always in a state of dynamic interaction with its surrounding environment in physical, sensory, physiological and information means.

Heat and moisture transport between human body and its surrounding is a result of processes that run on the surface of skin and lungs, processes that arise from conduction, convection, radiation and evaporation. The contribution of numerous processes to the whole system differs for various surrounding conditions.

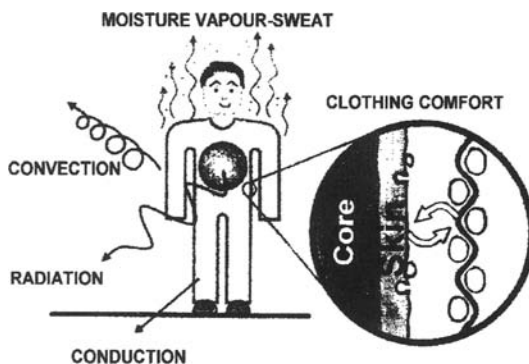
“Humans have a special set of nerves for feeling pleasure at a mother’s caress or lover’s embrace. While the thick fibres rapidly shoot electrical signals to the somatosensory cortex of the brain and convey information about



RYC 1 Consumers' requirement of clothing (Y. Li. Wool sensory properties and product development, Textile Asia, 1998, Vol. XXIX, 5)

contact and pressure, the thin slow fibres connect to the insular cortex and convey the emotional context of the toughing. The fast fibres indicate, when we are touched and how strong the touch is. The slow fibres signal the fine aspects of the touch."

In the similar way the touch receptors placed in the skin are transmitting information to the brain concerning stimuli from the clothing. The nerve ends



RYC 2 The human-clothing-environment system (Source: Y. Li, The Science of Clothing Comfort [25]).

A mother's touch, a lover's caress

Study locates special nerves for gently transmitting love

By Shankar Vedantam
The Washington Post

WASHINGTON: Neuroscientists have discovered what romantics have always known: The touch of a lover's hand is special.

Scientists announced Sunday a study that shows humans have a special set of nerves for feeling pleasure at a mother's caress or a lover's embrace.

These nerves are sensitive to the soft touch of fingers gliding over a forearm or a parent's soothing hand, but not to rough touches, jabs or pinches. Scientists speculate that the nerves might be designed to guide humans toward tenderness and nurturing — a theory bolstered by the fact that the nerves are wired to the same brain areas activated by romantic love and sexual arousal.

Although these special nerves, which have thin fibers and send relatively slow signals to the brain, had been identified in animals and humans, their role had been unclear.

Scientists had wondered about their purpose, especially because

they do not work as efficiently as thick nerve fibers, which are also found in skin.

The research, published in the current issue of *Nature Neuroscience*, indicates that while the thick fibers rapidly shoot electrical signals to the somatosensory cortex of the brain and



sets of nerves is that the slow fibers function from the earliest hours of life, perhaps even in the womb, while the fast fibers develop slowly after birth.

Newborns might be able to feel the love in a parent's touch before they can feel the touch itself.

Referring to studies showing that babies need physical contact and nurturing, the group of scientists wrote, "The profound importance of such a system for human well-being has long been suggested, at least since the classical study of baby monkeys who show affection for a surrogate mother in response to tactile comfort."

The nerve system continues to function throughout life, underscoring the importance of such comfort. While the thicker nerve fibers that communicate contact information are more densely packed into areas such as the palm, the thinner nerves are found on hairy areas of the skin such as the forearm.

Their functional role is below the level of consciousness and has to do

convey information about contact and pressure, the thin, slow fibers connect to the insular cortex and convey the emotional context of the touching. Both sets of fibers fire together, and the brain combines information about physical contact with information about emotional context, melding them into the richness of physical experience.

A crucial reason nature might have endowed people with two different

See TOUCH, Page 7

RYC 3 "TOUCH: Special nerves help babies and lovers feel pleasure, softly" Source: The Washington Post, July 30, 2002 (by Shankar Vedantam).

collect the stimuli from skin exposed to clothes and send the information to the brain. This way they stimulate certain processes in human's body.

Depending on the kind of clothing stimuli can be pleasant or not. Except of stimuli directly received by fast and slow fibres of nerves placed in the skin, there are many other factors deciding about complex impression of the user of clothes. The aspects of comfort as well as the hygienic properties of clothing have been a scope for many researches. There is a set of publications concerning that topic.

Traditional tests on physic-mechanical characteristics of textile products are not enough today if we concern an objective evaluation of textile properties. In the tests described below we have tried to go further. The aim was not the comfort itself but the changes on human body caused by the clothing. Under the term "changes" we mean the state of immunological system, allergic reactions. According to the results of research of clothes influence on plasma level of immunoglobulin E and histamine, an increase in allergic reactions can be observed with people wearing synthetic clothing. That effect does not exist in case of people wearing natural fibres garment. Therefore we have tested clothes that are common in our everyday life. Two groups of raw material were distinguished: natural and synthetics fibres.

SLEEP AND NATURAL FIBRES

At the Institute we have established a new laboratory – Laboratory for Physiological Influence of Cloth on Human Body. Laboratory is fully air-conditioned what guarantee stable temperature and humidity on level resulting experiments requirements. The experiments are done in cooperation with Karol Marcinkowski University of Medical Sciences in Poznań under the agreement with its Commission of Bio-ethics. were done experiments on the influence of bedding on sleep conditions. A comparative test has been done on beddings made of natural (100% linen, 100% cotton) and synthetic (100% PES) fabrics. Some of the most important fabrics features are shown below.

Experiments Methodology

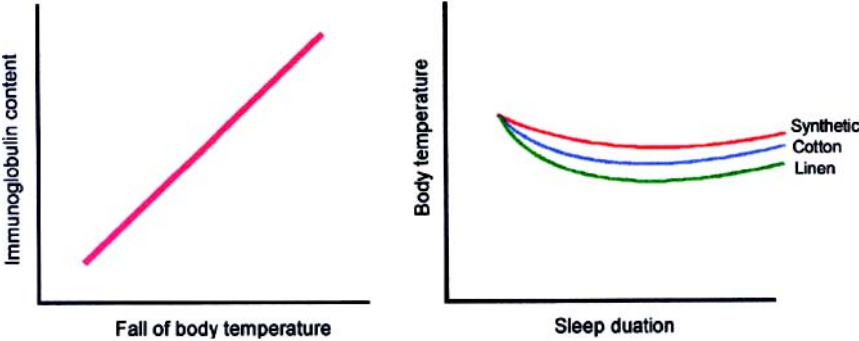
During the experiments skin and inner body temperature as well as level of immunoglobulin A was measured. Young males slept for 8 hours in linen bedding followed by sleep in polyester bedding. The environmental conditions were strictly defined for each experiment to avoid any accidental differences in results. Air temperature 20°C, humidity 50%, sleep duration 22.00 till 6.00, springtime. The men were in similar age and similar constitutional conditions. Temperature was measured in 10 minutes intervals. The level of immunoglobulin A was measured through saliva analysis.

(IgA) A class of antibodies, often formed as a dimer (i.e., two antibody molecules attached to each other end to end), that is secreted into bodily fluids such as saliva. IgA protects the body's mucosal surfaces from infections.

Results of experiments showed that temperature of body is lower during sleep in linen and cotton bedding. Also in that case level of immunoglobulin A content is higher than for polyester bedding. That means a deeper sleep when human body regenerates quicker and rests better. Human immune system grows stronger.

TABLE 1

Fabric	Surface mass g/m ²	Hygroscopicity at 65% humidity	Hygroscopicity at 100% humidity	Resistance Ω	Heat Resistance Km ² /W
100% linen	152.3	7.0	16.2	5.5×10^9	12.2
100% cotton	141.4	6.4	15.1	1.2×10^9	10.6
100% PES	138.6	0.3	1.5	1×10^{12}	7.5



RYC 4 Temperature and immunoglobulin content for cotton and polyester bedding.

SEBACEOUS GLAND

H. Tokura *et al.* [23] described different adaptability of sebaceous gland activity to two kinds of clothing with hydrophilic (cotton) and hydrophobic (polyester) properties. Human skin has been evolved, being surrounded by clothing with hydrophilic properties.

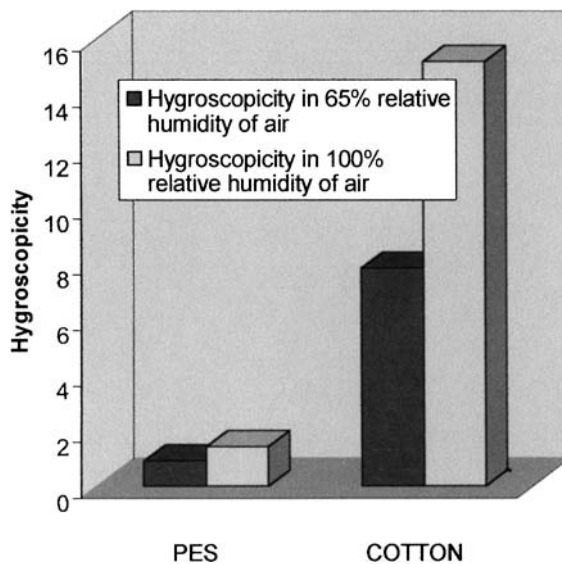
The sebaceous glands are located approximately 0.5 mm under the skin surface. On human skin they are distributed almost over the entire body with the exception of palms and soles (feet). The amount of glands per cm² skin and their size varies considerably. On the scalp, the most and the largest sebaceous glands are to be found, up to 800 per cm².

The secretory product of the sebaceous gland films thinly over the hair and surface of the stratum corneum, which may spread up to the upper layers of the stratum corneum. Thus, water permeability is reduced and the resistance to acid, lye and bacterial contamination is increased.

Ten female adults wore pajamas with hydrophilic properties and ten female adults wore pajamas with hydrophobic properties during night sleep for the month. The pajamas were worn directly to the skin. The authors collected sebum from the back skin two times and samples of blood for the measurements of Natural Killer Cell Activity.

Squalene, waxester and triglyceride being derived from sebaceous gland, increases from start to finish of experiment significantly in cotton pajamas, but did not change significantly in polyester pajamas (Ryc. 7–9).

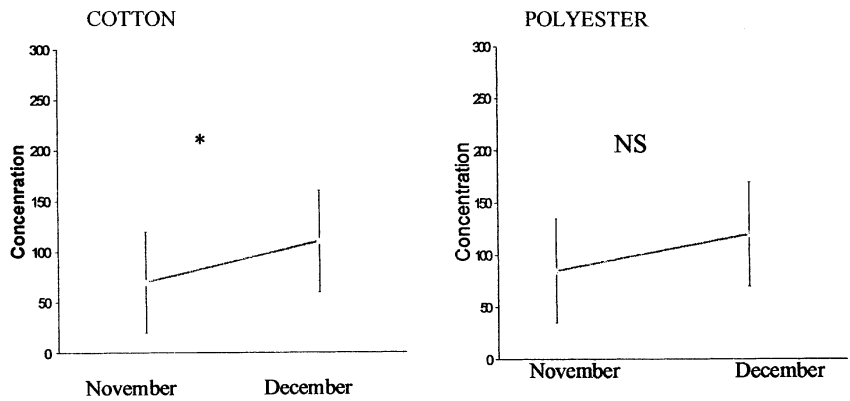
Prof. Tokura maintained that Natural Killer cell activity increased significantly in PES (Ryc. 10). It indicated, that the subject wearing polyester pajama were more stressful during night sleep. Stress could decrease the level of androgen. Its reduced level could also suppress the sebaceous gland activity.



RYC 5 Higorescopicity of cotton and polyester fabric.



RYC 6 Copyright © 2000–2003 skin care forum.



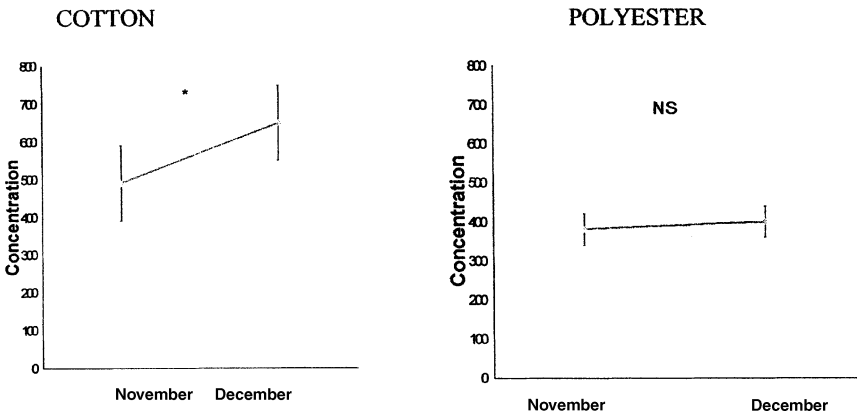
RYC 7 Average SQ (Squalene) in pajama; [μg/ml].

Constant skin cover by clothing with hydrophilic properties (cotton) could enhance sebaceous gland activity. It indicates that skin as a defense barrier against attack from surrounding agents could function more effectively. Synthetic clothing (with hydrophobic properties) would suppress natural and seasonal increment of sebaceous activity.

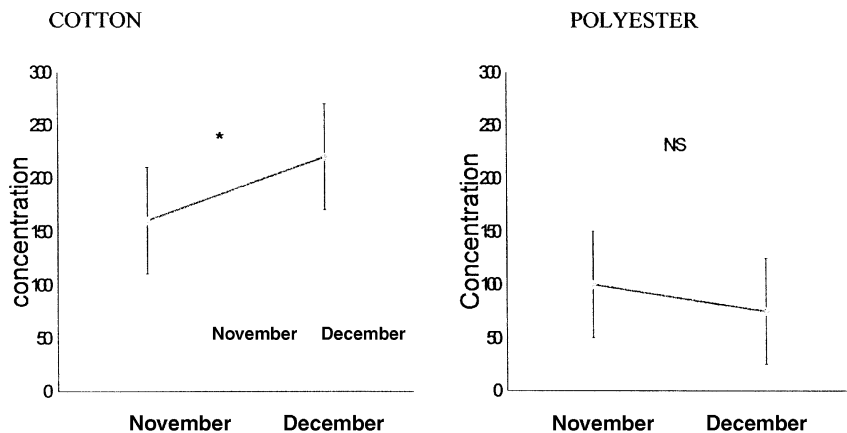
OXIDATIVE STRESS

Material

Natural fibres including linen and hemp are human friendly in every way. They guarantee high comfort as well as environment protection. Since ages



RYC 8 Average TG (triglyceride) in pajama; [μg/ml].

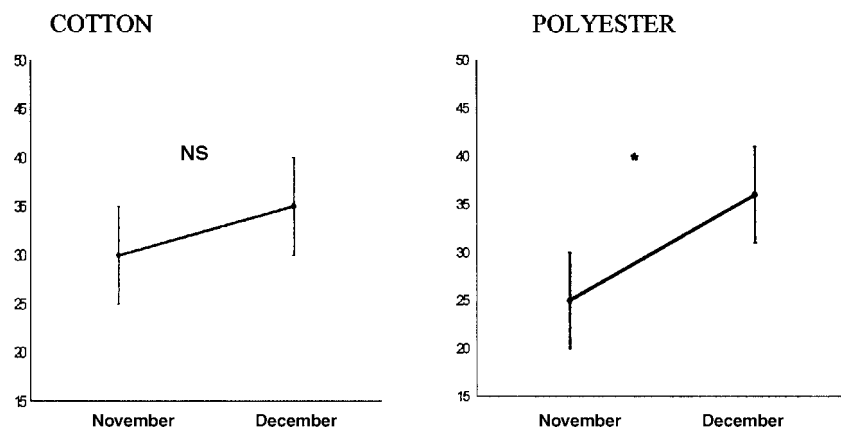


RYC 9 Average WE (waxester) in pajama; [$\mu\text{g}/\text{ml}$].

they are a natural human protection against weather conditions giving comfort to the man.

Natural and synthetic fibres clothing have been used as a tested material linen and polyester. Tests have been done on man shirt made of above mentioned fibres; same model, long sleeves, same construction. Only size has varied due to the differences in volunteers who had signed up for the trails.

Characteristics of textile metrology parameters of used clothes are shown in Table 2.



RYC 10 Average NK cell (Natural Killers) activity in pajama [%].

TABLE 2

Material	Hygroscopicity		Surface resistance [Ω]	Electro-static discharge time constant [ms]	Heat resistance [Km ² /W]
	65% air humidity	100% air humidity			
100% linen	9.3	17.1	1.5 × 10 ⁹	56	14.8
100% PES	1.0	1.3	6.5 × 10 ¹¹	1891	5.4

Time Constant of ms unit is a time for 67% discharge of electrostatic charges gathered on clothes surface.

Conditions for the measurement of Time Constant were as follows:

- Upper limit of time constant potential – 150 V
- Lower limit of time constant potential – 50 V
- Air humidity – 55%
- Air temperature – 20%

Lower values of surface resistance and time constant of electrostatic discharge for linen fabric compared to values measured for polyester concludes that linen clothes do not allow for gathering electrostatic charges on their surface. Person wearing polyester garment is exposed to a danger of a constant influence of electrostatic field and rapid discharges in contact with conducting materials.

That is a consequence of polyester ability for gathering electrostatic charge.

Methods

The tests were conducted on 6 healthy, untrained, similarly built males of age 19–23. The control group were people wearing linen garments, the tested group were the same people wearing polyester clothes. The people stayed in specially adopted climatic chamber (Laboratory of Physiological Testing at the INF) in temperature 20°C and relative humidity 50% and air movement smaller than 0.5 m/s.

The tests were conducted during resting –8 hours, moderate physical exercise –20 min, and after post-exercise restitution (until blood pressure and pulse was stabilize). The physical activity was on the level of 75 W according the cyclometer (Hellige) Ryc. 11.

In the period before rest, before exercise, after exercise and after restitution, the physiological parameters were tested and blood samples for



RYC 11 Moderate physical exercise.

biochemical assessment were taken. TAS (total antioxidant status) was measured using colorimetric method (Randox Laboratories Ltd. GB). The authors of the study have a permission of the Bioethical Commission at the University of Medical Sciences in Poznań for conducting those tests.

Results

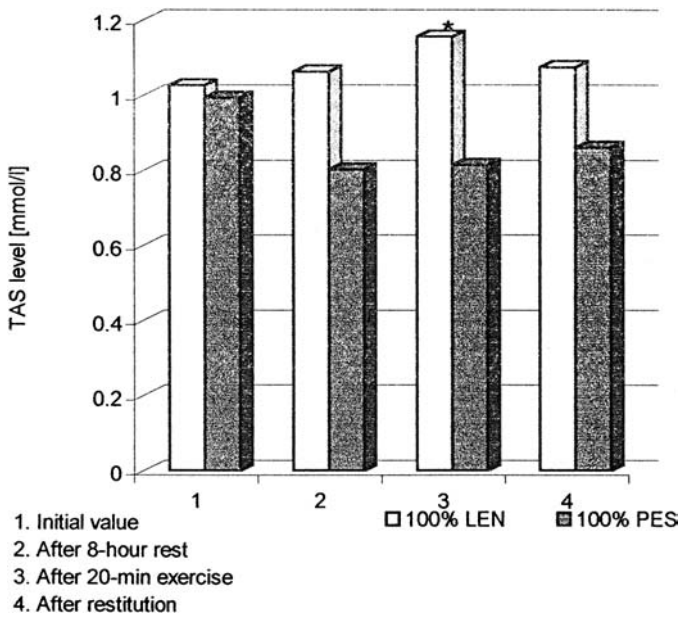
The aim of the tests was to find the answer to the question, whether staying in different kinds of wear in given conditions, during the rest or exercise may be the cause of the oxidative stress and how the organism defense mechanisms change.

One of the ways to test the ability of the organism to defense itself against the reactive oxygen species is to determine so called total antioxidant status (TAS) [4]. This parameter informs about total ability of tissues to neutralize exactly determined amount of reactive oxygen species.

The results of TAS level testing in people wearing linen and polyester clothes in controlled conditions are shown in Ryc.12.

The results show that the TAS value is lower for individuals wearing PES for 8 hours as compared to linen. The difference is considerable bigger after moderate exercise. Similarly TAS is higher in individuals wearing linen after post-exercise restitution.

Obtained results may show that the antioxidative reserves are over, resulting from increased amounts of ROS in individuals wearing PES.



RYC 12 The TAS level in people wearing linen and PES.

It is supposed that the polyester wear may cause higher production of ROS, which reduces the antioxidative reserves of the organism.

Change of parameters of antioxidative system may reflect the oxidative stress i.e. disorder in physiological defense mechanisms against the reactive oxygen species.

NATURAL FIBRES CLOTHING AND MUSCLE TENSION

Everyday clothing can influence human muscles tension what can be a reason for an increase in tiredness feeling. That was confirmed by the experiments done by the Institute of Natural Fibres in cooperation with Department of Pathophysiology of Locomotor Organs of Karol Marcinowski University of Medical Sciences in Poznań.

Experiments Methodology

The studies were performed on six volunteers who worn preliminary linen garments and than polyester garment. The electromyographical parameters of muscles were gathered before exposition to the tested garment

and after it. The volunteers group consisted of men with similar age, height, weight and constitutional conditions. The exposition duration with both garments was similar as well environmental conditions to avoid any accidental differences in results. Duration of exposition was strictly connected with biological day rhythm. The EMG device recorded the level of muscle tension on surface of forearm during activity and static performance of volunteers.

Results

Covering temporary tested forearm muscles with polyester fabric a change in electromyographical parameters can be observed. That effect does not exist in case of linen fabric. Even if changes in EMG recording have acceptable range still they confirm existence of some desynchronization in muscle activity. That can lead towards tiredness during longer exposure to synthetics fabrics.

The mentioned occurrence is a result of a higher skin temperature observed under polyester clothing (resulting from lower air permeability and heat diffusion) and presence of electrostatic charges on its surface.

NATURAL FIBRES FABRICS AND UV PROTECTION

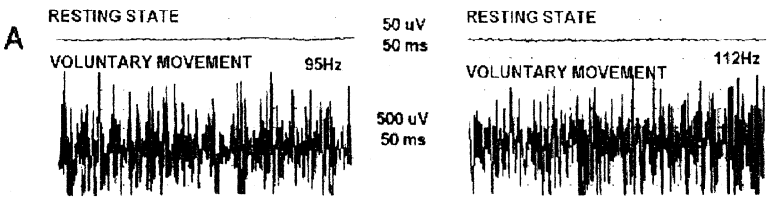
Apparels made of natural fibres not only influence favorably to some of the physiological factors of our body but also ensure safety during sunny days protecting us against hazardous ultraviolet radiation.

Ultraviolet rays emitted by the sun and enlarging thinner ozone layer (or even a hole) create together a high risk to the human. That's why clothing should guarantee a protection to user against higher level of UV radiation. The mentioned protection is strictly connected with structural parameters of cloth like its density, thickness, clearance as well as color. Type of fibre origin is important especially in case of raw fabrics (non-dyed). Natural fibres containing natural pigments and lignin are perfect absorbers of ultraviolet rays. Linen and hemp fibres contain in their structure lignin and so they can be classified as perfect protectors against UV rays.

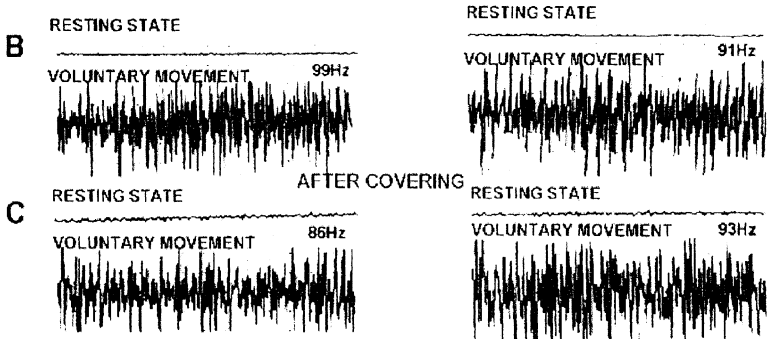
As it can be seen from the Ryc. 14, linen fabrics of lower clearance level so fabrics of more dense structure assure a perfect protection against hazardous ultraviolet radiation – the UPF factor is high.

It is well known that linen and hemp fabric is sometimes finished in liquid ammonia. That aims towards reducing crease ability and better touch. Liquid ammonia gives a softer touch as well as increases “easy-care”.

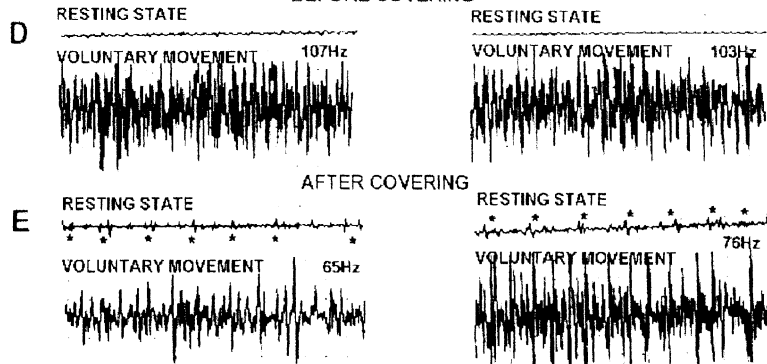
ELECTROMYOGRAPHICAL EXAMINATIONS
CONTROL GROUP - HEALTHY VOLUNTEER



GROUP I - INFLUENCE OF THE NATURAL CLOTH COVERING
BEFORE COVERING

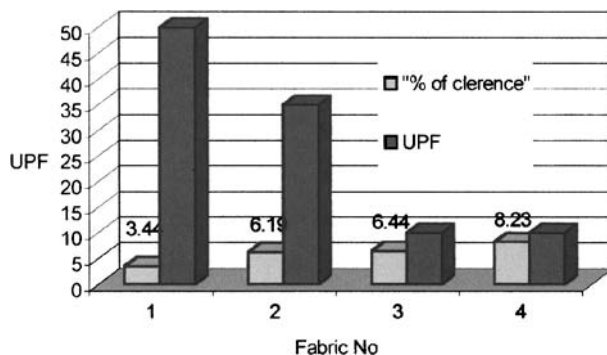


GROUP II - INFLUENCE OF THE SYNTHETIC CLOTH COVERING
BEFORE COVERING



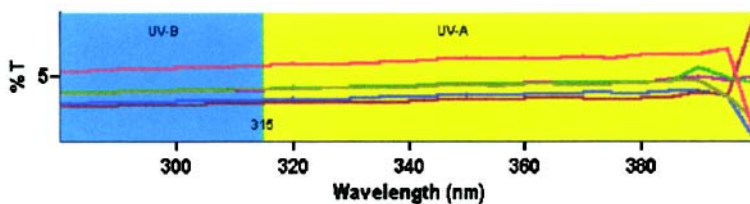
FLEXOR FOREARM MUSCLES EXTENSOR FOREARM MUSCLES

RYC 13 Examples of EMG recordings obtained in the healthy volunteer (A) and two subjects of group I (B, C) and group II (D, E) before and after covering the forearm with two kinds of clothings. Upper records – recordings at the resting state, lower records – recordings during the voluntary movements. Stars show the presence of the spontaneous discharges. Numbers in the upper right corner show the frequency of the action potentials appearing in each record during the voluntary movements.

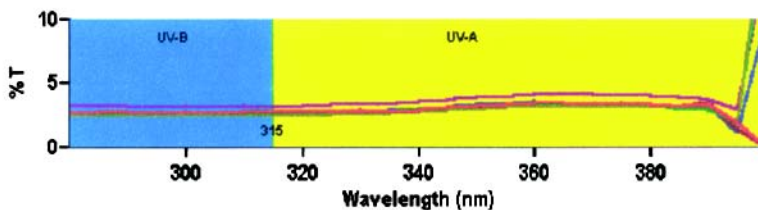


RYC 14 UPF and percentage of clearance for linen fabrics.

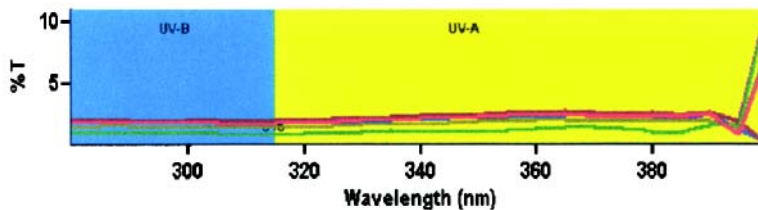
Raw hemp fabric; UPF = 15



Hemp fabric after ammonia; UPF = 30



Hemp fabric after finishing with resins; UPF = 50



GRAPH 15 The UV transmittance through hemp fabrics after different steps of finishing.

That finishing (two steep processes) makes fabric structure denser and so increases UV protection factor.

More dense structure of fabric with lower level of clearance guarantee to the user better protection against ultraviolet radiation of B type which is responsible for skin burning and A type that penetrates skin deeper creating cancer. Recently media on base of medical reports often say that cosmetic creams and fluids often called protectors do not fulfill their scope and tasks. And so the clothes seems to be the most effective and most important way to protect human against UV radiation. It guarantees a perfect and full protection for people exposed to the sun. This is very important for military and special dress.

CONCLUSIONS

1. According to the results of researches, garment made of cellulosic fibres like cotton, linen and hemp has a positive influence on physiological parameters of human body: level of immunoglobulin A, histamine and sebaceous gland activity and muscle tension in comparison to the examined polyester clothing which may have an unfavorable influence on human body.
2. The lower level of total antioxidative status in individuals wearing polyester may show that probably this is an effect of increased production of reactive oxygen species, which are responsible for the oxidative stress.
3. Linen and hemp apparels guarantee safety to the user even in conditions of high ultraviolet radiation as well as ensure good comfort and cool touch.
4. The most important step the research schedule will be determination of optimal natural and synthetic fibres blend that would assure user on one hand a good comfort and health typical for natural fibres and on the other easy care of synthetics.

The aim and reason of studies is clear to everyone. We should know everything about the relations between clothing and our body and influence over our health. In days of high textile market competitiveness consumer should be aware of the consequences when buying various garments.

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