REVISTA

DE PIELĂRIE ÎNCĂLŢĂMINTE

Leather and Footwear Journal

March / Martie 2019
Volume / Volumul 19
Issue / Ediția 1

INCDTP - SUCURSALA INSTITUTUL DE CERCETĂRI PIELĂRIE ÎNCĂLȚĂMINTE
INCDTP - DIVISION: LEATHER AND FOOTWEAR RESEARCH INSTITUTE

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JOURNAL SPONSORSHIP

Edited with the sponsorship from the Ministry of Education, Research and Innovation of Romania, National Authority for Scientific Research. We are pleased to acknowledge support from the following: The Confederation of National Associations of Tanners and Dressers of the European Community – COTANCE, Belgium; Romanian Leather and Fur Producers Association, APPBR, Romania; SFERA FACTOR, Romania.

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Revista de Pielarie Incaltaminte / Leather and Footwear Journal requires article processing charges of 100 EURO per article, for accepted manuscripts, payable by the author to cover the costs associated with publication. There are no submission charges.

Hard copies of journal issues are available for purchase at subscription rates of 160 EURO for companies and 100 EURO for individual subscribers, while the rate for a single issue is 40 EURO. Subscriptions (include mailing costs) can be made at the editorial office, to the following address:

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Both article processing charges and subscription fees are to be paid in the following account:

Account holder: INCDTP – Division: Leather and Footwear Research Institute; Address of the account holder: 93 Ion Minulescu Street, postal code 031215, sector 3, Bucharest, Romania, Europe

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CERTEX Publishing House – Bucharest, 16 Lucreţiu Pătrăşcanu St., sector 3; Tel./ Fax: (0040) 21 340.55.15; certex@ns.certex.ro

Website: http://www.revistapielarieincaltaminte.ro

Facebook: http://www.facebook.com/LeatherFootwearJournal

Title DOI: https://doi.org/10.24264/lfj

REVISTA DE PIELĂRIE ÎNCĂLŢĂMINTE LEATHER AND FOOTWEAR JOURNAL

REVISTA DE PIELĂRIE ÎNCĂLŢĂMINTE LEATHER AND FOOTWEAR JOURNAL

ISSN: 1583-4433
Volume 19, No. 1, March 2019
https://doi.org/10.24264/lfj.19.1

EFFECTS OF THE STRIDE LENGTH ON THE GAIT AND INTRA-LIMBS COORDINATION OF HEALTHY CHILDREN AGED 3 TO 6

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Received: 11.09.2018 Accepted: 17.01.2019 https://doi.org/10.24264/lfj.19.1.1

EFFECTS OF THE STRIDE LENGTH ON THE GAIT AND INTRA-LIMBS COORDINATION OF HEALTHY CHILDREN AGED 3 TO 6

ABSTRACT. Body motion adjusts while the stride lengths changes, but few studies report those influences on the gait mechanism and intra-limbs coordination of children; therefore, the purpose of our study was to evaluate the gait mechanism and intra-limbs coordination of healthy children aged 3-6 under stride length adjusting, so as to add the knowledge of motor development of healthy children. Forty-five healthy children and ten adults walked on a 6m walkway at three stride lengths (short stride (SS), normal stride (NS) and long stride (LS)) and key kinematical parameters such as Euler angles and angular velocities were first recorded by CodaMotion 3D measure system; and then those two variables were applied to calculate the continuous relative phase (CPR) which specified coordination in the knee and ankle. Results showed that when transferring from short stride to normal stride long stride, children were to deal with by increasing stride length, Froude number, swing phase, and decreasing frequency. However, there were no significant differences between SS and LS in kinematical parameters; meanwhile, those significant variations were not found between age groups. In terms of intra-limb's coordination, there were no significant differences in values of relative phases within and between age groups. In conclusion, as early as age 3, young toddlers have already mastered the basic ability in adjusting gait while walking.

KEY WORDS: child development, gait, intra-limbs coordination, long stride, short stride

INFLUENŢA LUNGIMII PASULUI ASUPRA MERSULUI ŞI COORDONĂRII MEMBRELOR INFERIOARE LA COPII SĂNĂTOŞI CU VÂRSTA ÎNTRE 3 ŞI 6 ANI

REZUMAT. Mişcarea corporală se reglează pe măsură ce se modifică lungimea paşilor, însă puţine studii raportează aceste influenţe asupra mecanismului mersului şi coordonării membrelor inferioare la copii; prin urmare, scopul studiului nostru a fost de a evalua mecanismul mersului şi coordonarea membrelor inferioare la copii sănătoşi cu vârste cuprinse între 3 şi 6 ani, în condiţiile ajustării lungimii paşilor, pentru a contribui la cunoştinţele privind dezvoltarea motorie a copiilor sănătoşi. Patruzeci şi cinci de copii sănătoşi şi zece adulţi au mers pe o platformă de 6 m efectuând paşi de trei lungimi (pas scurt (SS), pas normal (NS) şi pas lung (LS)), iar parametri cinematici cheie, cum ar fi unghiurile Euler şi vitezele unghiulare, s-au înregistrat prin sistemul de măsurare CodaMotion 3D; apoi acele două variabile au fost aplicate pentru a calcula faza relativă continuă (CPR) care specifică coordonarea la nivelul genunchilor şi gleznei. Rezultatele au arătat că, atunci când trec de la un pas scurt la un pas normal şi lung, copiii au trebuit să mărească lungimea pasului, numărul Froude, faza de balans şi să scadă frecvenţa. Cu toate acestea, nu au existat diferenţe semnificative între SS şi LS privind parametrii cinematici; nu s-au identificat aceste variaţii semnificative între grupele de vârstă. În ceea ce priveşte coordonarea membrelor inferioare, nu au existat diferenţe semnificative între valorile fazelor relative în cadrul grupelor de vârstă şi între acestea. În concluzie, încă de la vârsta de 3 ani, copiii au deprins deja abilitatea de bază de a ajusta lungimea paşilor în timpul mersului.

CUVINTE CHEIE: dezvoltarea copilului, mers, coordonare intra-membre, pas lung, pas scurt

L'INFLUENCE DE LA LONGUEUR DES FOULÉES SUR LA MARCHE ET LA COORDINATION INTRA-MEMBRE CHEZ LES ENFANTS EN BONNE SANTÉ ÂGÉS DE 3 À 6 ANS

RÉSUMÉ. Les mouvements du corps s'adaptent à mesure que la longueur des foulées change, mais peu d'études ont rapporté ces influences sur le mécanisme de la marche et la coordination intra-membre chez les enfants; notre étude visait donc à évaluer le mécanisme de la marche et la coordination intra-membre chez les enfants en bonne santé âgés de 3 à 6 ans en ajustant la longueur des foulées afin de contribuer à la connaissance sur le développement des capacités motrices des enfants en bonne santé. Quarante-cinq enfants et dix adultes en bonne santé ont marché sur une passerelle de 6 mètres en faisant des foulées de trois longueurs (foulée courte (SS), foulée normale (NS) et foulée longue (LS)), et les principaux paramètres cinématiques, les angles d'Euler et les vitesses angulaires, ont été enregistrés à l'aide du système de mesure 3D CodaMotion; ensuite, ces deux variables ont été appliquées pour calculer la phase relative continue (CPR) qui spécifie la coordination du genou et de la cheville. Les résultats ont montré que pour passer d'une foulée courte à une foulée normale et longue, les enfants devaient augmenter la longueur du pas, le nombre de Froude, la phase de la balance et diminuer la fréquence. Cependant, il n'y avait pas de différences significatives entre SS et LS en ce qui concerne les paramètres cinématiques; ces variations significatives entre les groupes d'âge n'ont pas été identifiées. En ce qui concerne la coordination intra-membre, il n'y avait pas de différences significatives entre les valeurs des phases relatives dans les groupes d'âge et entre celles-ci. En conclusion, depuis l'âge de 3 ans, les enfants ont déjà appris la capacité de base pour ajuster la longueur des foulées dans la marche.

MOTS CLÉS : développement de l'enfant, marche, coordination intra-membre, foulée longue, foulée courte.

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INTRODUCTION

Human's motor function is a complex system; it involves series components closely cooperated to complete a movement, such as muscles, joints and bones. Degree of freedom (DOF) [1-2] decides mode of nervous system to control muscles and bones; meanwhile, motor coordination [3-4] is a crucial mechanism to guarantee the efficiency and rhythms of walking. There is a specific route of this process: nervous system detects signals from environmental changes that impact the body; then coordinates the actions of muscles and bones by translating the signals into simple instructions that muscles and bones can accept. When the normal stride mode is interfered, for instance, it will directly lead to a new combination of DOF in NMS. So, by observing the variations while transferences would highlight the inner development mechanism in motion of healthy children. This study will focus on the transference from normal stride (NS) to long stride (LS) and short stride (SS) independently, so as to explore the ability of children aged 3-6 in dealing with those modifications.

Current studies reported that while environmental constraints change, stride length, step frequency and speed remained constant range [5] (such as backward walking, crossing obstacle and eyes-closed walking); whereas, patients of cerebral palsy, Parkinsonian syndrome and stroke, individuals would modulate their stride length to maintain balance [6]. LS and SS have been studied. Varraine *et al*. [7] found that adults would maintain balance in LS and SS by using different stance and swing phases. Huang *et al*. [8] studied influence of different stride-frequencies on spine stability and they summarized that LS with lower frequency significantly affected the phase changing of spine. Further, Young *et al*. [9] evaluated the varied width and length of steps on the trunk stability and suggested that SS had significant effects on the stability of trunk motions. However, Hak *et al*. [10] indicated that stride length adjusting modified the margins of stability, but it couldn't affect the local dynamic stability.

Current knowledge implied that stride length would significantly affect gait and intra-limbs coordination. Bernstein [1] pointed out that knowledge and experience have impact on the development of motor coordination. However, few qualified studies have showed when does motor coordination mature to cope with stride length adjustment. Since children aged 3-6 [11-12] were in a stage of an important first transition with regard to the amount of postural sway occurring, we could question that are there any differences in gait of healthy children between LS and SS, or is there any variation in intra-limbs coordination between LS and SS? Are there any inter-age differences in both gait and intra-limbs coordination?

Therefore, concerning with those questions, the purpose of our study was to evaluate the gait mechanism and intra-limbs coordination of healthy children aged 3-6 under stride length adjusting, so as to add the knowledge of motor development of healthy children. With respect to the first and second research question, we hypothesized that children would perform different gait and intra-limbs coordination between LS and SS. With respect to the third research question, we hypothesized that inter-age differences would exist both in gait and intra-limbs coordination.

EXPERIMENTAL

Subjects

Table 1: Individual Parameters for Five Groups

	Age 3 group	Age 4 group	Age 5 group	Age 3 group 6	Adult group
N	10	10	12	13	10
Mean Age (years)	3.2±0.3	4.4±0.3	5.1±0.2	6.0±0.1	34.5±9.8
Mean Weight (kg)	15.1±1.7	17.4±3.3	19.1±2.8	19.2±2.4	58.3±6.7
Mean Height (cm)	96.2±4.3	102.7±5.2	107.9±4.6	112.3±4.8	166.4±7.5
Mean BMI	16.2±0.9	16.4±2.3	16.34±1.3	15.2±1.1	20.9±1.7
Mean Leg length (cm)	52.9±2.5	54.3±2.8	62.2±2.3	64.1±2.4	99.8±7.3

Forty-five healthy children and ten adults were recruited and divided into five groups of 3, 4, 5, 6, and Adult. The characteristics of these groups are reported in Table 1. All subjects did not have orthopedic or neurological disorders. All the measures were executed after the study details were introduced to the children's parents and with their formal approvals. Moreover, all the measurements and procedures followed the principles of Helsinki Declaration.

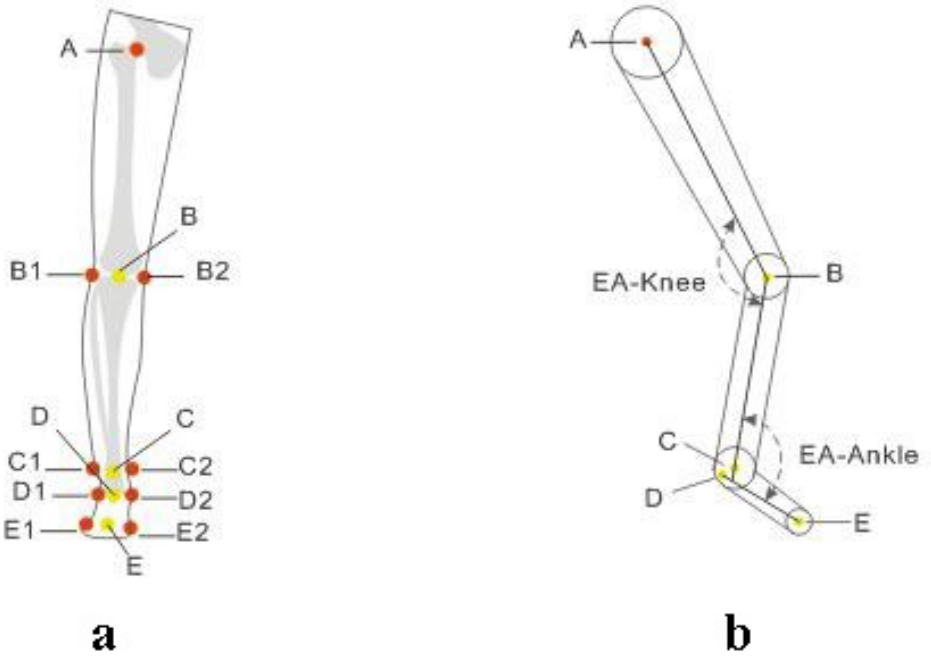

Figure 1. Markers location and Euler Angles for lower limbs
(a) Position of the landmark of elevation view; (b) Euler Angles of lateral view

Data Collection Protocol

The marking patterns of joints were divided into two types: anatomic markers and virtual markers (obtained by Odin software (V1.02, Charnwood Dynamics Ltd., United Kingdom)) (Figure 1. a). Details of anatomic markers included: marker 'A' represent a point of the anterior superior iliac spine; marker 'B1' and 'B2' are the lateral and medial prominences of the distal points of thigh; 'C1' and 'C2' imply the lateral and medial prominences of ankle; 'D1' and 'D2' are the lateral and medial extremities of the heel; 'E1' and 'E2' indicate the 5th and 1st MTH. Virtual markers included the central points of knee, ankle, heel, and forefoot, named B, C, D, E respectively. Motion in the sagittal plane, such as flexion/extension of the knee (ϑ (EA-Knee) / ω (EA-Knee)) and ankle (ϑ (EA-Ankle) / ω (EA-Ankle)) were showed in Figure 2. a.

Subjects walked at their own selected speed on the track, then the average step length was calculated, which was defined as the normal step length of each age group (36cm, 44cm, 60cm, 70cm and 90cm for age 3, 4, 5, 6 and Adult). Two stride lengths were provided: LS and SS. LS was defined as that participants walked with 150% step length of the normal walking (54cm, 66cm, 80cm, 105cm and 135cm for age 3, 4, 5, 6 and Adult); while SS was that participants walked with 50% step length of the normal walking [13-14] (18cm, 22cm, 30cm, 35cm and 45cm for age 3, 4, 5, 6 and Adult). LS and SS were randomly assigned to children in the measure.

Subjects were asked to warm up for 60 seconds firstly, and then they chose their own preferred speed and walked along a 6m walkway (Figure 2). The walking path was composed of two parts: the first one was 3m normal walking area, and the last 3m was the stride changing area. Two Codamotion cameras were aligned on both sides of the 6m walking track, placing at an angle of 160°. Five successful walking trials for each condition were used for further analysis. A successful trial included five consecutive foot strikes with full-marker-visibility.

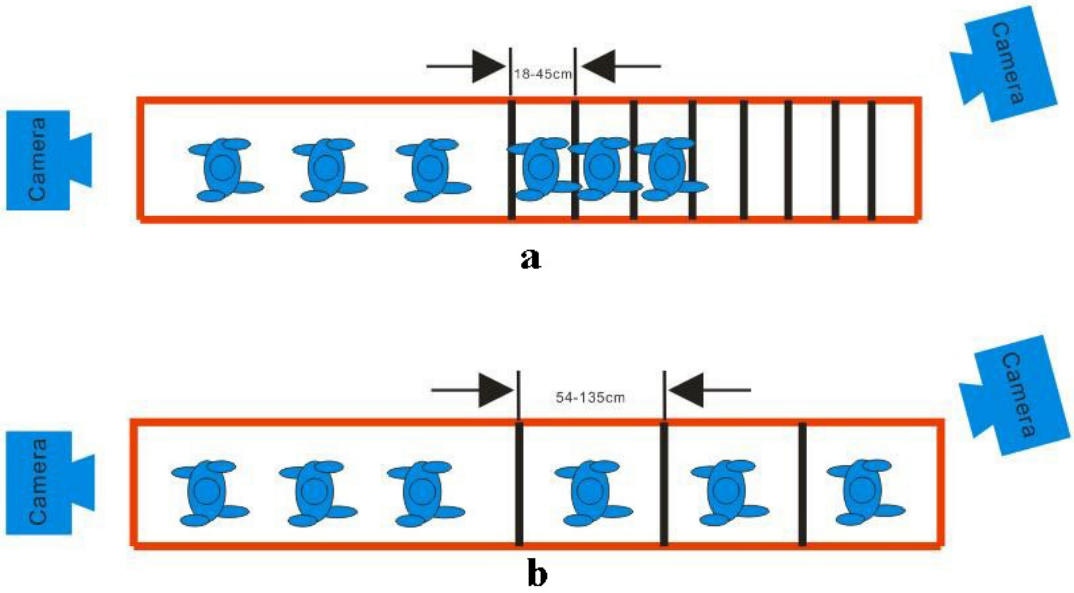

Figure 2. Definition of the LS and SS
(a) Walking sketch map of SS; (b) Walking sketch map of LS

Data Processing

TSP (tempero-spatial parameters) were processing first, which included frequency (steps/time), Froude number (Fr=V^2/g·L (V: velocity, g: acceleration of gravity, L: leg length), stride time (the interval of two times forefoot contacting phase of right foot), percentage of stance duration (the percentage of right foot supporting phase during gait cycle) and percentage of swing duration (the percentage of right foot lifting phase during gait cycle).

The time-courses of the Euler angle (ϑ) and angular velocity (ω) of lower-limb were calculated in the Odin software with respect to the vertical in the sagittal plane (200Hz). and they were filtered using a FIR filter with cut-off of 6Hz. Then three-times-spline-curve was used for interpolation calculus to create a 100-point time-normalized gait cycle (GC) [15]. Finally, the mathematical model of the continuous relative phase (ϑ_{CRP} (A-K)) was computed between the ankle and knee, and it was used to analyze the timing of the interlimb movements. The calculation procedures were as follows: first, the Euler angle (ϑ) and angular velocity (ω) were normalized into ϑ and ω (Eqs. (1) and (2)). Second, the point phase angle (PA) was computed according to (Eqs. (3)). Finally, the ϑ_{CRP} (A-K) was resolved (Eqs. (4)). Coordination stability was described by standard deviation (SD) of CRP, and the dispersion degree of parameters was characterized by Range.

$$\dot{\theta} = 2\left[\frac{\theta - min(\theta)}{max(\theta) - min(\theta)}\right] - 1 \quad (\text{Eps. } 1)$$

$$\dot{\omega} = \left[\frac{\omega}{max\ (|\omega|)}\right] \quad (\text{Eps. } 2)$$

$$\varphi\ (i)\ = tan^{-1}\left[\frac{\bar{\omega}(i)}{\bar{\theta}(i)}\right], i = 1,2,\dots,n (\text{Eps. } 3)$$

$$\theta_{CRP}\ (i)\ = |\varphi_1(i) - \varphi_2(i)| \quad (\text{Eps. } 4)$$

Statistical Analysis

Normal distribution was tested by One Sample K-S model and the results indicate that all data obey the normal distribution. Gait differences between LS and SS were assessed using Paired-Samples T Test, and inter-age differences were assessed by One-Way ANOVA. All the statistical models were executed under SPSS 16 with the significance level of 0.05 and confidence interval of 95%. The coordination stability of joint was described by standard deviation (SD), and the dispersion degrees of parameters was characterized by Range.

RESULTS

Character of TSP

Compared with SS, LS showed a longer stride time, larger Froude number (according to Figure 3), shorter stance duration and lower frequency. But stride time and stance duration of both gait decreased gradually with the increasing of age. In addition, all parameters were close to adult level gradually, except frequency and Froude number.

In the two walking tasks, the results of variance analysis of inner-age groups showed that there were significant differences in each age of 4-6 in terms of stride time ($p<0.05$), and the Froude number of all groups were different, except with that of age 6. What's more, the swing duration in age 4, 5 and adult groups also revealed remarkable differences ($p<0.05$). According to the results of variance analysis of inter-age groups, the differences between children and adult mainly existed in the frequency of LS ($p=0.002<0.05$) and the stride length of LS ($p=0.003<0.05$).

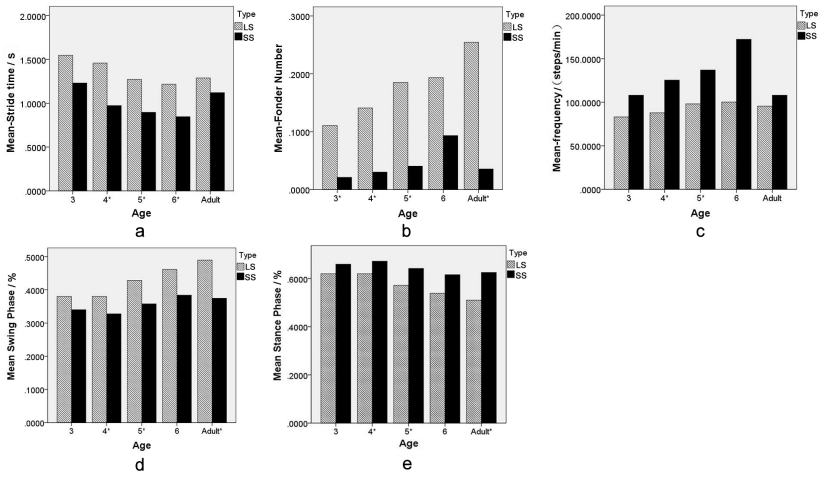

Figure 3. Portraits of the TSP
(a) Mean stride time; (b) Mean Froude Number; (c) Mean frequency;
(d) Mean swing phase; (e) Mean stance phase.
* significant difference between LS and SS within groups

The Relationship between the Normalized Euler Angles and Angular Velocities of Joints

The relationship between the normalized Euler angles and angular velocities of all joints were observed for both gait (Figure 4). In both joints, there was no difference ($p>0.05$ for all) between the LS and SS of all inner-age groups. Nevertheless, comparison between different age groups, ankle joint SD of adult was significantly higher than that of children aged 3-4 under LS (Adult vs. age 3, $p=0.021<0.05$, Adult vs. age 4, $p=0.04<0.05$).

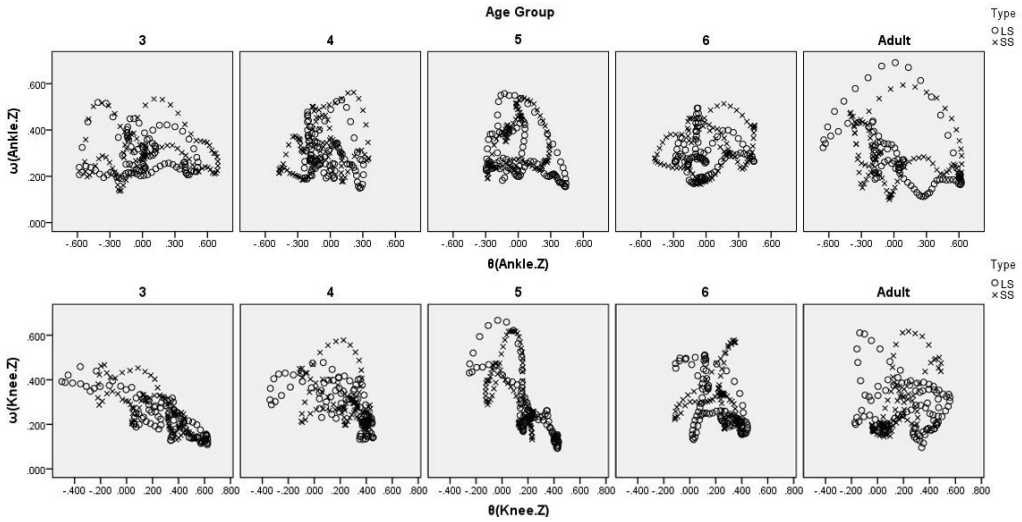

Figure 4. Portraits of the relationship between the standard Euler Angles and velocities of knee and ankle joints

Intra-limb Coordination of Each Joint

According to (Figure 5), the ϑ_{CRP} (A-K) of adults under LS was higher than that under SS during the period of heel contact (1%-17% GC) and toe off (41%-61% GC). Then it decreased dramatically in the swing phase (71%-100% GC). Results of Range and SD showed that there was no significant difference in inner-age groups ($p>0.05$), except with those of age 6 ($p=0.007<0.01$ for SD; $p=0.039<0.05$ for Range). Meanwhile, there was no significant difference in Range and SD between different age groups ($p>0.05$ for all).

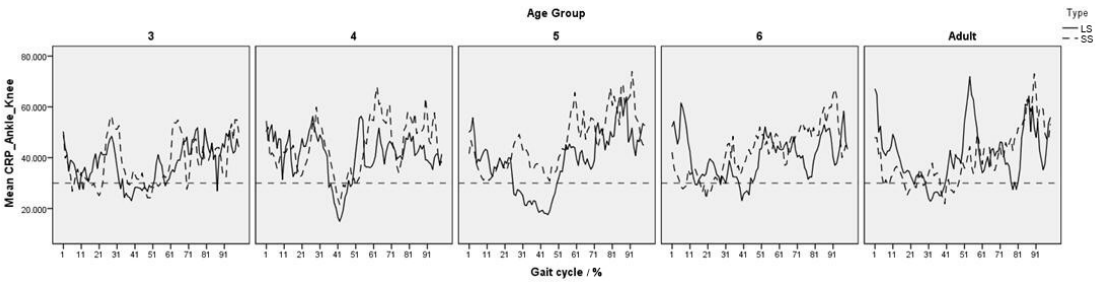

Figure 5. Portraits of continuous relative phase between the Knee and Ankle Joints

DISCUSSION

The purpose of our study was to evaluate the gait mechanism and intra-limbs coordination of healthy children aged 3-6 under stride length adjusting, so as to add the knowledge of motor development of healthy children. Results showed that when transferring from short stride to normal stride long stride, children were to deal with by increasing stride length, Froude number, swing phase, and decreasing frequency. However, there were no significant differences between SS and LS in kinematical parameters; meanwhile, those significant variations were not found between age groups. In terms of intra-limb's coordination, there were no significant differences in values of relative phases within and between age groups.

Hak *et al*. [10] pointed out that increasing stride length would lead to higher speed, and lower frequency. Our results supported this idea, all groups may increase Froude number and decrease stride frequency to response the conversion of SS to LS. The above results showed that length adjustment could significantly affect TSP. In addition, there was no significant difference in TSP between adults and children, which indicated that children's ability to control stride length had basically matured at the age of 3.

Varraine *et al*. [7] evaluated the two controlling mechanisms of LS and SS. On one

hand, the activity of hip extensor-biceps femoris of the SSing leg would increase so as to finish leg-swing in advance, thus shortening the swing-duration during SS. On the other hand, the controlling mechanism was opposite during LS. The activity of ankle extensor muscles–soleus, and the hip extensors-biceps of ipsilateral leg increased to improve propulsive force in stance stage. Meanwhile there was also an increasing activity in hip and ankle flexors-rectus femoris and tibialis anterior during the ipsilateral swing stage for maintaining flexion-state of ipsilateral leg so that the foot would land later. Thereby longer swing-duration would be obtained. Our findings are consistent with Varraine *et al*. [7] who reported that swing-duration increased significantly from SS to LS. Moreover, swing-duration of children would gradually be close to that of adults with age increasing, both showed in LS and SS. It is also confirmed by Perry *et al*. [16] who suggested that the foot development was normally low-energy trend.

In terms of the relationship between Euler angles and velocities in joints of knee and ankle, no significant differences were observed in most parameters across age groups. It was in agreement with the results of Sutherland *et al*. [17] who reported that the activity of intra-limbs in children aged 3-4 was similar to that in adults. Furthermore, Ounpuu *et al*. [18] demonstrated that gait kinematic parameters of children aged 5-16 were consistent with those of adults. Based on the above results, it would appear that the fundamental basis for the adaptation of LS and SS is fully achieved at 3 years.

The differences of ϑ_{CRP} (A-K) were discovered during the period of heel contact (1%-17% GC), toe off (41%-61% GC), and swing phase (71%-100% GC) between LS and SS, which may be due to the longer and faster stride. During heel contacting, due to high speed, ankle-knee joint would absorb more ground reaction force. As for toe-off, intra-limbs needed to achieve higher forward moving force. And during swing phase, body needed to prolong the contacting time of swing leg to obtain body compensation. Our results were confirmed by Huang *et al*. [8] who found that increasing stride length (with lower frequency) led to larger spinal rotations, larger thorax–pelvis relative phase and lower pelvis–leg relative phase. Our study was also confirmed by Varraine *et al*. [7] who reported the control systems of LS and SS.

Our findings of ϑ_{CRP} (A-K) also showed that there was no inter-age difference under both gaits. This was proved by Warren *et al*. [19] who pointed out that shortening and widening step length didn't affect walking stability. Danion *et al*. [20] reported that gait was a very stable behavior, although gait parameters changed. That is to say, the basic principle of intra-limbs coordination had already formed at the age of 3.

Besides, there are some limitations in our study. (1) Children chose their preferred walking speed during measurement; (2) Markers were set on tight clothing rather than skin. This would cause movement of the marker while walking; (3) Broad categories of age were chosen in our study, regardless of details of development within each age; (4) Only the right-side limbs were studied because of the markers limitation of our system.

CONCLUSIONS

In conclusion, as early as age 3, young toddlers have already mastered the basic ability in adjusting gait while walking.

Acknowledgements

The study was supported by Project of Education Department of Sichuan province, China (18ZB0569) and National Natural Science Foundation of China (31700813).

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INVESTIGATION AND EVALUATION OF THE QUALITY FEATURES RELATED TO COMFORT OF CASUAL SHOES IN BANGLADESHI LEADING RETAIL BRANDS USING PHYSICAL AND CHEMICAL STANDARD TEST METHODS

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Received: 03.01.2019 Accepted: 17.02.2019 https://doi.org/10.24264/lfj.19.1.2

INVESTIGATION AND EVALUATION OF THE QUALITY FEATURES RELATED TO COMFORT OF CASUAL SHOES IN BANGLADESHI LEADING RETAIL BRANDS USING PHYSICAL AND CHEMICAL STANDARD TEST METHODS

ABSTRACT. Several materials and chemicals are being used during manufacturing processes of shoes which are responsible for a good quality product. Nowadays it has been coming out of the current market of Bangladesh that leading retail brands are not providing good quality footwear to their customers. The aim of the study was to investigate different physical and chemical properties of sample shoe materials related to comfort features. Ten pairs of casual leather shoes were brought from five leading Bangladeshi retail brand outlets focusing on equal price point and best-selling article. These samples underwent different physical and chemical tests following standard methods of SATRA (Shoe and Allied Trade Research Association), IUP (International Union for Physical testing) and SLC (Society of Leather Chemists) such as whole shoe flexing, sole adhesion, flexing endurance of upper materials, SATRA-Bata sole flexing, shrinkage temperature, percentage of chromium (expressed as % Cr_2O_3) content, water absorbency, water vapor permeability (W.V.P) and pH. All samples showed poor sole adhesion as average separation load were recorded 13.9 kg, 14.2 kg and 20.1 kg at the toe, ball and heel areas respectively that were far below than standard values. Three sample soles were broken down after 30,000 and 40,000 cycles rendering poor flexing resistance, whereas the upper materials of four samples showed poor flexing endurance with break pipiness scale ratings 4/5 and 4 before desired 50,000 cycles. Especially sole adhesion and flexing endurance properties should be ameliorated to gratify customers' expectations.

KEY WORDS: casual shoe, comfort, chemical test, physical test, quality

INVESTIGAREA ŞI EVALUAREA CALITĂŢII CONFORTULUI ÎNCĂLŢĂMINTEI LEJERE A MARILOR BRANDURI DIN BANGLADESH UTILIZÂND METODE STANDARD DE TESTARE FIZICĂ ŞI CHIMICĂ

REZUMAT. În procesele de fabricare a încălţămintei se utilizează mai multe materiale şi substanţe chimice care sunt responsabile pentru un produs de bună calitate. În zilele noastre, de pe actuala piaţă din Bangladesh reiese că marile branduri care vând cu amănuntul nu furnizează clienţilor încălţăminte de bună calitate. Scopul acestui studiu a fost de a investiga diferitele proprietăţi fizice şi chimice ale materialelor pentru pantofi care contribuie la caracteristicile de confort. Au fost testate zece perechi de pantofi lejeri din piele provenind de la cele mai importante cinci puncte de vânzare cu amănuntul din Bangladesh, alese pe criterii precum preţul egal şi cel mai bine vândut articol. Aceste eşantioane au fost supuse unor încercări fizice şi chimice diferite, în conformitate cu metodele standard SATRA (Asociaţia de Cercetare pentru Încălţăminte şi Domenii Conexe), IUP (Uniunea Internaţională pentru Testare Fizică) şi SLC (Societatea Chimiştilor Pielari), cum ar fi rezistenţa la flexiune a întregului pantof, aderenţa tălpii, rezistenţa la flexiune a materialelor pentru feţe, rezistenţa la flexiune a tălpii SATRA-BATA, temperatura de contracţie, conţinutul de crom în procente (exprimat în % Cr_2O_3), absorbţia apei, permeabilitatea la vaporii de apă şi pH-ul. Toate probele au prezentat o aderenţă slabă a tălpii, deoarece s-au înregistrat valori ale forţei medii de desprindere de 13,9 kg, 14,2 kg şi 20,1 kg în zona degetelor, în zona metatarsofalangiană, respectiv în zona călcâiului, care au fost cu mult sub valorile standard. Trei tălpi de probă s-au rupt după 30.000 şi 40.000 de cicluri, demonstrând o rezistenţă slabă la flexiune, în timp ce materialele pentru feţe ale celor patru eşantioane au prezentat o rezistenţă slabă la flexiune, obţinând notele 4/5 şi 4, înainte de a finaliza cele 50.000 de cicluri. Proprietăţile de aderenţă a tălpii şi de rezistenţă la flexiune ar trebui îmbunătăţite în mod special pentru a satisface aşteptările clienţilor.

CUVINTE CHEIE: încălţăminte lejeră, confort, test chimic, test fizic, calitate

ENQUÊTE ET ÉVALUATION DE LA QUALITÉ DE CONFORT DES CHAUSSURES LÉGÈRES DE GRANDES MARQUES DU BANGLADESH À L'AIDE DE MÉTHODES STANDARD D'ESSAI PHYSIQUE ET CHIMIQUE

RÉSUMÉ. De nombreux matériaux et produits chimiques sont utilisés dans les processus de fabrication des chaussures et sont responsables d'un produit de bonne qualité. De nos jours, le marché actuel au Bangladesh montre que les grands détaillants ne fournissent pas de chaussures de bonne qualité à leurs clients. Le but de cette étude était d'examiner les différentes propriétés physiques et chimiques des matériaux de chaussure qui contribuent aux caractéristiques de confort. Dix paires de chaussures légères en cuir provenant des cinq principaux détaillants du Bangladesh ont été testées, sélectionnées sur la base de critères tels que le prix égal et le produit le plus vendu. Ces échantillons ont été soumis à différents essais physiques et chimiques conformément aux normes SATRA (Association pour la Recherche sur la Chaussure et les Domaines Connexes), IUP (Union internationale pour les Essais Physiques) et SLC (Société des Chimistes du Cuir), telles que la résistance à la flexion de la chaussure entière, l'adhérence de la semelle, la résistance à la flexion des matériaux pour la tige, la résistance à la flexion de la semelle SATRA-Bata, la température de rétraction, la teneur en chrome en pourcentage (exprimé en % Cr_2O_3), l'absorption de l'eau, la perméabilité à la vapeur d'eau et le pH. Tous les échantillons ont présenté une adhérence de la semelle réduite, enregistrant des valeurs moyennes de la charge de séparation de 13,9 kg, 14,2 kg et 20,1 kg dans la région des doigts, dans la région du gros de l'orteil et dans la région du talon, respectivement, étaient bien en dessous des valeurs standard. Trois échantillons de semelles se sont cassés après 30 000 et 40 000 cycles, démontrant une faible résistance à la flexion, tandis que les matériaux pour la tige des quatre échantillons ont présenté une faible résistance à la flexion, obtenant les marques 4/5 et 4 avant de compléter les 50 000 cycles. Les propriétés de l'adhérence de la semelle et de la résistance à la flexion doivent être spécifiquement améliorées pour répondre aux attentes des clients.

MOTS CLÉS: chaussures légères, confort, essai chimique, essai physique, qualité

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INTRODUCTION

Nowadays a pair of shoes is not only used for the protection of feet but also it has a great fashion value. There are seven basic styles of shoes such as oxford, derby, casual, moccasin, court, boot and sports; among these styles casual shoe is mostly used in Bangladesh for its convenient features such as unlaced and wider opening area with elastic. There are different parts of a shoe such as upper, lining, inter-lining, toe-puff, counter-stiffener, insole, midsole, shank, heel and outsole etc [1]. There are different materials which are used in different parts of a shoe, such as leather, synthetic, mesh as upper and lining materials; leather and synthetic along with poly urethane (PU) or latex foam are mostly used as insole material; a piece of metal is used as shank board between the insole and outsole, various types of outsole such as poly urethane (PU), poly vinyl chloride (PVC), thermo plastic rubber (TPR), vulcanized rubber (VR) and phylon are mostly used in shoe making. Each and every components or parts of a shoe should ensure some standard test values with a view to manufacturing good quality shoes and satisfy customer's needs. The standard values of related tests can vary from one style to another and also from one construction to another. At present, it has been a buzzing word in Bangladesh that most of the popular footwear brands are manufacturing its goods with low quality materials and customers are facing severe problems about sole adhesion failure and materials deterioration of their shoes. The aim of this study was to investigate the different quality aspects of casual shoes, bought from leading five retail brands of Bangladesh.

There are several attributes which are responsible for making the shoe qualityful and comfortable. Garvin introduced the five approaches to define quality such as transcendent, product, user, manufacturing and value based [2]. Transcendent based definition of quality: "Quality is neither mind nor matter, but a third entity independent of two, even though quality cannot be defined, you know what it is [3]." Product based definition of quality: "Quality refers to the amounts of the unpriced attributes contained in each unit of the priced attribute [4]. User based definition of quality: "Quality is the degree to which a specific product satisfies the wants of a specific consumer [5]. Manufacturing based definition of quality: "Quality means conformance to requirements [6]. Value based definition of quality: "Quality is the degree of excellence at an acceptable price and the control of variability at an acceptable cost [7]. There are eight dimensions of quality such as performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. On the other hand, comfort can be defined as a feeling of relaxation and well-being [8]. Comfort is a subjective perception that is based on several variables, such as shape of the foot, foot sensibility, inside shoe climate, pressure on the foot, the vertical impact and shock absorption as well as pressure on the foot [9-11]. Mechanical and thermal characteristics of shoes are the major two drivers of comfort [12]. Air space and ventilation system inside the shoe are the crucial factors for thermal comfort which should be considered at the design phase of the shoe to impart coolness and comfort [13]. On the other hand, flexibility, softness, durability and reduced weight are the mechanical factors for shoe comfort. Moisture disposal means water vapor of shoe upper has been identified as one of the most influential factors for shoe comfort which absence creates moisture saturation that is responsible for bad odor inside the shoe rendering discomfort [14-15]. Flexibility of upper materials and sole flexibility enhance ankle joint movement that ultimately lessen metabolic and respiratory cost which are also found as quality features of shoe [16-17]. Weight of the shoes also has a great influence over comfort properties that is recommended to be less than 500 gm whereas every 100 gm increase in footwear mass can add energy expenditure by 0.7-1% [16, 18]. Proper size & fit, cushioning, flexibility, light weight, breathability, arch support and toe room allowance was found as the most vital factors for shoe comfort [16]. A study was conducted in Ethiopia to find the performance of leather uppers of footwear where average tear strength, tensile strength, percentage of elongation of upper and color fastness test reports were below than the standard value [19].

From literature review, it has been found that there were several studies about thermal comfort and different ergonomic factors for shoe comfort which were mostly survey based but most surprisingly to find that very little study was conducted to reveal the actual quality features through standard tests that are responsible for comfort shoes. To best of our knowledge, there were no study on shoe testing values of leading retail brands of Bangladesh which are prerequisite for quality and comfort shoes. In our previous study, we have unveiled the purchasing factors and comfort features of shoes; now this study will reveal the actual scenarios of shoes quality of leading retail brands that will help the customers to choose their reliable brand as well as retailers will get their products testing report through which they can take necessary measures to amplify the quality features of shoes.

EXPERIMENTAL

Materials and Methods

Study Area

The study area comprises most popular footwear brands of Bangladesh. A field survey was conducted among 200 participants in order to know the most popular brands in Bangladesh by the customers. After analyzing the collected data, it was found that Apex, Bata, Orion, Bay and Jennys are the leading footwear retail brands in Bangladesh. In contrast, sample shoes were undergone different physical and chemical test methods to investigate the quality features of sample shoes with available lab facilities.

Figure 1. Different parts of a casual shoe with major physical tested sample area

Sample Collection

Since there were different articles in a store of those brands with different price points, it was very difficult to collect a sample and compare among these. After analyzing the sales trend with the help of respective brand, it was observed that a casual shoe which price of TK 2490 was the best-selling article of all brands. Total 10 pairs of sample casual shoes with 2 pairs from each brand were bought from respective outlets for the quality features that are expressed as B1, B2, B3, B4 and B5.

Table 1: Upper, lining and soling materials of samples

Sample	Upper material	Lining material	Soling material
B1	Semi-aniline leather	Coated split leather	Polyurethane (PU)
B2	Semi-aniline leather	Fabric	Polyurethane (PU)
B3	Coated split leather	Coated split leather	Polyurethane (PU)
B4	Semi-aniline leather	Fabric	Thermoplastic rubber (TPR)
B5	Aniline leather	Fabric	Polyurethane (PU)

Physical Tests

Several physical tests were carried out for evaluation of existing quality features of those brand sample shoes following standard methods. Those physical tests were whole shoe flexing endurance test-SATRA PM 92, water vapor permeability test of upper leather- IUP 15, flexing endurance of upper leather-SATRA PM 55, SATRA Bata Belt sole flexing-SATRA TM 133, sole adhesion test-SATRA AM 04 and shrinkage temperature-IUP 16 and water absorption-IUP 7.

Chemical Tests

There are some tests those are related with directly or indirectly with the ideal properties of shoe which were conducted as per standard methods. Those tests were determination of chrome content as per SLC 8 (IUC; BS 1309:8) and determination of pH as per IUP 11.

Instruments

Various international lab standard equipment, instruments and glass accessories were used for all physical and chemical tests. Following instruments had been used for the methods performed for different tests- pH meter (Orion perpHect LogR meter model 370), shrinkage machine (SATRA STD 114), water vapor permeability machine (SATRA STM 473), bally flexometer 2396, SATRA/BATA belt flexing machine (SATRA STM 459), sole adhesion testing machine (SATRA STD 185) and whole shoe flexing machine (SATRA STM 184).

RESULTS AND DISCUSSION

Since there were 2 pairs of shoes per brand, in total 10 pairs of shoes; results were made by average of 2 pair of shoes for each brand that was identified as B1, B2, B3, B4 and B5. Some test results were reproduced and standard deviations is showed in the graph as error bar.

Results of Physical Test

Whole Shoe Flexing Test

This test was carried out by following standard method SATRA PM 92 with SATRA whole shoe flexing machine at room temperature (25 ºC). The result is depicted in the table as given below.

Table 2: Whole shoe flexing observation

SL No.	Sample Name	No of revolution	Observation	Remark
01	B1	300,000 cycles	No visual crack found	Acceptable
02	B2	300,000 cycles	No visual crack found	Acceptable
03	B3	300,000 cycles	No visual crack found	Acceptable
04	B4	300,000 cycles	No visual crack found	Acceptable
05	B5	300,000 cycles	No visual crack found	Acceptable

Total 300,000 cycles were conducted for this test and observed whether any presence of crack along the tread line of the shoe. After each 50,000 cycles shoes were checked for any kind of damage. After observing total 300,000 cycles, all samples were found crack free. So, the samples were in acceptable condition. All of the samples' upper were made of leather that paved the way for getting high endurance.

Sole Adhesion Test

Sole adhesion test was carried out following standard method SATRA TM 411 and separation load was identified at 4 points of a sample. Obtained results were averaged per brand and expressed as left and right shoe for each selected 4 portions.

Generally minimum load for separation of sole adhesion test at toe and ball area for men's shoe is 25 kg and 35 kg for heel area. SATRA recommends minimum load 3.0 N/mm should be followed. From the above result of sole adhesion test it comes to light that each sample was very far below than the standard value. Even no pair of shoes from any brands at any point met the standard value that have emerged as a severe bond failure problem. There are some possible reasons for this bond failure such as chemical preparation technique of upper and soling materials, proper quality of adhesive selection, drying time of adhesive, upper and soling materials quality and lack of applied pressure that should be properly maintained during manufacturing process.

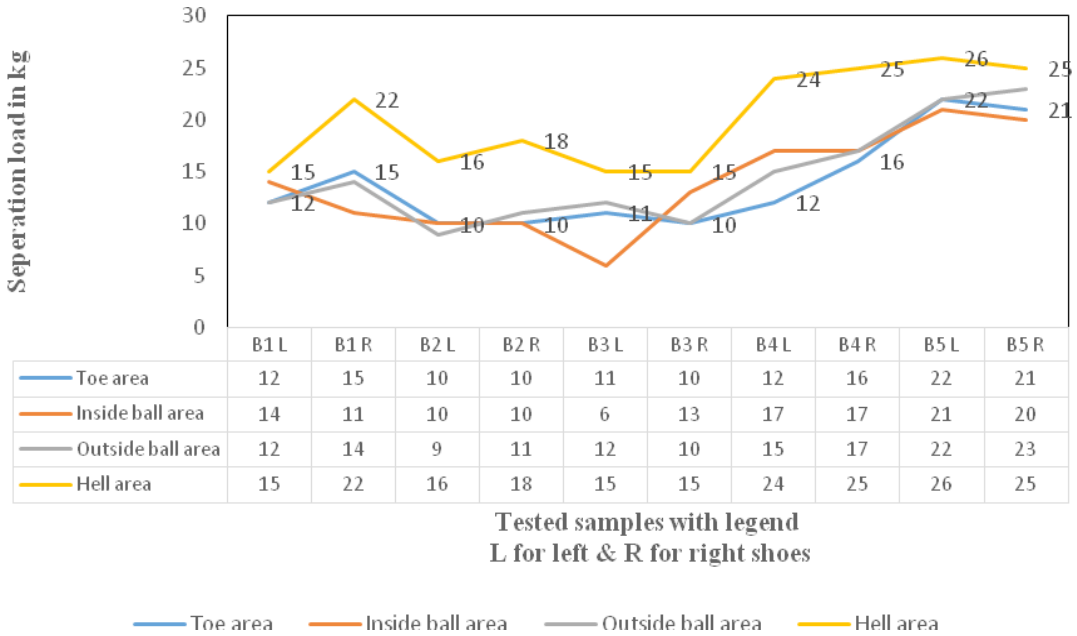

Figure 2. Required load for separation of sole from upper

SATRA-BATA Belt Flexing of Sole

Table 3: SATRA-BATA belt flexing

Sl. No	Sample Name	Observation after 50,000 cycles
01	B1	No damage
02	B2	No damage
03	B3	Damaged
04	B4	No damage
05	B5	No damage

This test was conducted as per SATRA-BATA belt flexing method at normal temperature which basically investigate the flexing endurance of sole. There were 5 periods of 10,000 cycles, in total 50,000 cycles and after completing each cycle any kind of damage was observed. As our feet flexes during walking, our shoes have to face several flexing at the time of walking. From the Table 3, it has been observed that the all 2 samples of brand 3 were damaged before predetermined cycle. The poor composition and validity period of PU soling materials may be the reason of this failure. On the other hand, remaining samples showed acceptable result.

Flexing Endurance of Upper Material

This test was conducted as per IUP 20 standard method which defines the resistance of getting wrinkled against flexing of upper material.

Table 4: Flexing endurance of upper material

Sl. No	Sample Name	Observation after 300,000 cycles Break pipiness scale rating
01	B1	4
02	B2	4
03	B3	4/5
04	B4	¾
05	B5	2/3

A standard sample 70 mm × 45 mm was cut and it was faced several repeated flexing of total 6 periods of each 50,000 cycles, and any formation of wrinkle was observed comparing with break pipiness scale rating after completing each cycles; the standard value of this result is 1-3/4. From table 4, it can be said that only B4 and B5 has met the standard value and remaining samples showed unacceptable results. Coated split leather showed minimum flexing endurance and maximum flexing endurance was found for aniline finished leather.

Water Vapor Permeability of Upper Leather

Almost all upper leathers should be permeable of water vapor because the perspiration formed inside the shoes should go out through the leather to provide comfort to the users. Water vapor permeability is a very important characteristic for upper leather which helps the feet to get comfort and protect any microorganisms' growth inside the shoe.

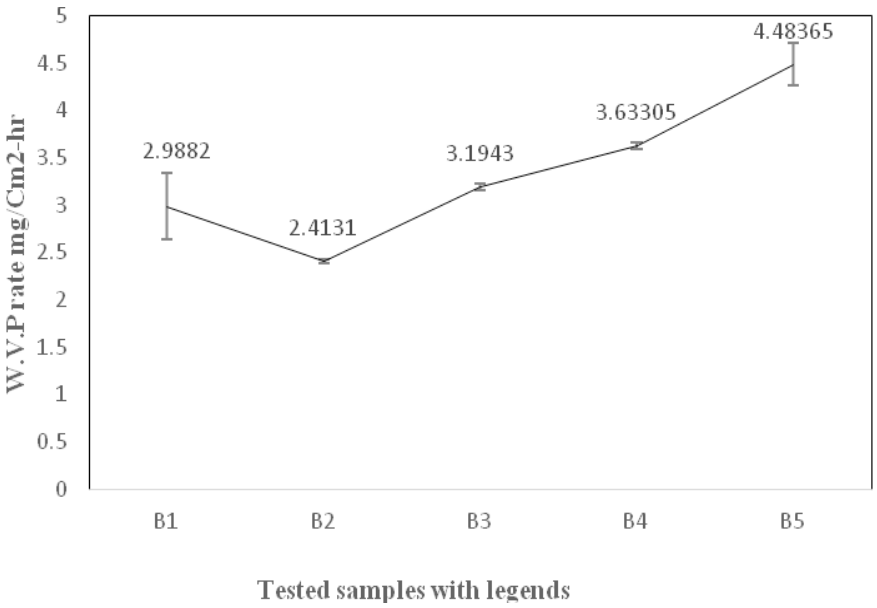

Figure 3. Water vapor permeability of upper leather

This test was carried out following standard method IUP 15 where upper leather should have minimum 0.8-1 mg/Cm^2-hr rate of passing vapor. From the above observed data, it has been noticed that all of the samples showed higher water vapor permeability than acceptable value which is congenial for wearers. The reason for this higher permeability was upper materials made of leather.

Determination of Water Absorption

Least amount of water absorption of leather means good leather. The standard value of water absorption is maximum 30% after 2 hours [20]. Here % of water absorption of all leather samples were in acceptable range in the figure 3. Among five brands B4 was comparatively good than other samples.

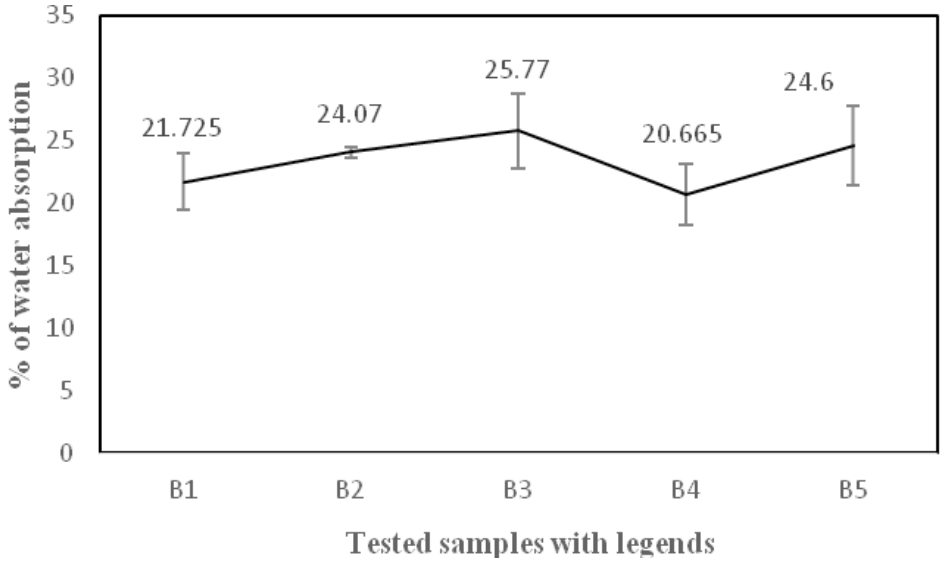

Figure 4. Percentage of water absorption

Determination of Shrinkage Temperature

Shrinkage temperature defines the resistance power of the fiber of material against particular temperature. Higher shrinkage temperature signifies good quality leather that usually shows 97-105 ºC for shoe upper leather [20].

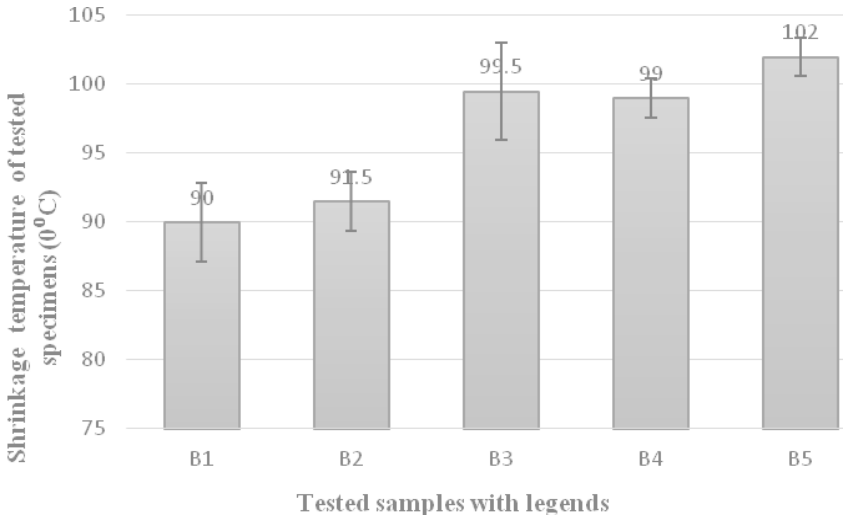

Figure 5. Shrinkage temperature of tested samples

From the figure 5, it is observed that B1 and B2 were not in acceptable range but B3, B4 and B5 were in acceptable range. Since upper materials was leather, maximum of samples showed optimum shrinkage temperature.

Results of Chemical Tests

Percentage of Chromic Oxide (Cr_2O_3) Content

In case of leather tanning chromium (Cr) is mostly used where at least 2.5% Cr_2O_3 should be used for leather tanning and less than 5% is good [20]. Least amount of chromium (Cr) content indicates good quality leather which provide light weight leather as well as flexible fiber with enough strength.

On the other hand, excess amount of chromium produces high Cr content in effluent which has a detrimental effect to the environment. From the experimental data, it is observed that all of the samples were in acceptable range and were chrome tanned leather.

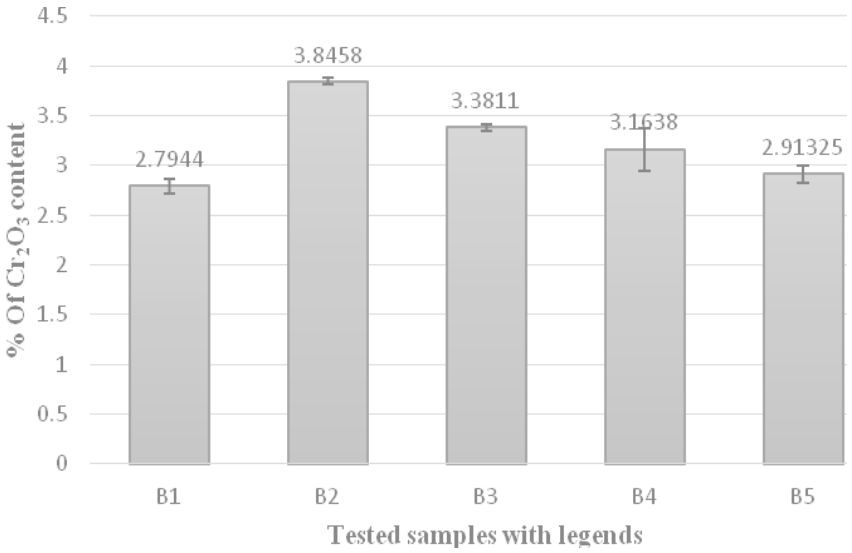

Figure 6. % of Cr_2O_3 content of tested samples

pH Determination of Tested Samples

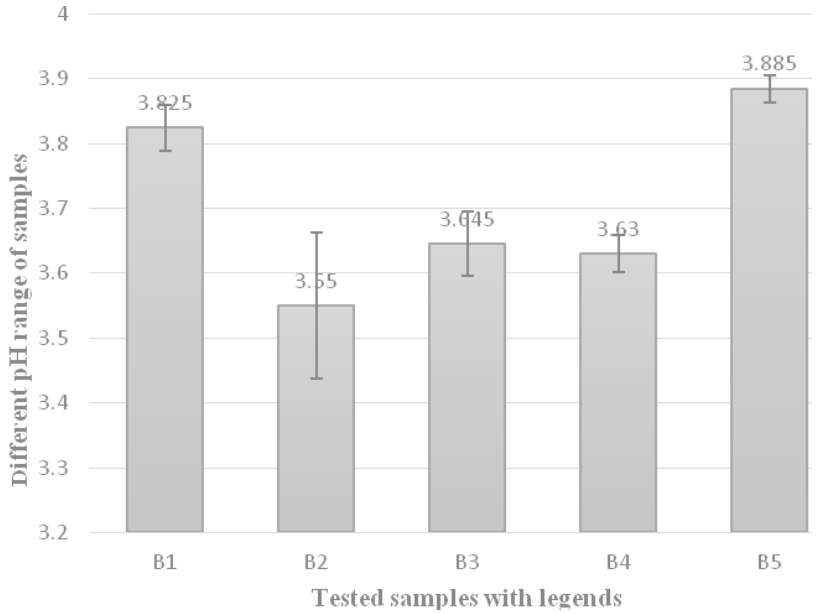

Figure 7. Results of pH value of different samples

pH value of all samples were identified as per IUP 11 method where pH value should not be below than 3.5. Among these results only B2 showed value slightly lower than 3.5; remaining samples were recorded with desired value.

CONCLUSION

It is very necessary to inspect several features to measure the quality of shoes. Delving into the tested results, it was found that all of the samples showed very poor sole adhesion which will cause separation of sole from upper part before expected life cycle and obviously it will render customer's dissatisfaction. Flexing endurance of upper materials was also poor for two samples which indicates leather will be wrinkled after wearing of these shoes at early period. As all of these samples were made of leather, these showed very high water vapor permeability above acceptable value and also met the acceptable value of these tests, i.e.; water absorption, pH, Cr content and whole

shoe flexing. On the other hand, the two sole samples were damaged in the SATRA-BATA belt flexing showing poor flexing endurance and the remaining samples met the minimum standard value of the test. In order to assess quality features, shoe manufactures should determine these tests prior to bulk production, especially they should ensure the standard value of sole adhesion test because it has been a common problem of all brands. There are lot of reasons for any bad test results that may be identified in pilot production to find out the root causes of problems using cause and effect diagram.

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MOTION COMPENSATION STRATEGY OF PRESCHOOLERS COPING WITH TASKS OF STRIDE LENGTH CHANGES AND CURVE TURNINGS: IN TERMS OF CENTRE OF MASS

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Received: 13.09.2018 Accepted: 07.02.2019 https://doi.org/10.24264/lfj.19.1.3

MOTION COMPENSATION STRATEGY OF PRESCHOOLERS COPING WITH TASKS OF STRIDE LENGTH CHANGES AND CURVE TURNINGS: IN TERMS OF CENTRE OF MASS

ABSTRACT. The purpose of this study was first to disclose motion compensation strategy of healthy preschoolers according to evaluate how the stride length changes and curve turnings affected their Centre of Mass (CoM) performances; and then to comprehend the process of children develop in motion. Ten healthy children aged around 6 and 9 adults aged 23-47 were recruited in this study. The CoM was calculated based on four key markers in pelvis and its trajectory in five tasks including the stride length changes (short stride, straight walking and long stride) and curve turnings (0°-30°-60°) were first recorded; and then variables such as trajectory of CoM in sagittal and coronal plane, Unit of Energy (uEN), Energy Kinetic (uEk) and Gravitational Potential Energy (uEg) in the critical gait period were analyzed. Results show that as the stride length increase, child accordingly enlarged their motion range of CoM both in mediolateral and vertical direction to assist the whole-body movement; meanwhile, children's uEN increased as the stride length prolonged. Further, since 10%GC, child's CoM shifted gradually to the curving direction (right) as curve turning angle aggregated; while, dramatic change occurred at 60%GC, where a larger CoM deviation was found in 60° than that of 30°. The uEN of children was low before 60%GC, but it raised prominently after 60%GC. Overall, adult-like CoM were partly found in healthy preschoolers when coping with varied gait tasks, however distinctions existed which demonstrated that compensative strategies of those children were still developing.

KEY WORDS: center of mass, children development, compensative strategy, stride length, curve turning

STRATEGIA DE COMPENSARE A MIŞCĂRII LA PREŞCOLARI LA MODIFICAREA LUNGIMII PASULUI ŞI LUAREA CURBELOR: REFERITOR LA CENTRUL DE MASĂ

REZUMAT. Scopul acestui studiu a fost acela de a descoperi mai întâi strategia de compensare a mişcării la preşcolarii sănătoşi, pentru a evalua modul în care modificarea lungimii pasului şi luarea curbelor au afectat performanţele Centrului de masă (CoM); şi apoi de a înţelege procesul de dezvoltare a mişcării la copii. În acest studiu au fost recrutaţi zece copii sănătoşi cu vârsta de aprox. 6 ani şi nouă adulţi cu vârsta cuprinsă între 23-47 ani. CoM a fost calculat pe baza a patru markeri cheie în regiunea pelvisului şi traiectoria acestora pe măsura efectuării a cinci acţiuni, printre care modificarea lungimii pasului (pas scurt, mişcare dreaptă şi pas lung) şi luarea curbei (0°-30°-60°) care au fost înregistrate mai întâi; apoi s-au analizat variabile precum traiectoria CoM în plan sagital şi coronal, Unitatea de Energie (uEN), Energia Kinetică (uEk) şi Energia Potenţialului Gravitaţional (uEg) în perioada critică a mersului. Rezultatele arată că, pe măsură ce creşte lungimea paşilor, copilul îşi măreşte intervalul de mişcare a CoM, atât în direcţie mediolaterală, cât şi verticală, pentru a ajuta circulaţia întregului corp; în acelaşi timp uEN al copiilor a crescut pe măsură ce s-a mărit lungimea paşilor. Mai mult, la 10% GC, CoM al copiilor s-a mutat treptat în direcţia de curbare (dreapta), pe măsură ce unghiul curbei s-a mărit; în timp ce o schimbare dramatică a avut loc la 60% GC, unde s-a constatat o deviaţie mai mare a CoM la 60° comparativ cu 30°. uEN al copiilor a scăzut înainte de 60% GC, dar a crescut vizibil după 60% GC. În ansamblu, un CoM asemănător celui întâlnit la adulţi a fost întâlnit parţial la preşcolari sănătoşi atunci când aceştia s-au confruntat cu diverse acţiuni legate de mers, cu toate acestea au existat distincţii care au demonstrat că strategiile compensatorii ale acelor copii erau încă în curs de dezvoltare.

CUVINTE CHEIE: centrul de masă, dezvoltarea copiilor, strategie de compensare, lungimea pasului, luarea curbelor

STRATÉGIE DE COMPENSATION DU MOUVEMENT DES PRÉSCOLAIRES DANS LE CHANGEMENT DE LA LONGUEUR DES FOULÉES ET LES TRAJECTOIRES COURBES: À PROPOS DU CENTRE DE MASSE

RÉSUMÉ. Le but de cette étude était d'abord de découvrir la stratégie de compensation du mouvement des préscolaires en santé afin d'évaluer comme les changements de la longueur des foulées et la marche sur des trajectoires courbes sur les performances du centre de la masse (CoM); et ensuite pour comprendre le processus de développement du mouvement chez les enfants. Dix enfants en bonne santé âgés environ 6 ans et neuf adultes de 23 à 47 ans ont été recrutés dans cette étude. Le CoM a été calculé à partir de quatre marqueurs clés dans la région du pelvis et sa trajectoire dans cinq actions, notamment les changements de longueur de foulée (foulée courte, marche droite et foulée longue) et les trajectoires courbes (0°-30°-60°) ont été enregistrés pour la première fois, et ensuite on a analysé des variables telles que la trajectoire de CoM dans le plan sagittal et coronal, l'unité d'énergie (uEN), l'énergie cinétique (uEk) et l'énergie potentielle gravitationnelle (uEg) dans la période de marche critique. Les résultats montrent que, à mesure que la longueur de la foulée augmente, l'enfant élargit en conséquence sa plage de mouvements de CoM à la fois dans la direction médiolatérale et verticale afin d'aider le mouvement du corps entier; dans le même temps, la valeur uEN chez les enfants augmentait à mesure que la foulée se prolongeait. En outre, depuis 10% GC, le CoM de l'enfant est passé progressivement dans la direction de la courbe (à droite) à mesure que l'angle de rotation de la courbe s'agrégeait; tandis que, un changement dramatique s'est produit à 60% GC, où un écart de CoM plus grand a été trouvé à 60° comparativement à 30°. La valeur uEN chez les enfants était basse avant 60% de GC, mais elle a augmenté nettement après 60% GC. Dans l'ensemble, un CoM semblable à celui des adultes a été partiellement détecté chez des enfants d'âge préscolaire en bonne santé lors de tâches de démarche variées. Cependant, des distinctions existaient, démontrant que les stratégies de compensation de ces enfants étaient encore en développement.

MOTS CLÉS : centre de masse, développement des enfants, stratégie compensatoire, longueur de la foulée, trajectoires courbes

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INTRODUCTION

Motion is an essential ability in the development of children [1], and it is the outcome of complicated coordination within neural, muscle and skeletal systems. After the first step moved forward, young toddlers would repeat it in their lifetime. Commonly, toddlers were eager to establish their basic kinematics and kinetics format during first 5-6 months after independent walking [2, 3], or even earlier, where Hallemans [4] reported young toddlers already grasped the roll over gait pattern in their four months after independent walking. However, children were still in the further fine-turning develop process: ability to control gait and achieve a better coordination within limbs. On the one hand, adult's like length, width and frequency of gait were obtained after the age of 13 [5]; on the other hand, further development was aimed to obtain an economical energy cost and make the walking more efficiency [6, 7], where central nervous system coordinated various parts of the body so as to accomplish actions as well as achieving the minimum consumption of energy [8, 9]. Although various approaches could be used in the assessment of children develop in motion, Centre of Mass (COM) was a superior one and it could be used to quantify the biomechanics issues, such as kinematic and balances of whole-body motion. Vlutters *et al*. [10] predicted pelvis perturbation by COM velocity; meanwhile Smith and Lynnelle [11] disclosed gender differences existed during walking in pelvic motion. Yamamoto even indicated that substantial effects of knee behavior on the COM kinematic in quiet standing [12]; Wada *et al*. [13] analyzed the COM movement and kinematic changes in rotation condition, and they found significant correlation between lateral COM and rotational side. Moreover, Hernández *et al*. found that the reduced acceleration of COM in mediolateral direction can be assisted to comprehend the walking balance issues in elder group [14]. Additionally, the COM was used to quantify the effect of the exoskeleton robotic device on the walking of the wearers [15, 16]. In terms of optimization algorithm for COM calculation, Gard reported that when two dimensional COM data might produce errors when explaining the COM in three dimensional environment, and those results can be misleading [17]; so the trajectory in three-dimension would be more preferable for the COM analysis.

Engsberg was an early researcher to report the application of COM in assessment for children below knee amputation. Their results suggested that COM of those children was lower and anterior than in healthy children [18]. Moreover, in terms of children with cerebral palsy, Bennett *et al*. [19] found the intervention can help the patient to utilize kinetic energy in push-off walking; Jing [20] examined the COM of spastic hemiplegia children and their findings implied that trailing leg taken the leading role of propelling the COM motion [20]. Stride length and curve turning represented two kind of changes and they were common motions in daily life. The success finish of these gaits represented a senior ability of motion control. However, the above literature studies did not explain the compensative strategies of healthy children when they cope with the changes of stride length and curve turning; further what those changes affected their COM performances were still not explicit.

Thereby, the purpose of our study was to systematically investigate the influence of the stride length and curve turning changes on their COM performances and so as to disclose the basic regulation of the compensative strategies in healthy children.

EXPERIMENTAL

Subjects

Since children aged around 6 are still in the period when motion is developing, the findings of COM compensative strategies of children when they are facing the change of stride length and curve turning are meaningful. Ten healthy children aged around 6 (Male: Female=1: 1, Mean age (SD)=6.0(0.0) years, weight (SD)=19.0(2.7)kg, height(SD)=112.5(5.7)

cm, foot length (SD)=59.3(4.9)cm) and nine healthy adults as control group (Male: Female=5: 4, Mean age (SD)=34.6(11.0) years, weight (SD)=58.3(6.7)kg, height (SD)=166.4(8.0)cm, foot length (SD)=84.5(6.4)cm) participated in this study. The criteria for inclusion are shown below: (1) without foot deformities or injuries in the last year; (2) walk independently; (3) without abnormal gait patterns, such as a crouching gait or equines. With the introduction to the parents of the children and after obtaining their formal approvals, all the tasks were executed following the principles of Helsinki Declaration.

Motion Capture of Subjects' COM

The model of the pelvic region was first established following the instruction of Coda Motion System (Coda Motion cx1, Charnwood Dynamics Ltd., United Kingdom), where four markers were marked on the left and right anterior-posterior of pelvic region (Figure 1, marker1: anterior left of pelvis; marker2: anterior right of pelvis; marker3: the posterior right of pelvis; marker4: the posterior left of pelvis), and then the COM was defined as the central point of the pelvic model. Five gait tasks were defined as below:

- Straight walking (SW): Subjects walked at their self-selected speed in straight direction, also represented 0° curve turning tasks.
- Long stride walking (LS): Subjects walked as their 150% stride length in the straight direction.
- Short stride walking (SS): Subjects walked as their 50% stride length in the straight direction.
- 30° curve turning (30°CT): Subjects walked as their self-selected speed turning to 30° curve direction.
- 60°curve turning (60°CT): Subjects walked as their self-selected speed turning to 60° curve direction.

Gait tasks were randomly arranged to the participants and a 6m treadmill (Figure 2) was used in our test. Subjects changed their clothes to our tight ones when they came to the laboratory, and they walked at their self-selected speed. A 3-5 minutes warm-up was provided and at least five successful trails were obtained in each task.

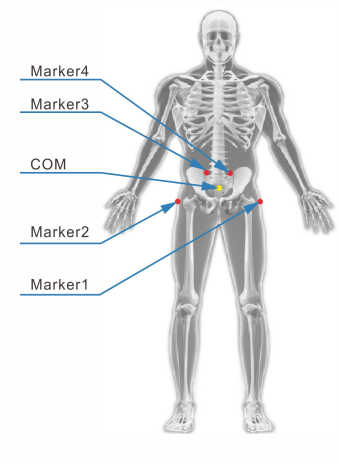

Figure 1. Demonstration of how the pelvic region was marked and the Centre of Mass was calculated

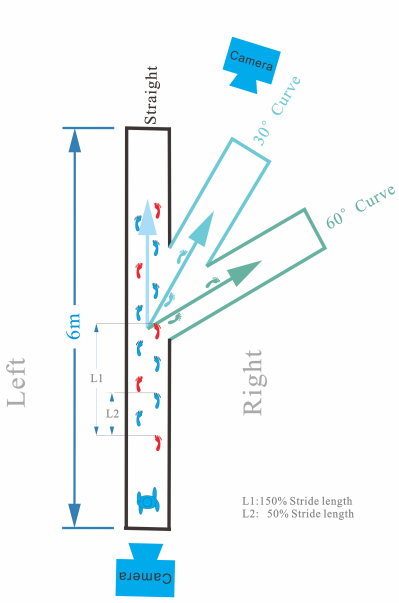

Figure 2. Gait tasks executed in the study. (subjects walked following the arrow on the ground, straight direction was used for straight walking; in terms of stride length tasks, subjects performed their short step (SS) gait follow the red and blue foot prints, and long stride (LS) walking only in red foot prints. Another two treadmills were used for curve turning task.)

Data Processing and Statistic Analysis

A 6 Hz cut off strategy was firstly applied in the period of data processing, then three-dimensional coordinates of COM were obtained by utilizing the algorithm of the Coda system (1.02, Charnwood Dynamics Ltd., United Kingdom). X and Z displacement of COM were first considered and their means and standard deviation (SD), as well as the range of motion (ROM) and time to peak value (TPv) in a gait cycle were calculated; meanwhile energy issues of COM such as energy kinematics. The normalization procedures were executed in order to achieve a comparable result: X and Z displacement of COM was divided by leg length of each subject and transfer into X-rel and Z-rel variables [21]; then the energy variables were divided by their body weight and were transferred into unit ones: uEk(E_k), uEg(E_g) and uEN(E) were computed (Formula 1-3) [19].

Gait cycle of each test was also normalized into 100 points (%GC).

$$E_k = 0.5v^2 E_k = 0.5v^2 \quad (1)$$

$$E_g = ghE_g = gh \quad (2)$$

$$E = E_k + E_p E = E_k + E_p \quad (3)$$

All those data were computed under the environment of SPSS (22.0, IBM, USA), with significant level of 0.05 and confident interval of 95%.

RESULTS AND DISCUSSIONS

Results

COM Solution when the Stride Length Changed

Generally, in SW, COM of children moving around the center line of motion, while that of adult group shifted to the left side (Figure 3); meanwhile, as the stride length increased, children's ROM increased as well (SS ROM(SD)=0.21(0.07), SW=0.33 (0.12) and LS=0.57(0.21)). Changed stride length advanced the first TPv in both SS and LS, comparing with SW (the 1st peak of SW is 28%GC, SS is 26% GC, LS is 16% GC); further, the second TPv was delayed in SS and advanced in LS (the 2nd peak of SW is 69%GC, SS is 75% GC, LS is 67% GC). In contrast with their peer adults group, similar COM trajectory in medio-lateral were found for the three gait types, as well as ROM, SD and TPv, totally adults showed larger ROM and range than children. In terms of sagittal plane, amplitude of COM, as well as its ROM and SD promoted both in child and adult groups (SS mean (SD, ROM) is 0.009 (0.005, 0.018), SW is 0.011 (0.008, 0.024; LS is 0.035 (0.021, 0.07)) as the stride length increased (from SS to SW to LS). Except the child's SS whose time to the 1st peak was extended, TPv of SW and LS were similar (P1 of SS=7%GC, SW=4%GC, LS =4%GC; P2 of SS=38%GC, SW=27%GC, LS=27%GC).

In energy conversion, the children's uEn overall increased as the stride length prolonged; their volume of uEn in LS was lower than that of adults, whereas, similar uEn performances were found in SS and SW between the children and adults.

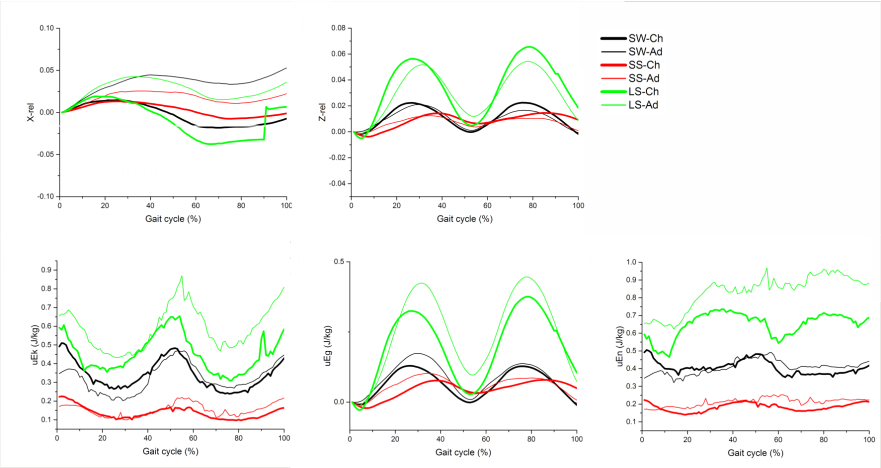

Figure 3. Results of Centre of Mass when coping with different stride length. (SW-Ch means children in SW tasks, SW-Ad means adults in SW tasks; SS-Ch means children in SS tasks, SS-Ad means adults in SS tasks; LS-Ch means children in LS walk tasks, LS-Ad means adults in LS tasks; a is the X-rel displacement of COM in coronal plane, b is the Z-rel displacement of COM in sagittal plane, c is the uEk changes in one GC, d is the uEg changes in one GC, e is the uEn changes in one GC).

COM Solution while Curve Turning

As the curve turning aggregated, child's COM shifted gradually to the curve direction (right) since 10%GC (Figure 4); further dramatic change occurred at 60%GC, where a larger COM deviation was found in 60° than that of 30°. In adult peer groups, a smaller deviation was recorded while turning in 30° (ROM=0.193 For 30-Ad V.S. ROM=0.356 For 30-Ch). The amplitude of COM while turning curves showed that child lifted their COM in a high position in contrast with SW, as well as with their adults group. Further, TPv would delay as the angle of curve increased.

Energy transferred while curve turning indicated that with the increase of curvature (0°-30°-60°), uEk decreased and the uEg increased; nevertheless, adult group could maintain both the uEk and uEg while the process of walking direction changed. In uEk of child, TPv in 30° and 60° postponed relative to the SW; moreover, as the curving turning increases, the total uEn of children was lowered before 60%GC; after 60%GC, 30° > straight walking > 60° could be obtained.

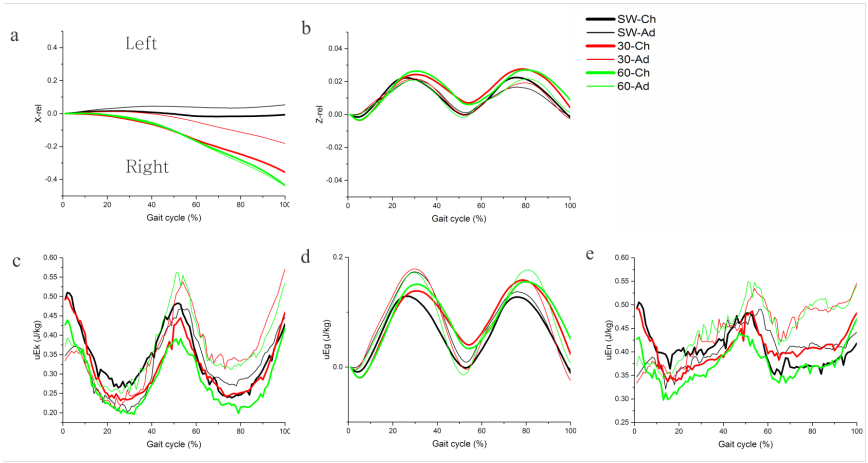

Figure 4. Results of Centre of Mass when coping with varied curve turning tasks. (SW-Ch means children in SW task, SW-Ad means adults in SW task, 30-Ch means children in 30CT task, 30-Ad means adults in 30CT task, 60-Ch means children in 60CT task, 60-Ad means adults in 60CT task; a is the X-rel displacement of COM in coronal plane, b is the Z-rel displacement of COM in sagittal plane, c is the uEk changes in one GC, d is the uEg changes in one GC, e is the uEn changes in one GC.)

Discussion

In our study, we investigated COM compensative strategies of children when they are coping with the change of stride length (SS and LS) and curve turning (0°-30°-60°) and the trajectory of COM in sagittal and coronal plane, uEn, uEk and uEg conversion while the critical gait period were analyzed. Those findings were helpful for us to comprehend the mechanism of gait adjustment in children, so as to understand their development in motion.

In the viewpoint of COM, children finished their gait through those events [4]: heel contact, toe contact, heel off, toe off, heel contact. During single-support phase, the leading leg was contacting with the ground and trailing leg went forwards by rotating the pelvis; at the same time, COM showed a tendency towards the leading leg and COM crossed the middle of central axis, then it reversed following the toe-off of the leading leg. When the stride length increased/decreased, an additional stretch of leg was required to rise/descend the thigh so as to increase/decrease the height of COM. Meanwhile, enhanced stretch motion also postponed the key gait events in coronal plane (X direction) and sagittal plane (Z direction). Further, the uEk and uEn increased/decreased as the added/shorted stride length performed, those changes also accelerate the walking velocity [22]. Our above findings also approved that adult-like ability in motion was not fully mastered in children aged 6 and it was in accordance with Jianhua *et al*. [23] and Beerse [19], whose studies disclosed that children at 5-11 ages are still developing their motion ability and they would spend 10 years to gain an adult-like variability-partitioning capability.

When turning a curve, the trailing leg would stretch much more, so as to generate sufficient rotate motion to complete the curve turning. Our results showed that the leading leg of children started swing earlier than their adult's counterparts, at round 60%GC. This phenomenon implied that when they decided to increase turning curve, they usually need more time to make adjustment, in order to finish the gait successfully, they have to do it earlier than their normal situation (such as SW); moreover, our outcomes also suggested that the ability of children to finish the sharp turn was still developing. Additionally, delayed TPv and increased height of COM in sagittal plane of children were the results of the increased stretch and pelvic rotation while curve turning and a lower uEk and uEn can be explained that children slow down their speed during this difficult curve turning tasks [22]. However, in curve turning, adults showed a stable COM pattern, even in the energy issues, which implied that curve turning tasks were easy for them as they were confident with their body size, as their past experiences and their better body coordination ability [22]. Therefore, the adults didn't need to stretch their leg as hard as children and to choose an economical gait [7].

In this study, two limitations existed, and they need to be declared before comprehending our results: (1) markers were set on tight clothing rather than skin, which would cause movement of the marker while walking; (2) model of COM in our study was a little different from the literature, such as Bennett [19], Eames [24] and Jensen [25], distinctions in the results might exist.

Table 1: Mean, SD and range of COM parameters

	X-rel		Z-rel		uEk(J/kg)		uEg(J/kg)		uEn(J/kg)	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
SW-Ch	-0.003±0.012	0.033	0.011±0.008	0.024	0.341±0.078	0.271	0.066±0.047	0.140	0.406±0.038	0.155
SS-Ch	0.003±0.007	0.021	0.009±0.006	0.018	0.137±0.032	0.129	0.045±0.03	0.101	0.182±0.023	0.083
LS-Ch	-0.008±0.021	0.057	0.035±0.021	0.071	0.456±0.104	0.525	0.198±0.122	0.404	0.918±2.657	26.740
30-Ch	-0.132±0.112	0.356	0.015±0.009	0.031	0.318±0.075	0.267	0.089±0.051	0.178	0.407±0.037	0.155
60-Ch	-0.146±0.134	0.438	0.016±0.009	0.030	0.283±0.069	0.243	0.09±0.052	0.175	0.373±0.038	0.172
SW-Ad	0.035±0.011	0.053	0.01±0.007	0.022	0.323±0.076	0.266	0.085±0.054	0.178	0.408±0.038	0.169
SS-Ad	0.017±0.007	0.025	0.007±0.004	0.014	0.153±0.034	0.119	0.059±0.032	0.114	0.211±0.023	0.087
LS-Ad	0.027±0.011	0.043	0.03±0.017	0.056	0.589±0.114	0.438	0.246±0.142	0.459	0.834±0.098	0.345
30-Ad	-0.048±0.061	0.193	0.011±0.007	0.024	0.358±0.091	0.360	0.087±0.061	0.203	0.446±0.058	0.212
60-Ad	-0.148±0.141	0.439	0.011±0.008	0.023	0.365±0.084	0.313	0.088±0.062	0.191	0.453±0.056	0.207

	TPv (GC%)													
	P1	P2	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
SW-Ch	28	69	4	27	53	76	2	25	52	76	4	27	53	76
SS-Ch	26	75	7	38	56	85	2	33	58	81	7	38	56	86
LS-Ch	16	67	4	27	53	78	3	22	54	76	4	27	53	78
30-Ch			5	30	54	78	2	26	53	73	5	31	54	78
60-Ch			5	31	54	80	2	32	53	79	5	31	54	79
SW-Ad	40	75	2	30	53	76	5	29	56	78	2	30	53	76
SS-Ad	37	78	5	35	55	80	4	30	55	70	5	35	55	80
LS-Ad	34	70	4	31	54	78	5	27	55	72	4	32	54	78
30-Ad			3	30	53	80	6	23	54	73	3	30	53	80
60-Ad			3	29	52	81	2	26	51	76	3	30	52	81

SW-Ch: children in SW task; SS-Ch: children in SS task; LS-Ch: children in LS task; 30-Ch: children in 30CT task; 60-Ch: children in 60CT task; SW-Ad: adults in SW task; SS-Ad: adults in SS task; LS-Ad: adults in LS task; 30-Ad: adults in 30CT task; 60-Ad: adults in 60CT task. P1: Time to Peak value1Pv1;P2: Time to Peak value2;P3: Time to Peak value3;P4: Time to Peak value4.

CONCLUSIONS

When the stride length and curve turning changes, COM of healthy children in either coronal and sagittal plane, as well as the energy exchanges showed partly similar to those of adult. But some distinctions existed which demonstrated that compensative strategies of those children were still developing.

Acknowledgements

The authors appreciate all the children and adults who participated in this study. Funding: This work was supported by the National Natural Science Foundation of China [grant numbers 31700813]; China Postdoctoral Science Foundation [grant number 2015M571896].

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INFLUENCE OF ADDING FUNCTIONALIZED MICROPARTICLES ON THE PHYSICAL-MECHANICAL, STRUCTURAL, AND PROCESSABILITY PROPERTIES OF THERMOPLASTIC RUBBER

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Received: 03.12.2018 Accepted: 04.02.2019 https://doi.org/10.24264/lfj.19.1.4

INFLUENCE OF ADDING FUNCTIONALIZED MICROPARTICLES ON THE PHYSICAL-MECHANICAL, STRUCTURAL, AND PROCESSABILITY PROPERTIES OF THERMOPLASTIC RUBBER

ABSTRACT. The aim of this paper was to assess the influence of powders, modified on the surface with organic-inorganic compounds, on the block copolymer styrene-butadiene-styrene (SBS) type thermoplastic rubber properties, obtained by the mixing. Powder surface of kaolin, $CaCO_3$, and $MgCO_3$ modification with precursors of TiO_2 and SiO_2 aimed at improving the interface, dispersion, and physico-mechanical properties, of the composites based on SBS. Titanium isopropoxide was used as a precursor to TiO_2, and for SiO_2 the tetraethyl orthosilicate (TEOS). Modified powders were morpho-structural characterized by SEM, FTIR, and EDAX. FTIR spectra highlight the bands characteristic of individual powders, but functional groups derived from TiO_2 and SiO_2 could not be viewed. Due to this issue, it has resorted to an EDAX analysis of all the powders, and the presence of silicon and/or titan elements confirmed that modification occurred. SEM microscopy performed on modified versus the simple powder, shows a reduction of areas containing particle agglomerations, due to the reduction of surface energy and implicitly electrostatic, and attraction forces. The results of the physical-mechanical properties, show that for the composites containing mixture of modified particles (even at high amounts 75%) values of resistance to tear strength, elongation at break, elasticity, were superior to blends containing unmodified particles, to SBS respectively. The results obtained confirm that by modifying the particle surface, improves dispersion, and compatibility between phases, due to achieving optimal interface between particle/polymeric matrix. Melt flow index are lower for the reinforced SBS with high amounts of particles, but without raising issues of processability.

KEY WORDS: styrene-butadiene-styrene, carbonates, aluminum silicate, organic-inorganic compounds, characterization

INFLUENȚA ADĂUGĂRII DE MICROPARTICULE FUNCȚIONALIZATE ASUPRA PROPRIETĂȚILOR FIZICO-MECANICE, STRUCTURALE ȘI DE PRELUCRARE ALE CAUCIUCULUI TERMOPLASTIC

REZUMAT. Scopul acestei lucrări a fost evaluarea influenței pulberilor modificate la suprafață cu compuși organo-anorganici asupra proprietăților cauciucului termoplastic de tip bloc copolimer - stiren-butadienă-stiren (SBS), obținute prin procedeul de amestecare. Modificarea suprafeței pulberilor de caolină, $CaCO_3$ și $MgCO_3$ cu precursori de TiO_2 și/sau SiO_2 a avut ca scop îmbunătățirea interfeței, dispersabilității și a proprietăților fizico-mecanice, ale compozitelor pe bază de SBS. Ca precursor de TiO_2 s-a utilizat izopropoxidul de titan iar pentru SiO_2 – tetraetilortosilicatul (TEOS). Pulberile modificate au fost caracterizate morfo-structural prin SEM, FTIR și EDAX. Spectrele FTIR pun în evidență benzile caracteristice pulberilor individuale, însă grupările funcționale provenite din TiO_2 și SiO_2 nu au putut fi vizualizate. Din această cauză, s-a recurs la analiza pulberilor prin EDAX, care a confirmat faptul că modificarea a avut loc datorită prezenței elementelor siliciu și/sau titan, în cazul tuturor celor 3 tipuri de pulberi. Microscopia SEM efectuată pe pulberile modificate raportat la cele nemodificate arată o reducere a zonelor ce conțin aglomerări de particule, datorită reducerii energiei de suprafață și implicit a forțelor electrostatice, de atracție. Rezultatele fizico-mecanice arată ca în cazul compozitelor ce conțin amestec de particule modificate (chiar la cantități ridicate 75%) se obțin valori ale rezistenței la rupere, tracțiune, sfâșiere, elasticitate, modul net superioare față de amestecurile ce conțin particule nemodificate, respectiv față de SBS. Rezultatele obținute confirmă faptul că, prin modificarea suprafeței particulelor, se îmbunătățește dispersabilitatea și compatibilitatea dintre faze datorită obținerii unei interfețe optime între particule/matrice polimerică. Indicii de fluiditate se reduc în cazul ranforsarii SBS-ului cu cantități ridicate de particule, fără însă a ridica probleme de procesabilitate.

CUVINTE CHEIE: stiren-butadienă-stiren, carbonați, alumino-silicat, compuși organo-anorganici, caracterizare.

L'INFLUENCE DE L'ADDITIVATION DE MICROPARTICULES FONCTIONNALISÉES SUR LES PROPRIÉTÉS PHYSICO-MÉCANIQUES, STRUCTURELLES ET DE TRAITEMENT DES CAOUTCHOUCS THERMOPLASTIQUES

RÉSUMÉ. Le but de cet article a été d'évaluer l'influence des poudres modifiées en surface avec des composés organo-inorganiques sur les propriétés du caoutchouc thermoplastique copolymère bloc styrène-butadiène-styrène (SBS) obtenu par le procédé de mélange. La modification de la surface des poudres de kaolin, $CaCO_3$ et $MgCO_3$ avec des précurseurs de TiO_2 et/ou SiO_2 visait à améliorer l'interface, la dispersibilité et les propriétés physico-mécaniques des composés à base de SBS. L'isopropoxyde de titane a été utilisé comme précurseur du TiO_2 et le tétraéthylortosilicate (TEOS) comme précurseur du SiO_2. Les poudres modifiées ont été caractérisées du point de vue morpho-structurel par MEB, FTIR et EDAX. Les spectres FTIR mettent en évidence les bandes caractéristiques des poudres individuelles, mais les groupes fonctionnels dérivés de TiO_2 et de SiO_2 n'ont pas pu être visualisés. Pour cette raison, une analyse EDAX a été réalisée sur les poudres, ce qui a confirmé que la modification était due à la présence d'éléments en silicium et/ou en titane dans les trois types de poudres. La microscopie au MEB réalisée sur les poudres modifiées par rapport aux poudres non modifiées montre une réduction des zones contenant des agglomérats de particules due à la réduction de l'énergie de surface et, implicitement, des forces d'attraction électrostatiques. Les résultats physico-mécaniques montrent que, dans le cas de composés contenant un mélange de particules modifiées (même à des volumes élevés, 75%), les valeurs de résistance à la déchirure, à la traction, l'élasticité et le module sont nettement supérieures aux mélanges contenant des particules non modifiées, c'est-à-dire à SBS. Les résultats obtenus confirment que, en modifiant la surface des particules, la dispersibilité et

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la compatibilité entre les phases sont améliorées en obtenant une interface optimale entre les particules/matrice de polymère. Les rapports de fluidité sont réduits lorsque le SBS est renforcé avec de grandes quantités de particules, mais ne posent pas de problèmes de capacité de traitement.
MOTS CLÉS : styrène-butadiène-styrène, carbonates, aluminosilicate, composés organo-inorganiques, caractérisation

INTRODUCTION

Filling materials are one of the most important additives used in the rubber processing industry [1, 2]. Using filling materials can improve processability and bring numerous economic benefits. However, the efficiency of reinforcement depends on the properties of the filler, the particle size, shape, surface area, degree of dispersion as well as the interactions taking place with the polymer [3, 4]. The properties of the composite materials could be optimized by increasing the size of the interface and modifying the strength of bonds/interactions that occur between the polymer matrix and the filler. An increase of interface dimensions could be achieved by reducing particle size to nanometer. This decrease to nanometric level in particle size leads to a higher degree of agglomeration, to a poor dispersion and reduced physico-mechanical, chemical and thermal properties [5]. These properties could be obtained by modifying the surface of the particles with different coupling agents. Adding a surface-modified nano (micro) filler can improve properties because it reduces surface hydrophilia, improves dispersion and interactions that occur at the interface. Styrene-butadiene-styrene thermoplastic rubber is one of the most widely used elastomers in various industrial applications, mainly due to its high filling capacity, high flexural strength, etc. Therefore, in the case of the development of composite materials, SBS plays the role of polymer matrix [6].

The most common reinforcing agents used in polymers are organic and inorganic. Among the most commonly used inorganic particles are SiO_2, TiO_2, $CaCO_3$, talc, polyhedral oligomeric silsesquioxane (POSS), carbon fiber, montmorillonite clay (MMT), multi-wall carbon nanotubes [7-10], carbon black [11], nanodiamond [12], boron carbide [13] etc. Of these, calcium carbonate ($CaCO_3$) is the most commonly used as a filler material in various polymers. However, due to the hydrophilic nature of the surface, $CaCO_3$ is incompatible with the vast majority of polymers - hydrophobic. Moreover, calcium carbonate has a very low surface chemical activity. Due to this issue, it is used rather as a conventional filler material (for cost reduction) and not as an active reinforcement agent, capable of improving some properties of interest (physico-mechanical, chemical, thermal, etc.). In order to be used as an active reinforcement agent, it is necessary to modify its surface with coupling agents or with organic acids [14]. The most common organic acid used to modify the surface of $CaCO_3$ is stearic acid. Its presence on the $CaCO_3$ surface induces surface hydrophobicity and implicitly improves compatibility with various polymers such as high density polyethylene (HDPE), polypropylene (PP), etc. [15]. Surface treatment leads to the reduction of particle-particle interactions and the increase of matrix/filler adhesion. However, SiO_2 particle surface modification is much easier than $CaCO_3$, because it has more reactive surface groups. Calcium carbonate does not contain -OH groups on its surface and therefore the percentage of silane left over by the modification is reduced by about 19%. In the case of mineral clays, due to the presence of Si-OH and Al-OH on the surface, it is possible to form covalent bonds with silanol. The percentage of silane remaining on the clay surface is about 66% [16]. A recently reported method for modifying the surface of precipitated $CaCO_3$ (PCC) was to modify the surface with silica produced by sol-gel method. The PCC surface was modified with silica produced via hydrolysis and condensation reactions of tetraethylorthosilicate (silica precursor) in ethanol/water solutions under alkaline conditions [17]. Another method for modifying $CaCO_3$ was to treat the surface with a mixture of silane coupling agents, amino- and mercapto groups for use as reinforcing agent in

isoprene rubber. The amount of chemisorbed silanes on the surface of $CaCO_3$ measured by thermogravimetry indicates a higher amount of aminosilane than mercaptosilane, and higher for the trialkoxy structure than for dialkoxy. Moreover, higher values for stress at 500% strain, fracture stress, and elongation at break were determined for the treatment with amino- and mercapto-functional silanes having a trialkoxy structure from the stress-strain curves of composite. Treating the mixture with silanes containing mercapto and amino functional groups having the dialkoxy structure did not sufficiently improve the mechanical properties [18]. Another method presented in the literature for the chemical modifying the surface of calcium carbonate particles was focused on the grafting reaction using maleic anhydride grafting polyethylene wax (MA-g-PEW) as a coupling agents, having a weight ratio between MA-g-PEW and $CaCO_3$ ranging between 1 to 2.5 wt%. FTIR spectra showed that by this method, surface modification of $CaCO_3$ was achieved by chemical bonding [19]. Other methods for improving the compatibility of calcium nanosize carbonate with PVC matrix have been focused on surface modification using polymerization in the presence of 2 monomers, methyl methacrylate (MMA) and Butyl acrylate (BA) [20]. Kaolin is a natural, nontoxic and inexpensive layered alumino silicate with a chemical structure rich in reactive hydroxyl groups, capable of numerous chemical and ion exchange reactions. Kaolinite is the most commonly 1:1 (two-sheet) - type clay mineral with its basic unit consisting of a tetrahedral sheet of SiO_2 siloxane units and an octahedral sheet of $AlO_2(OH)_4$. After modification, kaolinite particles can become evenly dispersed in the rubber matrix and be used as a functional filler for rubber because of its light color, special stratified structure, and availability [19].

Therefore, kaolin is considered an excellent substrate for anchoring metal oxides, with applications in many fields. Different TiO_2 precursors ($TiCl_4$, $TiOSO_4$ and Ti (IV) alkoxides respectively) were used to modify kaolin [21]. Other coupling agents (octadecylamine, N-(3-trimethoxysilyl) propyl ethylene diamine and bis- (γ-triethoxysilylpropyl) -tetrasulfide-Si69) were used to modify the surface of the layered clays in order to improve compatibility with styrene butadiene rubber [22, 23]. Due to the fact that the layered clays have reactive free -OH groups, modification with coupling agents is much easier compared to carbonates. However, an absolutely necessary condition is that these coupling agents are able to react with these hydroxyl groups. By using coupling agents, the hydrophilic surface of the particles is transformed into hydrophobic, thereby improving compatibility and dispersion in the polymeric matrix. However, the effect of modifying the surface with these coupling agents depends largely on the number of hydroxyl groups present on the surface of the fillers. Unfortunately, the vast majority of inorganic particles possess a low number of hydroxyl groups on the surface. Therefore, it is important to increase the number of hydroxyl groups on the surface of some inorganic agents [24]. Of the magnesium compounds, the most commonly used as reinforcing agents in the various polymers are simple magnesium hydrates or modified with fatty acids, titanate coupling agents, silane coupling agents, etc [25, 26].

The purpose of this paper was to evaluate the influence of kaolin, $CaCO_3$, and $MgCO_3$ particles unmodified/modified with organo-inorganic compounds (TiO_2 and/or SiO_2) on the physico-mechanical, structural and processability properties of the styrene-butadiene-styrene block copolymer rubber (SBS).

EXPERIMENTAL

Materials

The following raw materials were used in the experiments: Calcium carbonate (type Omya-Carb10-AZ), from Omya North America with the following specifications: specific gravity – 2.70 g/cc, brightness – 94%, moisture absorption at equilibrium – 0.070 %, particle size – 12 µm, calcium carbonate % – 97, magnesium carbonate % – 0.5, retained in 325 mesh (dry) ppm – 0.2; Magnesium Carbonate - grade standard: food grade, industrial grade, color: white, boiling point: 540°C, melting point: 700°C (1292°F), molecular

weight: 485 g/mol; solubility: insoluble in cold water, hot water, alcohol, purchased from Bridgexim SRL; Kaolin – calcined (*Snowpaque*), purchased from Bridgexim SRL; Tetraethyl orthosilicate (TEOS) – reagent grade, assay – 98%, molecular weight – 208.33; Dimethylpolysiloxane – viscosity 500cSt (25°C) (lit.); Titanium (IV) isopropoxide, ≥ 97%, molecular weight: 284.22, density: 0.96g/mL at 20°C (lit.) from Sigma Aldrich, Ethyl Alcohol – for analysis, molecular weight: 46.07 acquired from Chimreactiv SRL, Styrene-butadiene-styrene rubber (SBS) – type Eurruber from Tecnofil SME, Italy.

Methods

Modifying Kaolin, Calcium, and Magnesium Carbonate Particles with Organo-Inorganic Compounds

In the first stage, 100 grams of kaolin powder was immersed/coated with ethyl alcohol (reaction medium) and mixed with a magnetic stirrer until full dispersion of the powders, at 300 rpm and temperature of 40-50°C. Next stage, 10 mL of titanium isopropoxide was added as fine drops and kept under continuous stirring for another 2h. To achieve the hydrolysis of the organo-titanates in the powder mass, 10 mL of distilled water was added, and stirred for another 20 minutes. The resulting mixture is then vacuum filtered and washed with abundant alcohol to remove the excess functional agent, dried at 80°C, and milled. Calcium, and magnesium carbonate were modified in similar conditions to kaolin, with the mention that, due to the lack of the -OH reactive groups on their surface, the silicon precursor - TEOS to obtain silanolic bonds was introduced in the first stage, followed by the addition of droplets of titanium isopropoxide. Moreover, the amount of precursors added was calculated so that 5 g of SiO_2 (18.6 mL), and 5 g of TiO_2 (24.67 mL) were finally obtained, the rest of the stages being the same as in the case of kaolin modification.

Obtaining Composites based on SBS / Unfunctionalized or Functionalized Particles

Composites based on SBS reinforced with varying percentages of modified/unmodified (15, 45 and 75%) mixed particles were processed on a Brabender mixer with capacity of 370 cm^3. Prior to blending, both unmodified/modified powders and SBS rubber were subjected to a pre-drying process, in a hot air oven at 103°C for a minimum of 2 hours. After drying, the formulations presented in Table 1 were processed in the Brabender mixer at 160°C and a speed between 30 rpm for 1 minute, and 130 rpm for 3 minutes. The total processing time in the Brabender mixer was 4 minutes, for every composites processed.

Table 1: Formulations based on SBS rubber reinforced with unmodified/modified particles, wt%

Sample / Raw materials	SBS	1	2	3	4	5	6
SBS rubber	100	100	100	100	100	100	100
Kaolin		5		15		25	
$CaCO_3$		5		15		25	
$MgCO_3$		5		15		25	
Kaolin /10% TiO_2			5		15		25
$CaCO_3$/5%SiO_2 + 5%TiO_2			5		15		25
$MgCO_3$ /5%SiO_2 + 5%TiO_2			5		15		25

From the blends processed on Brabender 150x150x4 mm sheets were obtained, by pressing in the mold at the following optimal parameters: plate temperature – 170°C; preheating – 2 minutes, pressing – 2 minutes, cooling – 8 minutes, and pressure – 300 kN.

From the composites sheets obtained, dumbbell specimen for tensile strength, and panting specimen – tear resistant were cut out. After conditioning for 24 hours at room temperature, are subjected to physico-mechanical and structural determinations (FTIR).

RESULTS AND DISCUSSIONS

FT-IR Analysis of Particles and Composite Blends

The FTIR spectra recorded on the powders of kaolin, $MgCO_3$ and $CaCO_3$ simple and modified with organo-inorganic groups are shown in Figures 1-3.

In the case of the FTIR spectrum recorded on simple kaolin, the following characteristic bands could be identified. The 3681 cm^{-1} band

is attributed to the stretching -OH interlamellar groups of the Al-O-H bond, and that of 3619 cm^{-1} is associated with stretching bond of intra-lamellar -OH groups [27]. The group at 3619 cm^{-1} is characteristic of the high amounts of Al-OH in the octahedral layer. The bands at 3407 and 1648 cm^{-1} are characteristic stretch and deformation bonds of the -OH group in the adsorbed physical water. The band at 1112 cm^{-1} is characteristic of the Si-O stretch bond, and the 788 and 750 cm^{-1} is attributed to the bending vibration of Si-O-Al bonding in the inner layer. The band at 989 and 638 cm^{-1} is attributed to bending bond of -OH and Si-O groups, respectively [28]. The 680 cm^{-1} band is characteristic of the Mg/Al-OH bond and the 514 cm^{-1} characteristic to stretching bond of Fe-O, Fe_2O_3 or Si-O-Al, similar to the results obtained by other researchers [29, 30]. In the case of kaolin powders modified with 10% titanium isopropoxide, the characteristic band of the OH-interlamellar from Al-OH bond at 3681 (simple kaolin) shifts to 3685 cm^{-1}, and the disappearance of the -OH bands at 3407 and 1648 cm^{-1}, as a result of the functionalization reactions involving OH groups in kaolin and which also reduce its affinity to bind/adsorb the moisture, is observed. Weak vibrations of stretch-C-H bonds can also be seen close to 2900 cm^{-1}. The significant shift of the bands from 989 to 997 cm^{-1} and 514 to 522 cm^{-1}, respectively, can be observed in the case of titanium isopropoxide modified kaolin, sufficiently large displacements that demonstrate the functionalization of kaolin.

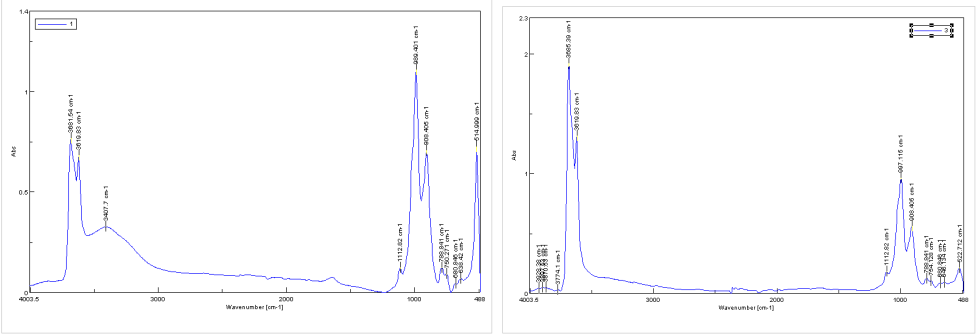

Figure 1. The FTIR spectra of unmodified (left) kaolin and kaolin modified with 10% titanium isopropoxide (right)

In the FTIR spectra recorded on the simple $CaCO_3$ powder (Figure 2, left), it can be seen (3597 cm^{-1}) having a low intensity the -OH bond of $Ca(OH)_2$ left behind after the carbonation process. The bands of 1388 (stretching mode), 871 (O-C-O bending-out plane deformation) and 709 (O-C-O bending-in-plane deformation) cm^{-1} correspond to the three different C-O stretching modes, and the one of 2514 (are harmonic vibration of these elongation modes). The low intensity bands at 2869 and 1797 cm^{-1} correspond to C = O bonds in the carbonate ion. The 501 cm^{-1} band is associated with Ca-O bonds [31, 32]. In the case of $CaCO_3$ / 5% TEOS + 5% titanium isopropoxide powder (Figure 2), the characteristic bands are shifted, especially from 1388 to 1402cm^{-1}, which proves that the carbonate is altered throughout the mass.

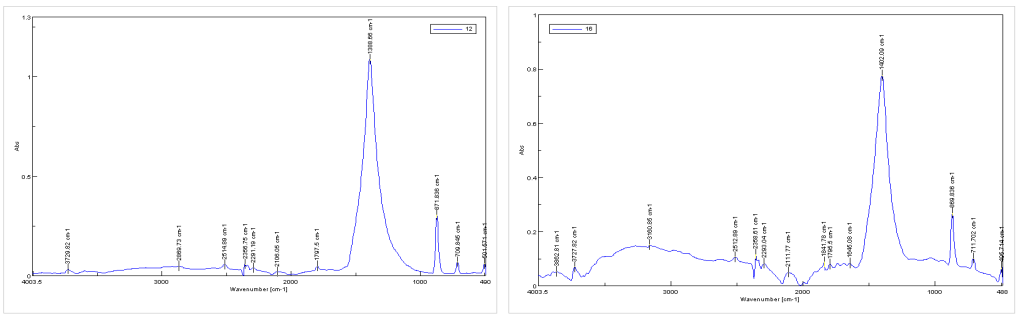

Figure 2. FTIR spectra of the simple $CaCO_3$ powder (left) and $CaCO_3$ / 5% TEOS + 5% titanium isopropoxide (right)

Figure 3 (A) shows the FTIR spectrum of styrene-butadiene-styrene thermoplastic rubber. The bands 3066 and 3020 cm^{-1} are associated with the stretching vibrations of the CH_2 bond of the polybutadiene, and the CH groups in the aromatic ring (styrene). The band 2920 cm^{-1} and 2850 cm^{-1} are associated with the asymmetric and symmetrical stretch vibration of the CH_2 bond in the polybutadiene unit. The band at 1601 cm^{-1} is attributed to the stretch vibration of the carbon atoms in the aromatic ring. The band at 1450 cm^{-1} can be associated with the bending vibrations of the CH_2 group of the cis- and trans-polybutadiene units, or the stretch bond of the C-O group. In this case, it seems, to be associated with the filling used in SBS, namely, calcium carbonate. The 1072 cm^{-1} band is characteristic of polystyrene units, and those of 1026 cm^{-1} can be attributed both to polystyrene groups and vibrations of C-C bond from cis-polybutadiene. The bands of 964 and 906 cm^{-1} can be associated with out-of-plane (wagging) vibrations of CH groups near the double bond in trans- and vinyl- polybutadiene units. The band at 752 cm^{-1} and 694 cm^{-1} represents the bending vibration and out-of-plane bending of the CH bond in the aromatic ring. The band at 540 cm^{-1} is also characteristic of polystyrene units [33, 34]. In the case of the spectrum recorded on the composite – SBS / 75% mixture of (Kaolin – 10% titanium isopropoxide, $CaCO_3$ – 5% TEOS + 5% titanium isopropoxide; $MgCO_3$ – 5% TEOS + 5% titanium isopropoxide) (Figure 3, B), the characteristic kaolin bands can be highlighted at 3694 and 3617 cm^{-1}. The bands characteristic of TiO_2, SiO_2, magnesium or calcium carbonate could not be observed due to their content, and especially their molar absorptions compared to SBS, are moderate.

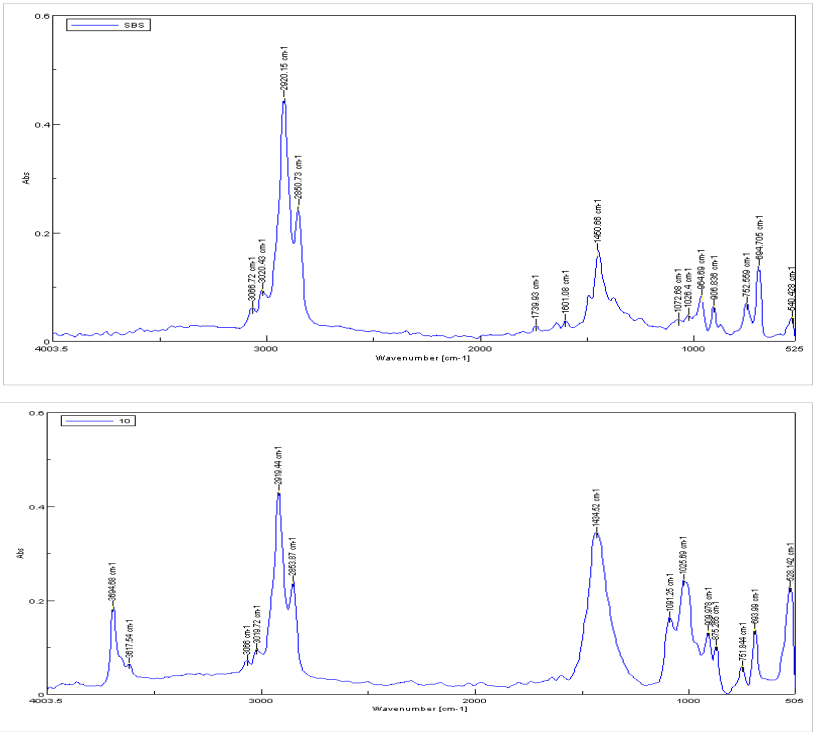

Fig. 3. The FTIR spectra of SBS and composite rubber – SBS / 75% (Kaolin/ 10% TiO2, CaCO3 / 5% TEOS / 5% Titanium Isopropoxide, and MgCO3 / 5% TEOS / 5% Titanium Isopropoxide (10)

EDAX Analysis of Unmodified / Modified Particles

The EDS analysis is a useful method of identifying constituents in the sample as well as their relative ratio. As can be seen from Figure 4 (left) obtained on simple kaolin, the following elements could be identified: O, C, Si, Al, Fe and K. Based on these elements it can be concluded that the used kaolin is not of advanced purity, due to the identification of slight Fe and K. In the case of the spectrum recorded on kaolin powder modified with 10% titanium isopropoxide (Figure 4, right) besides the elements identified in pure kaolin, the presence of Ti element at different

intensities can be visualized, which demonstrates that functionalization took place. In the case of the spectrum recorded on the powder of simple $CaCO_3$ (Figure 5, left) the following could be visualized, C, O and Ca, confirming the advanced purity of this type of powder. In the case of modified $CaCO_3$ powders with silicon and titanium precursors (Figure 5, right), the Si and Ti elements could also be seen. In this case, it is confirmed that the chosen functionalization method allows the successful modification of these powders. Quantitative analysis of these powders Table 2, shows the weight and atomic ratio between components. As can be seen, in the case of $MgCO_3$ powder, a higher percentage of titanium and silicon is retained on the surface compared to that obtained on the $CaCO_3$ powder, indicating a higher affinity of these powders for the functionalization process.

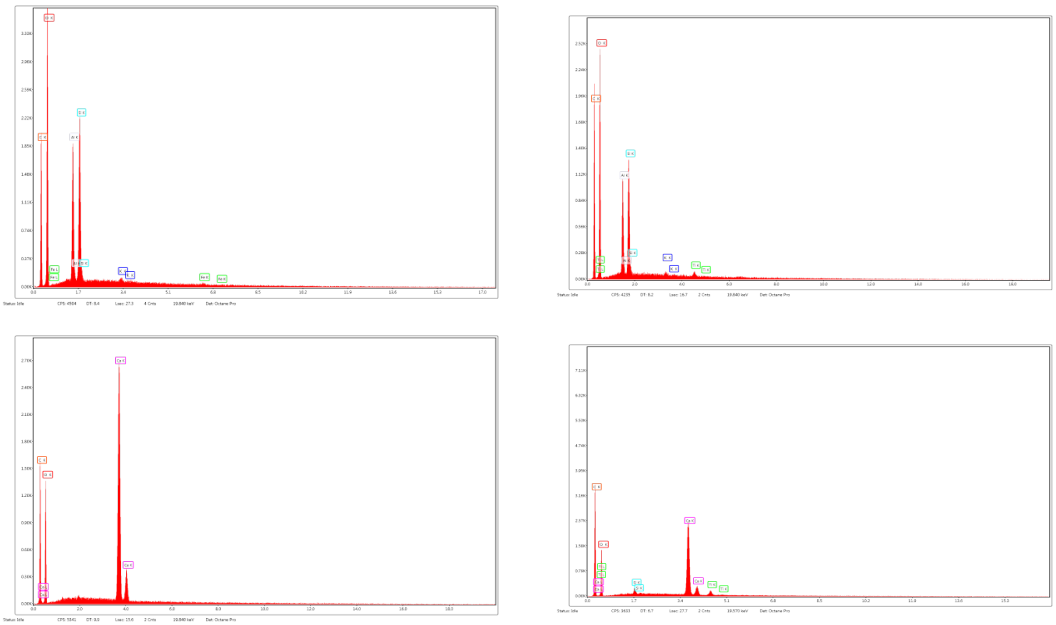

Figure 4. EDS analysis recorded on kaolin powder (left) and kaolin/10% titanium isopropoxide (right)

Figure 5. EDS spectra obtained on $CaCO_3$ powder (left) and $CaCO_3$ / 5% TEOS + 5% titanium isopropoxide (right)

Table 2: Quantitative analysis of kaolin, $CaCO_3$, and $MgCO_3$ unmodified/modified powders

Element	Weight %	Atomic %
Kaolin		
O K	67.44	78.32
Al K	13.98	9.63
Si K	17.6	11.64
K K	0.62	0.3
Fe K	0.35	0.12
Kaolin/10% titanium isopropoxide		
O K	68.56	79.35
Al K	13.66	9.38
Si K	16.04	10.58
K K	0.59	0.28
Ti K	0.68	0.26
Fe K	0.46	0.15
O K	68.56	79.35
Al K	13.66	9.38
$CaCO_3$		
C K	33.01	43.45
O K	50.76	50.15
Ca K	16.23	6.4
$CaCO_3$/5% TEOS/5% titanium isopropoxide		
C K	50.02	60.22
O K	40.01	36.16
Si K	0.45	0.23
Ca K	8.86	3.2
Ti K	0.66	0.2

	$MgCO_3$	
C K	18.13	25.18
O K	48.88	50.97
Mg K	32.99	23.84
$MgCO_3$/5% TEOS/5% titanium isopropoxide		
C K	40.82	50.88
O K	39.78	37.22
Mg K	16.71	10.88
Si K	0.8	0.43
Ti K	1.89	0.6

SEM Analysis of Unmodified / Modified Powders and Composite

SEM microscopy performed on unfunctionalized kaolin powder (Figure 6, image A) shows a relatively spherical shape of these as well as the presence of some areas with particle agglomerations. Agglomeration of untreated particles is due to electrostatic forces of attraction. As a result of the functionalization of kaolin with titanium isopropoxide (Figure A"), particle agglomeration zones are substantially reduced due to the modification of the surface with oxidic compounds, which reduce the surface energy and, implicitly, the electrostatic forces of attraction [35]. Thus, clear contours are observed between the particles, and their size is between 170 and 250 nm.

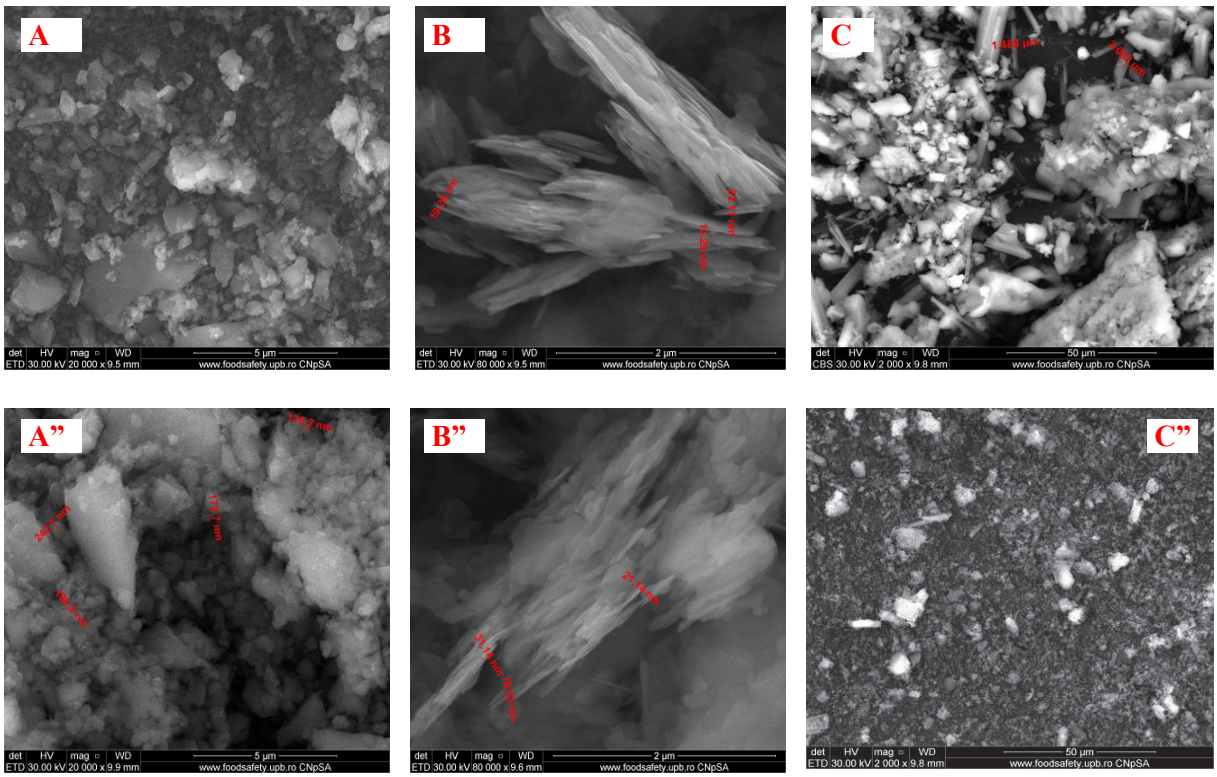

Figure 6. SEM images of unmodified and modified $CaCO_3$ (A), kaolin (B) and $MgCO_3$ (C) powders - $CaCO_3$-5% TEOS-5% titanium isopropoxide (A"), kaolin modified with 10% titanium isopropoxide (B), and $MgCO_3$ -5% TEOS-5% titanium isopropoxide (C")

The SEM images of commercial kaolin powder (Figure 6, image B), show its layered structure, the layer size being between 13.2-23.1 nm. Following the modification of kaolin with silicon and titanium precursors (image B"), a clear mapping / movement of the layers is observed due to Si and Ti localization between them. The size of the layers is not influenced by the presence of these inorganic powders, being maintained between 16.83-31.14 nm.

The SEM image obtained on commercial magnesium carbonate (Figure 6, image C), highlights an extremely varied morphology of the particles (filiform, spherical, cylindrical) with dimensions between 1.4-3 µm and an advanced agglomeration. Following the modification with

TEOS and titanium isopropoxide (Figure 6, image C"), an advanced disaggregation is observed, due to the reduction of the electrostatic attraction forces.

The SEM images obtained on the SBS/ 75% unmodified particle mixture (Figure 7, left) show a reasonable distribution of SBS mass. However, in some areas, areas with slight particle agglomerations or gaps (probably due to particle detachment following fracture of the samples in liquid nitrogen) can be seen, prior starting the analysis. In contrast, for the composites containing the same amount of particulate mixture but modified (Figure 7, right image), an advanced reduction of the voids and particle agglomerates is observed, due to their very good dispersion and compatibility with the polymer mass.

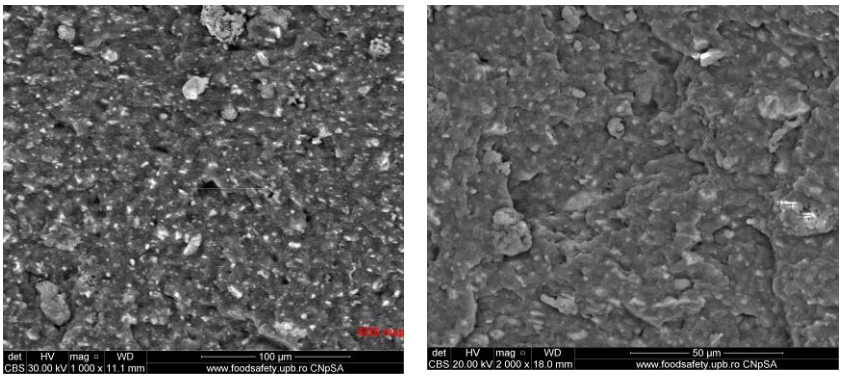

Figure 7. SEM image recorded on SBS composite - 75% unmodified particles - kaolin, $CaCO_3$ and $MgCO_3$ (left), and SBS-75% modified particles - kaolin, $CaCO_3$ and $MgCO_3$ (right)

Physico-mechanical and Rheological Characterization of Composite Materials based on SBS

The physico-mechanical results obtained on SBS-based polymeric composites reinforced with different ratios of modified/unmodified particulate mixture (kaolin, $CaCO_3$ and $MgCO_3$) are presented in In most cases, elasticity and elongation at break decrease with the increase in the amount of powders, due to reduced mobility of the macromolecular chains. Instead, higher values of the 100% modulus were obtained mainly for high hardness mixtures, respectively, when modified particles were used. The flow properties of composite mixtures improve if a mixture of unfunctionalized/functionalized particles is used up to a percentage of (15% and 45%), respectively, of the reference sample (SBS). In contrast, for composites containing high amounts of particles 75%, the flow properties drop to 244-132g / 10 min. However, during the process of obtaining the composites, there were no problems of processability.

Table 3. As can be seen, for all the composites obtained, the physical and mechanical properties are significantly higher than those obtained on the unmodified rubber. For samples 1 and 2, containing 15% of the three particle types, the hardness does not vary with the reference value. In contrast, in the case of mixtures containing high amounts of particulate mixture 45% (Samples 3 and 4), and 75% (Samples 5 and 6), the hardness gradually increases with the amount of particles. Moreover, in the case of mixtures containing powders modified with TiO_2 and SiO_2 (Samples 4 and 6), higher hardnesses are obtained, at the same degree of reinforcement compared to mixtures containing unmodified powders (Samples 3 and 5). Tensile strength is significantly improved over SBS for all blends. However, if modified particles (Samples 2, 4 and 6) are used, the tensile strength is higher compared to those containing unmodified particles (1, 3 and 5). This was to be expected, because by modifying the surface of the particles, the dispersion and adhesion with the SBS matrix improves. The highest value for the tear strength was obtained for the mixture containing 15% modified particles (Sample 2) followed by the mixture containing 75% modified powder mixture (Sample 6). This clearly demonstrates that modified powder reduces agglomeration, improves dispersion, and strong interactions

occur between the phases in the system, even at high amounts of reinforcing agents. Elasticity also improves for mixtures containing 15 or 45% modified powders, but decreases to high volumes (Sample 6), and for mixtures containing unmodified powders. In most cases, elasticity and elongation at break decrease with the increase in the amount of powders, due to reduced mobility of the macromolecular chains. Instead, higher values of the 100% modulus were obtained mainly for high hardness mixtures, respectively, when modified particles were used. The flow properties of composite mixtures improve if a mixture of unfunctionalized/functionalized particles is used up to a percentage of (15% and 45%), respectively, of the reference sample (SBS). In contrast, for composites containing high amounts of particles 75%, the flow properties drop to 244-132g / 10 min. However, during the process of obtaining the composites, there were no problems of processability.

Table 3: Physico-mechanical and rheological characteristics for obtained composite materials

Sample / Characteristic	SBS	1	2	3	4	5	6
PHYSICO-MECHANICAL							
Hardness, ^{0}ShA	60	59	60	66	71	73	78
Tensile strength, N/mm^2	1.29	3.17	3. 83	3.08	3.28	3.15	3.65
Module 100%	1.18	1.19	1.56	1.55	2.2	2.37	3.13
Module 300%	-	2.99	3.53	-	3.10	-	-
Elongation at break, %	120	300	400	260	320	280	160
Elasticity, %	34	37	38	40	42	37	34
Tear resistance, N/mm	8.97	15. 21	20. 27	20.05	21.99	20.97	19.07
RHEOLOGICAL – Melt Flow Index							
MFI, g/10 min	278	328	311	309	295	242	132

CONCLUSIONS

The affinity of powder surface to the modification with TiO_2 and SiO_2 precursors depends on the presence of reactive groups on the surface as well as on the type of powder used. Although kaolin has a much higher number of reactive groups than magnesium and calcium carbonate, the percentage of TiO_2 remaining on the surface of magnesium carbonate is the highest, based on results from the EDS quantitative analysis. The presence of TiO_2 and/or SiO_2 on the surface of powders leads to a reduction in agglomerations due to reduced electrostatic attraction forces. The use of modified powders in the SBS matrix improves physico-mechanical properties due to a reduction in agglomerations/ voids and to the formation of strong interactions at the interface. Hardness and melt flow index are reduced in the case of composites containing modified powders, however, they stay within acceptable limits for obtaining finished products by extrusion-injection.

Acknowledgements

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI - UEFISCDI, project number PN-III-P2-2.1-CI-2018-1056 - Thermoplastic polymer and nano/micro particle-based fireproof protection sole for firefighters, ctr. No. 183 CI/2018, within PNCDI III.

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SUSTAINABILITY IN THE PORTUGUESE FASHION ACCESSORY & FOOTWEAR INDUSTRY (CASE STUDIES)

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Received: 20.11.2018 Accepted: 30.01.2019 https://doi.org/10.24264/lfj.19.1.5

SUSTAINABILITY IN THE PORTUGUESE FASHION ACCESSORY & FOOTWEAR INDUSTRY (CASE STUDIES)

ABSTRACT. The Portuguese footwear has the second most expensive pair of shoes produced in Europe (Italy has the most expensive), it is the only country in the world that produces more footwear than it consumes. The main environmental impacts caused by this sector are at residues containing chromium in its composition, such as leather flaps and leather powder, which are difficult materials to degrade by the environment and therefore highly polluting. Being a thriving industry is also one of the firsts to have concerns with the issue of sustainability, emerging already some cases of good practice in the framework of sustainable strategies. This paper uses the case study research strategy of footwear brands and Portuguese accessories. The field study shows that the most commonly adopted sustainability principles are the choice of less polluting materials, less aggressive tanning leather, or even alternative materials. Products created with greater cultural value and in a more traditional way, towards the adoption of a slow fashion in the footwear sector.

KEY WORDS: Sustainability, fashion footwear, upcycling.

SUSTENABILITATEA ÎN INDUSTRIA ACCESORIILOR DE MODĂ ȘI ÎN INDUSTRIA DE ÎNCĂLȚĂMINTE DIN PORTUGALIA (STUDII DE CAZ)

REZUMAT. Industria de încălțăminte portugheză este pe locul doi în Europa privind prețul pentru o pereche de pantofi (Italia este pe locul întâi) și este singura țară din lume care produce mai multă încălțăminte decât consumă. Principalele efecte asupra mediului cauzate de acest sector sunt datorate deșeurilor care conțin crom, cum ar fi resturile și pulberea de piele, materiale care se degradează greu în mediul înconjurător și, prin urmare, sunt foarte poluante. Fiind o industrie înfloritoare este, de asemenea, una dintre primele care au preocupări privind sustenabilitatea, existând deja câteva cazuri de bune practici în cadrul strategiilor sustenabile. Această lucrare utilizează metoda de cercetare prin studii de caz ale unor branduri portugheze de încălțăminte și accesorii. Studiul de teren arată că principiile de sustenabilitate adoptate cel mai frecvent sunt alegerea materialelor mai puțin poluante, pielea tăbăcită mai puțin agresiv sau chiar materialele alternative. Produsele sunt create cu o valoare culturală mai mare și într-un mod mai tradițional, mergând spre adoptarea modei lente în sectorul încălțămintei.

CUVINTE CHEIE: sustenabilitate, încălțăminte de modă, upcycling.

DURABILITÉ DANS L'INDUSTRIE PORTUGAISE DE L'ACCESSOIRE DE LA MODE ET DE LA CHAUSSURE (ÉTUDES DE CAS)

RÉSUMÉ. L'industrie portugaise de la chaussure est classé deuxième en Europe en ce qui concerne le prix d'une paire de chaussures (l'Italie est la première) et c'est le seul pays au monde qui produit plus de chaussures qu'il n'en consomme. Les principaux effets environnementaux causés par ce secteur sont dus aux résidus contenant du chrome, tels que débris et poudre de peau, des matériaux difficiles à dégrader dans l'environnement et sont donc très polluants. Elle est une industrie florissante mais également l'une des premières à se préoccuper de la durabilité, certaines bonnes pratiques étant déjà en place dans les stratégies de durabilité. Cet article explore la méthode de recherche à travers des études de cas de marques portugaises de chaussures et accessoires. L'étude sur le terrain montre que les principes de durabilité les plus couramment adoptés consistent à choisir des matériaux moins polluants, du cuir tanné moins agressif, voire des matériaux alternatifs. Les produits sont créés avec une plus grande valeur culturelle et de manière plus traditionnelle, en allant vers l'adoption de la mode lente dans le secteur de la chaussure.

MOTS CLÉS: durabilité, chaussures de mode, upcycling.

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INTRODUCTION

The current commercial system is going through several modifications in attempting to solve or at least to relieve the problems from an unbridled production over the years. Numerous changes in the environment, including the greater scarcity of raw material resources, the observed climate changes, financial crises, and an increasingly uncertain future, have been collaborating for the companies to look for a way to reverse the situation by reviewing their actions and strategies of business and manufacturing for the future.

The moment lived is of great concern with the environment and issues related to the production processes, especially within the fashion world. It is becoming increasingly necessary to adopt a development model that minimizes environmental impacts. The accelerated ways of production are today one of the biggest reasons for the deterioration of the environment, which is the cause of the growing accumulation of industrial waste and immature discarded products.

Whenever a material results from a production left-over and has no longer valor after a process, is discarded by the industry and is then called industrial waste [1]. According to Sousa [2], "industries that use leather as a raw material (footwear, clothing, upholstery, bags, belts, etc.), about 15% of the raw materials put into operation are discarded as waste leather (leather flaps or scrap in semi-finished and finished)". These residues normally containing chromium in their composition, those are materials that are difficult to be degraded by the environment and therefore highly polluting, which can only be disposed of in landfills or in some cases for incineration (although with a risk of contamination). Among the major current challenges facing from the footwear and accessories industries is the search for an effective solution to first minimize these industrial waste, and then find efficient ways of recycling it in order to minimize the environmental impacts of these products. On the other hand, this sector, as well as all other fashion, has a strong competition with the entry of Asian countries into the world market with competitive prices and mass production. With all these factors, the footwear sector industry is increasingly concerned with the creation of a differentiated product of quality and the implementation of a system that contemplates the environmental issues, thus reducing the damage to the environment and at the same time creating a differential advantageous in this competitive market.

From a new reality compelled by environmental concerns, entrepreneurs and designers, driven by more conscious consumers, are concerned with finding viable solutions to the environmental problem of contamination and undue disposal of waste. In response, the shoe sector has been seeking to develop more sustainable products. Discarded waste is often a quality raw material that can be reinserted into the more artisanal production chain. Waste that is discarded, properly or unduly, in the environment is a concern and reuse is one of the most sustainable processes in the search for the valuation of discarded materials, studied by sustainable design [3].

Thus, designers are increasingly involved in the issue of sustainability, undertaking the study of the Product Life Cycle, seeking to satisfy an increasing concern in the development of sustainable products that involves not only the selection and use of materials but also the forms of construction involved and the disposal. When it comes to products developed from highly polluting raw materials, the study of waste generated is fundamental, and the designer plays an important role in the search for solutions for the reduction of industrial waste, and in the creation of alternatives for the reuse of these wastes [4].

Based on this context and seeking to know better the strategies of the footwear sector involving sustainable development, this paper studies the brands of the Portuguese footwear companies concerned and involved in sustainable projects. Thus, the main objective of this article is to study the case of footwear/ accessories brands in Portugal, to analyze the sustainability principles most commonly adopted by companies and to understand the reasons why the footwear sector is concerned with issues related to investment in sustainable products.

Footwear Industry in Portugal

The Portuguese footwear business has the second most expensive pair of shoes in Europe behind only the Italian withal is a unique case in which it is the only country in the world that produces more footwear than it consumes [5]. This has the entire production chain, with a good knowledge of production, fashion, and design. According to the World Footwear Congress, held in May 2018, "the Portuguese footwear industry is innovative and strong performance in exportation." According to the same source, "more than 95% of its production is destined for external markets and that, it exported more than 80 million pairs of footwear in 2017". The Congress approached the theme "From-Fashion to Factory: a new technological age", and argues that the footwear industry in Portugal represents a model of competitiveness and one of the great examples of modernization and innovation in tradition [6].

According to APICCAPS (Portuguese Association of Manufacturers of Footwear, Components and Leather Products founded in 1975 and headquartered in Porto), the Portuguese footwear industry has been growing more and more in the foreign market and is in the eighth consecutive year of international growth [7]. This growth is part of the goals contained in Footure 2020 - Strategic Plan of the Cluster of Portuguese Footwear. Among the actions included in this plan is also the search for sustainable and responsible development, this line of action aims at the development and dynamization of new social practices and methodologies in the areas of environment, energy, and certification. Its objectives are also to develop solutions to increase the efficiency in the use of raw materials, principles of footwear eco-design, new processes of recycling of products and development of tools for the sustainable management of waste and by-products [8]. According to the same source, in the last decade more than 342 footwear brands were created in Portugal, data from the GAPI (Support Office for the Promotion of Industrial Property) of the Technological Center of Footwear of Portugal which demonstrates a new reality in the sector, a greater valorization of shoes collections, products and "Made in Portugal" as a brand.

These new brands are part of the priority of the strategic plan created by the sector, the "Footure 2020", which looks forward to a more modern industry focused on the future, combining the tradition of Portuguese footwear and technologies. This movement has been running since 2008 with the "Portuguese Shoes: Designed by the Future" campaign, in which companies/brands have focused mainly on the international market [8].

Through the 2014-2020 action plans, the footwear cluster strategy aims to consolidate Portugal's position as a "benchmark of the footwear industry worldwide, grounding the creativity and sophistication of products with a sustainable production base and highly competitive, based on knowledge and innovation". Following this proposed action plan, it can be said that the Portuguese footwear sector continues to be aligned with the principles of a "circular economy", with a concern for the reuse of resources and the use of more sustainable raw materials, while continuing technological innovation.

Portuguese companies have searched for technological intervention together with the adoption of increasingly sustainable measures. The sector has been reinventing itself and has been positioning itself in the foreign market through high standards of quality and environmental concern. This is reflected in the APICCAPS data, which states that in 2017, the value of exports totaled 2 billion euros (corresponding to 83 million pairs of shoes sold). These figures point to a new record for the eighth consecutive year of growth, with industry growth of more than 55% since 2009 [8].

Development of Sustainable Products

By making an analysis on the environmental issue it is easily identified that the footwear industry is a highly polluting sector. This is due to the types of waste generated, many of them contaminated with heavy metals, being a big problem for the companies, the communities where they are inserted and for the environment in general. For these reasons, complying with tight Environmental Legislation in European is currently one of the greatest challenges for companies in the sector. However, the

Portuguese companies in the sector have been dedicated to sustainability issues with great success, which has brought them benefits both in the management of their business and in the sustainability of the environment [9].

According to the Technology Center of Footwear of Portugal (CTCP), companies have searched for support in the implementation of an environmental management system as well as its certification. This implementation of an environmental management system and its ISO 14001 certification allows companies to reduce the environmental impact by reducing waste, which means reducing costs of their entire production process, to be more environmentally and economically efficient, to improve their reputation to their consumers, as well as the conquest of new markets and customers [10].

The Portuguese footwear cluster has invested more and more in R&TD, currently around 8.2 M € of investment aiming at the differentiation and diversification of products with the objective of supporting the added value of exporting capacity, which includes the creation of new Competitive business solutions in the areas of materials, components and accessories; shoe; manufacturing processes, logistics and business models. Within the FOOTURE 2020 strategic plan is the project called FAMEST-Footwear and advanced technologies of materials, equipment, and software, which involves 33 co-promoters. Among the approaches are design, customization, additive manufacturing, industry 4.0, online sales, recycling and circular economy [11]. As it can be seen, the environmental issue is among the investments and strategies of the sector, giving focus to recycling and to the circular economy. The footwear sector in Portugal has invested heavily and is now considered a more sustainable industry, at the level of the productive processes and the level of the raw materials used and manufactured products, is also less carbon generator [11].

Focusing on environmental issues, CTCP has created the eco-label called Biocalce, this label serves to identify footwear that respects the environment during its manufacturing process this involves all phases, from design, when the material is chosen, to the way of manufacturing. Currently "more than 60% of the rubber soles used, which look like a rubber are made of thermoplastic and recyclable materials and the rubber when used whenever possible is recycled. The outer materials are also natural materials such as linen or cotton", explains Maria José Ferreira, director of the new materials unit at CTCP [12].

CASE STUDY: PORTUGUESE FOOTWEAR BRANDS SEARCHING FOR SUSTAINABILITY

The environment and sustainability are global concerns, brands are looking for strategies to solve problems with design as a great collaborator. The Portuguese footwear cluster has as action plans to search for better productivity, improved quality, innovation, and sustainability. In order to demonstrate these principles, Table 1 presents some cases of Portuguese footwear brands with success and in the sense of understanding the sustainable strategies adopted in the sector.

Table 1: Sustainable strategies adopted by Portuguese footwear brands

Brands	Sustainable Strategies
Nae Vegan Shoes www.nae-vegan.com	Footwear with animal-friendly and vegan philosophy since 2008. Use of natural and ecological materials certified by OEKO-TEX. Concerns with design, style, and quality. All the manufacturing in Portugal in places certified in environmental and social standings. A line of products made exclusively from recycled plastic bottles and tires, another line of products made with pineapple fiber fibers (Piñatex[†]). It is also the first world brand to develop footwear through the recycling of airbags.
MDMA Shoes www.mdmashoes.com	With the motto: "minimize damage MAXIMIZE ART", develops limited edition footwear lines, from discarded domestic garments and industrial waste. It works in partnership with the management of domestic and industrial waste companies. Uses rubber waste to the sole.
Balluta Shoes https://balluta-shoes.com	It uses traditional techniques and ecological materials (cork, textiles produced with European certification), and quality philosophy (recycled polyamide and non-solvent) in order to guarantee the quality of the product and reflect the brand's commitment to sustainability. The production is handmade in family factories with the tradition that respect the rights and decent working conditions of its employees.

[†] Piñatex: fiber produced from pineapple leaves, food waste, produced in the Philippines by an English company working with local pineapple communities, with the aim of helping communities through decent jobs, fair pay and local economy increasing.

Softwaves Green Edition (from Comforsyst Company)	Introduced in 2014 as a line of ecological footwear from the Comforsyst Portuguese company, whose main points is the comfort and the sustainability using only materials of natural origin such as natural fibers, cork, wood and "Leather BioNature". The "BioNature Leather" was developed for this shoe line in a project in partnership with the Portuguese tannery company ANC (António Nunes Carvalho) and the Faculty of Sciences of the New University of Lisbon (FCT-UNL), the CTCP and the CTIC. The objective was to develop "biodegradable leathers" with the least possible impact on the environment [13, 14].
AsPortuguesas www.asportuguesas.shoes.com	It develops sandals (flip-flops) in 100% natural material with low ecological impact (like the cork that is extracted without the need of cutting the tree). Its design is intended for surfers. Having social concerns the brand also has a project that involves supporting a social cause for each pair sold €1 reverts to Surf School created by Hawaiian surfer Garrett McManara in Nazareth and for helping orphaned children with this sport. The professional surfer is also the brand's new ambassador and will sign two collections a year titled "Everything is possible".
Zouri www.zourishoes.com	It arises from a dream of two friends to collaborate with the cleaning of the Atlantic Ocean. They decided to transform the bottles and rubbles of fishing nets left on the beaches and the result was the creation of the brand that each pair of slippers or sandals, incorporates between 80 to 100 grams of plastic which means about 6 plastic bottles. The brand does not use any animal product, it is a vegan company and seeks to develop organic products, ecological and with a fair trade policy. It also uses raw materials such as cork, recycled rubber, as Piñatex. The development of the soles that incorporate the plastic of the bottles was carried out in partnership with the University of Minho in Portugal and has already achieved the prize for Best Product Idea with Reutilization of Plastic Waste 2017. The company that owns the brand has a partnership with the City Council of Esposende in Portugal that organizes the action of cleaning the beach, in that action, it was collected in the last year about 1500 kilos of plastic that were milled and transformed into raw material for the manufacture of Zouri products. After collecting the plastic, it is transported and processed by Ecoibérica (a company specializing in the recycling of plastic waste) [15].

Subsequent the demonstrative presentation of some brands that are already committed to developing the products within a sustainable concept, it is presented the two case studies of Portuguese brands that were born as part of a sustainable philosophy, either from the environmental point of view, or socio-cultural, they are: the shoe and accessories company Marita Morena and the fashion accessory company Ideal & Co.

Case Study 1: "Marita Moreno"

Created in 2008 by Designer Marita Setas, the main objective is to contribute to innovation in the creation and production of sustainable fashion objects, with the main focus being the valorization of Portuguese products and materials. It seeks the application of new technologies without leaving aside the values of crafts, culture and traditional methods of production. The products are created and produced in Portugal and commercialized abroad, contributing to the dissemination of quality products made in Portugal: "Made in Portugal" to the world. The products are developed from the north of Portugal but worked with artisans from all over the country.

The CEO and designer of the brand like to work on themes of Portuguese culture as the Azulejos (Portuguese ceramic tiles) and whenever possible with traditional crafts making, she is keen on knowing all the artisans with whom she works [16]. One of the most recent collections is called Azores (Fig. 1), it is produced in the Azores and uses sustainable and different materials such as cork and the traditional weaving of Azorean quilts. The brand also uses wood and cork on the platforms, leather with sustainable production (tanned without using chromium) and "bio-leather".

The brand works with 3 lines, the line of leathers (ecological tannage), the vegan line that uses materials such as polyurethane microfiber, cork, and textiles, and also the line upcycling (with materials leftovers from other collections). Except for microfiber, all materials used are of Portuguese origin. The Dali collection presents a series of products with asymmetrical lines inspired by Salvador Dali paintings, is part of the upcycling line, all made with reuse of materials leftovers from previous collections [17]. The creations presented by the brand have products with a contemporary design that value the quality of raw materials, the manufacturing

and also the cultural and historical value that count and transport to the world, thus becoming a differentiated product capable of showing cultural and heritage values of Portuguese. The brand has created a line in which the products are made of fabric with leather details made with handcrafted white linen, and in contrast with vibrant and intense colors, referring to the typical of Portuguese ceramics tiles Azulejos (Fig. 1).

Figure 1. Collection Azores (Azores and quilts) | Artists & Artisans Collection, (Portuguese Ceramic Tiles) Source: Marita Moreno, 2018

The brand Marita Moreno was born as a brand of design and apparel, with the objective of developing unique pieces through Portuguese weaving and embroidery, in a socio-cultural sustainability approach, however, it begins to develop design pieces and accessories with the production of bags and shoes. What never changed was the brand's constant search for developing products using elements of Portuguese heritage and culture as inspiration in order to spread Portuguese culture in the national and international markets. The brand believes that 3 factors are fundamental, ethics, transparency and social sustainability [17].

According to its CEO, "the concern with ethical and sustainability values has a social responsibility as the main factor, through work with great technical knowledge, allowing the improvement of local processes and knowledge, contributing to the valorization and to increase the quality of life of the involved people". Marita adds that the company also creates training and professional opportunities for underprivileged communities to ensure good working conditions, and "only works with the (her) brand, companies that do not exploit child labor and pay fair salaries with good working conditions" [16]. The production of the brand is made with certified and accredited craftsmen and produces about 100 pieces per model (all pieces are numbered) in order to have the minimum environmental impact avoiding excess production and waste of materials. The production uses natural materials such as wool, flax, cotton, cork, and some other natural fibers and also makes use of recycling of its materials taking advantage of every piece of material even the smallest [17].

Case Study 2: IDEAL & CO

The company created in 2012 by designers Rute Vieira and José Lima was presented from the beginning by the slogan "Living Heritage". It was a way of honoring and prolonging the existence of a family heritage in which the leather tanning business was from the grandfather of Rute and served as inspiration for the creation of the brand [18]. As a result of this partnership linked to tradition and history comes the brand that develops bags, backpacks, covers for tablets and mobile phones, bicycle accessories, stationary for office among other handmade articles and signed by the craftsman who manufactures them (fig 2). The pieces are created in co-design by both designers and result in pieces with a unique and timeless design in a minimalist style and that seeks to preserve the knowledge of the artisans of the Serra d'Aire and Candeeiros Natural Park. The brand's mission is to create unique, quality models, respecting and preserving nature and past work from generation to generation of artisans [18]. Another characteristic of the brand is that most articles are intended for those who use bicycles as a means of transportation (Fig. 2). The relationship with the bicycle comes from the

Figure 2. “Mira” Bicycle Frame | “Candeeiros” Backpacks | “Air Messenger” Bag.
Source: Ideal & Co, 2018

history of the brand, in which the grandfather of the designer of the brand (Rute), used this transportation to trade his leather business in 1935, and also due to the passion for bicycles shared by the designer of the brand José Lima.

Ideal & Co aims to be a reflection of the Portuguese cultural heritage and the capital of Portuguese natural and human resources, using noble raw materials, transformed in an ecological and sustainable way, valuing the work of experienced craftsmen [19]. The brand based on sustainable concepts seeks for the product of quality and each stage is thought, from the origin of the raw material, the form of tanning, labor skills, the manual development of each piece, each stage of the process is thought searching for quality products and that represent something else for the customer and not just a simple accessory. The brand’s pieces have history and the brand wants them to carry its history and its values and that they make their ones history being passed down through generations. One of its most emblematic pieces is the Candeeiros backpack (Fig. 2) highlighted by the English magazine Monocle, as it has already conquered markets such as Singapore, Hong Kong, the United Kingdom, Germany and Denmark [19].

The pieces are produced individually by the hands of experienced craftsmen and made using the best Portuguese leather, the leather is tanned with vegetable tannins from trees and dyed with natural dyes. As a result of this process, the vegetable tanned leather develops a pátine that gives the piece its special appearance and beauty, and the more the piece is used and exposed to natural elements, such as the sun, the more beautiful it becomes. This type of traditional tanning work is done by a few factories in Portugal, it is a very old technique, but the brand has opted for the vegetal way of tanning the leather because it is the most ecological form and also because this type of tanning transmits to the products a unique character, the pieces come to life and the use of the pieces will personalize them. In each article manually created by the artisans, the phrase “some things stay with you forever” is engraved just to say that they are timeless pieces that can be passed down from one generation to the next [18]. The company Ideal & Co, at the same time as it intends to revive the traditional and non-polluting industry, also aims to stimulate the work of small workspaces and artisans who maintain the work in a traditional way. The brand search for to revitalize the artisans and workspaces in the Natural Park of Serra d’Aire and Candeeiros through the reintegration of different groups of artisans who worked alone or in small workshops (ateliers) and as a result of this integration an improvement in traditional production techniques [18].

CONCLUSIONS

The Industry, in general, is experiencing a need to create more environmentally friendly and sustainable solutions and products, but we must also reverse the scale of damage to the planet. The chemicals used to date that cause damage to the environment, excessive use of water in production, undue disposal of raw materials are some of the most important points in this new phase of production.

While these environmental issues are on

the rise and are a worldwide concern we have the economic need to increase production, and this article refers in particular to the cluster of Portuguese footwear that is in full development. APICCAPS (Portuguese Association of Footwear, Components and Leather Products Manufacturers) has created the strategic plan for the Portuguese footwear cluster, Footure 2020, which together with CTCP (Centro Tecnológico de Footwear de Portugal) promotes actions for the development of the sector of the Portuguese footwear industry, also involving sustainability. One of the actions is the campaign to promote the image of Portuguese footwear Portuguese Shoes: Designed by the Future, which has helped companies to disseminate their image and increase the number of exports with quality and preferably committed to sustainability. Portuguese footwear is already seen as a high-quality product and is increasingly investing in technology and image. Among the actions is the development of technological solutions that allow the developed product to have economic efficiency and at the same time the nobility of artisanal production.

The environmental issue is also very present, the entire production chain of footwear has focused on high standards of sustainability and social responsibility, contributing to the development goals of Portuguese society. In this way, the shoe cluster shares these objectives, promoting image, tradition, innovation, product quality, sustainability, and social responsibility. Among the fundamental values of the strategic plan of the shoe cluster is also the design as a differentiating factor in the sector.

Through the present study, it can be seen that there is an increasing number of new footwear brands created by young entrepreneurs with great concern for environmental issues. New brands with the intention of not only creating products but mainly making a difference, create products that do not exhaust natural resources and that help in the solution of the damages caused by the years of accelerated production without questioning raw materials and production methods. A generation of companies focused on the future, a great desire for internationalization, but without going over social and environmental values. There is a concern to follow the tradition of Portuguese footwear with the use of new materials, new components and new technologies for sustainable and responsible development, and often being able to reduce production costs. An appreciation of handmade products and respect for craftsmen through decent working conditions.

Among all the companies, it is verified that the principle of sustainability most commonly adopted was the recycling of both internal and external materials, recycling discarded material to create a new product with concern in design, comfort, social issues, and also in the use of raw materials, natural raw materials. Trademarks with a vegan philosophy, that is, they do not use any material of animal origin and no production process involving animal exploitation. These companies/brands adopted this philosophy in their products for personal, environmental and perceived a gap regarding the offer of this type of product in the sector

Within the studied companies in this cases studies, the brands Marita Moreno and Ideal & Co, concerns follow the same line of thought. They look for more ethics productions, transparency, and sustainability. There is also the focus on social issues, concern not only with the environment, origin of raw materials, production methods, but also with the quality of life of the workers involved. Together with these factors, they search to present to the world what Portugal does better, exporting together with its design products of quality, the culture, and history of the country.

The concern with the production of a sustainable product besides collaborating with the preservation of the environment still presents another great advantage that is the added value to the product. By being part of these ecological and social causes, brands end up having more credibility and consequently

having more visibility and gaining new markets. What we conclude for future productions is that products that use biodegradable raw materials, are sustainability-focused and have social causes involved will have a likely competitive advantage in the marketplace, and all Portuguese companies should be aware of this fact.

Acknowledgements

"This work is supported by FEDER funds through the Competitivity Factors Operational Programme - COMPETE and by national funds through FCT – Foundation for Science and Technology within the scope of the project POCI-01-0145-FEDER-007136".

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SIMULATING THE SURFACE OF LITCHI GRAIN LEATHER BY CREATING QUADRILATERAL-CONTINUOUS PATTERN IN ADOBE ILLUSTRATOR CC

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Received: 03.11.2018 Accepted: 05.02.2019 https://doi.org/10.24264/lfj.19.1.6

SIMULATING THE SURFACE OF LITCHI GRAIN LEATHER BY CREATING QUADRILATERAL-CONTINUOUS PATTERN IN ADOBE ILLUSTRATOR CC

ABSTRACT. The paper illustrates an approach of creating quadrilateral-continuous pattern for simulating litchi grain leather surface in order to solve the issue that the designer of leather products cannot simulate litchi grain surface simply or realistically. Adobe Illustrator CC is a kind of design software that possesses pattern-editing mode. Based on both the image of the litchi grain leather sample scanned by stereo microscope and the rationale behind the quadrilateral-continuous pattern, we obtained the wrinkles and pores of litchi grain leather sample in Adobe Illustrator CC without using any sophisticated algorithm, which in turn resulted in realistic and various effects on the surface of litchi grain leather. Moreover, the pattern exported from Adobe Illustrator CC can also be widely used in other kinds of design software.
KEY WORDS: litchi grain leather, quadrilateral-continuous pattern, Adobe Illustrator CC, surface simulation

SIMULAREA SUPRAFEȚEI PIELII CU MODEL ÎN RELIEF PRIN CREAREA UNUI MODEL PATRULATER CONTINUU ÎN ADOBE ILLUSTRATOR CC

REZUMAT. Lucrarea prezintă o abordare a creării unui model patrulater continuu de simulare a suprafeței pielii cu model în relief pentru a rezolva problema cu care se confruntă designerul de produse din piele care nu poate simula suprafața pielii în mod simplu sau realist. Adobe Illustrator CC este un software de design care permite modelarea tiparelor. Pe baza imaginii scanate la stereomicroscop a probelor din piele și pe baza raționamentului din spatele modelului patrulater continuu, am obținut „ridurile" și „porii" de pe suprafața pielii în Adobe Illustrator CC fără a utiliza niciun algoritm sofisticat, obținând efecte realiste și diverse pe suprafața pielii. În plus, modelul exportat din Adobe Illustrator CC poate fi folosit pe scară largă și în alte tipuri de software de design.
CUVINTE CHEIE: piele cu model în relief, model patrulater continuu, Adobe Illustrator CC, simularea suprafeței

SIMULER LA SURFACE DU CUIR EMBOSSÉ EN CRÉANT UN MOTIF QUADRILATÉRAL CONTINU DANS ADOBE ILLUSTRATOR CC

RÉSUMÉ. Cet article présente une approche permettant de créer un motif quadrilatéral continu pour simuler une surface de cuir embossé afin de résoudre le problème selon lequel le concepteur de produits en cuir ne peut pas simuler de manière simple ou réaliste une surface de cuir embossé. Adobe Illustrator CC est une sorte de logiciel de conception doté du mode d'édition de motifs. Sur la base de l'image de l'échantillon du cuir scanné au stéréomicroscope et de la logique du motif quadrilatéral continu, nous avons obtenu "les rides" et "les pores" de l'échantillon de cuir embossé dans Adobe Illustrator CC sans utiliser d'algorithme sophistiqué, en obtenant des effets réalistes et variés sur la surface du cuir embossé. De plus, le motif exporté depuis Adobe Illustrator CC peut également être largement utilisé dans d'autres types de logiciels de conception.
MOTS CLÉS: cuir embossé, motif quadrilatéral continu, Adobe Illustrator CC, simulation de la surface

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INTRODUCTION

Litchi grain is one of the most popular leather knurling textures which show a stereoscopic, roughened, distinct leather surface. Litchi grain leather (LGL) has characteristics of being soft, durable, comfortable and is commonly used for making leather products. It burnishes and beautifies as time goes by, developing a sought-after patina with unique character that can not be easily duplicated. This predicament occurs when designers simulate LGL merchandise and is used for texture mapping. It is a slow process and difficult to simulate the grained surface as it consistently looks artificial and unrealistic as well.

The texture synthesis technique is the best tool to solve these issues [1]. Some approaches that have been proposed for leather texture synthesis are physical simulation [2], which synthesizes the leather texture by directly simulating its physical generation processes and can model using cellular texturing [3, 4] as well as reaction diffusion [5, 6]. These techniques can generate textures directly with an efficient algorithm, but it is difficult for leather products designers to design an algorithm.

We hypothesise that the quadrilateral-continuous pattern (QCP) of LGL could be generated by a generic software, which could generate a unit that represents the appearance and structural elements of the LGL surface. The visualization, texture mapping and rendering of the LGL merchandise will be accelerated and more convenient.

The solution described in this study addresses the realistic requirement to accurately generate a vector quadrilateral-continuous pattern of LGL utilizing Adobe® Illustrator® (AI). An important attribute of such a continuous unit can be fast and efficient for leather products designers. Furthermore, this kind of vector quadrilateral-continuous pattern will not be distorted, the parameters can be transformed and the pattern can be modified to other appearances automatically and subtly. Moreover, the LGL quadrilateral-continuous pattern made by AI can be saved as many corresponding formats with high resolution, in order to use it for other software.

EXPERIMENTAL

Materials

Olympus SZX12 stereo microscope, equipped with a full-fledged optical system featuring a zoom ratio of 13, in order to obtain skeletons with informative LGL surface structural elements for referencing.

MShot Digital Imaging System, a program designed for a microscope camera to connect with the computer in order to view, capture, measure and process the LGL surface.

Adobe Illustrator CC, QCP of LGL can be customized from scratch with many tools in Adobe Illustrator.

Methods

Obtaining Referenced Skeletons

Olympus SZX12 Stereo Microscope equipped with a full-fledged optical system featuring a zoom ratio of 13 was utilized. There was a collaboration between the MShot Digital Imaging System v1.0 connected with the stereo microscope and the computer in order to view and capture the LGL surface. Figure 1 is a scanned piece of the LGL sample image under 10 times the stereo microscope. Lines and points were generated which represent skeletons in order to analyze and extract informative LGL surface structural elements (i.e. cristae, sulci, wrinkles, pockets and pores) for referencing [7, 8].

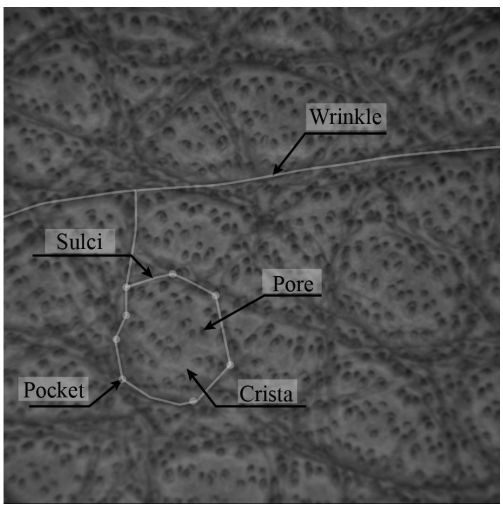

Figure 1. Scanning LGL sample image under 10 times the stereo microscope

Rationale of the Quadrilateral-Continuous Pattern

The quadrilateral-continuous pattern, also known as seamless repeat pattern or pattern tile, is a small artwork repeated next to each other in a seamless way that appears to be one single artwork. Figure 2 is an illustration of the rationale generating QCP, as an ordinary triangle was used as the element in this paradigm.

The broken lines represent the pattern bounding box which is an unfilled and unstroked (non-printing) rectangle. For filling patterns, the bounding box acts as a mask and defines a portion of the pattern tile which indicate that the fragmentary triangle on the right inner side should be completed on the left inner side. The same goes for the top and bottom positioning. After perfecting some details, a triangle quadrilateral-continuous pattern will be generated and appears repetitively without any flaws [9, 10].

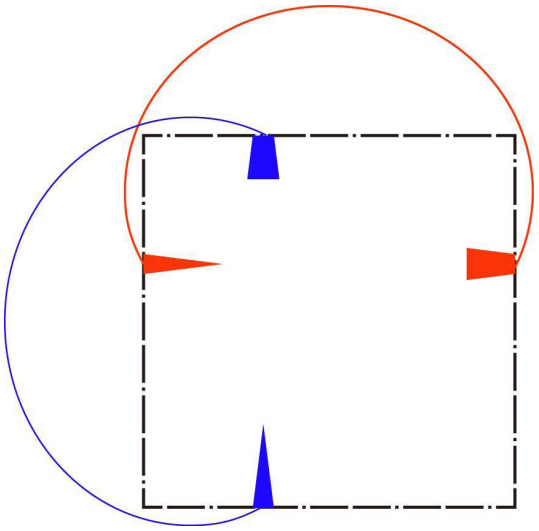

Figure 2. Illustration of the rational generating seamless repeat pattern

Rationale of Generating QCP in AI

According to the rational above, the production of the quadrilateral-continuous pattern was not always an easy task, requiring precision and patience. Nevertheless, with AI CS6 and later version CC, this process became automatic and accelerated. The pattern design tools are accessed through a new menu item: Object > Pattern > Make. Designers are taken into a new pattern generation mode, controlled by a new Pattern Options panel which offers a greater level of control over patterns.

The benefits of generating QCP by AI are not only described above but also because designers can set the repeating behavior by 5 tile type options in the Tile Type pull-down (i.e. Grid, Brick by row, Brick by column, Hex by column, and Hex by row) without having to figure out the algorithm that is needed to do it manually. These tile types enrich the style of SPR.

The Grid tile type follows the rationale of QCP described above, because of this, the Brick Offset value could be changed in Brick by row and Column which can interactively tweak the effects of Grid tile type. Moreover, the bounding boxes of Hex tile type have two more boundary handles than Grid type, a shape of hexagon thatcan create more varied effects. Figure 3 presents the pattern operation interface that contains tile types in AI and the differences of bounding box and rationale between grid tile type and hex tile type.

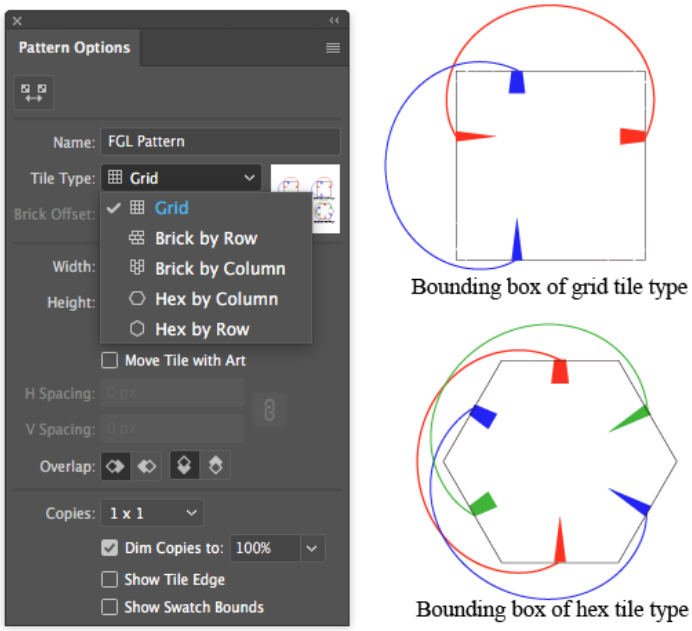

Figure 3. Pattern operation interface of AI & Different bounding boxes and rationales of grid tile type and hex tile type

Generate Wrinkles of LGL Surface

Following the operation procedures give instructions about generating the Grid type QCP of LGL surface as a paradigm using the latest version CC of AI. Brick type and Hex type are based on Grid type and after knowing the principle of generating Grid type pattern, it is easy to generate the other four kinds of QCP in AI. Keyboard shortcuts in brackets are given in this study.

Open Adobe Illustrator and create a new document named QCP of LGL (Cmd/Ctrl + N). Set the units as pixels, color mode as RGB and raster effects as 300 ppi. Place the scanning stereo microscope image into the document (File > Place > Embed). The skeleton of LGL will be extracted from referring to this image.

Based on the size of the placed raster scanning stereomicroscope image, create a rectangle using the Rectangle Tool (M) and set both the fill color and stroke color to None. Select the image and rectangle and set the Align as Horizontal Align Center and Vertical Align Center. This rectangle will play a crucial role when coloring the underpainting of LGL.

Select the image and rectangle, then go to Object > Pattern > Make, which changes to Pattern Editing mode. Lock the two layers and set the stroke color as R=25, G=25, B=25. Select the Tile type as Grid, overlap as Left in Front and Top in Front. Use the Copies pull-down to add repeats which can control the visibility (dimming, edges and bounds) of pattern tile, and keep these settings as the defaults. There will be a rectangle with the same size of the image which plays the role of the boundary box. Continue creating the skeleton of wrinkles while referring to the wrinkles on the bottom image with the help of the Pen Tool series (P).

In this mode, paths of wrinkles can be created inside the boundary box from left/top to right/bottom. The portions outside the right edge/bottom edge of the boundary box will be completed inside the boundary box from left/bottom. Meanwhile, the initial anchors and terminal anchors will be assembled on the left edge and top edge. Take advantage of these conveniences and automations; adjust the paths in order to make sure uniformity, continuity and extensibility with paths on adjacent tiles on the premise that there are no significant changes compared with referencing wrinkles, especially the anchors assembled on the boundary box edges.

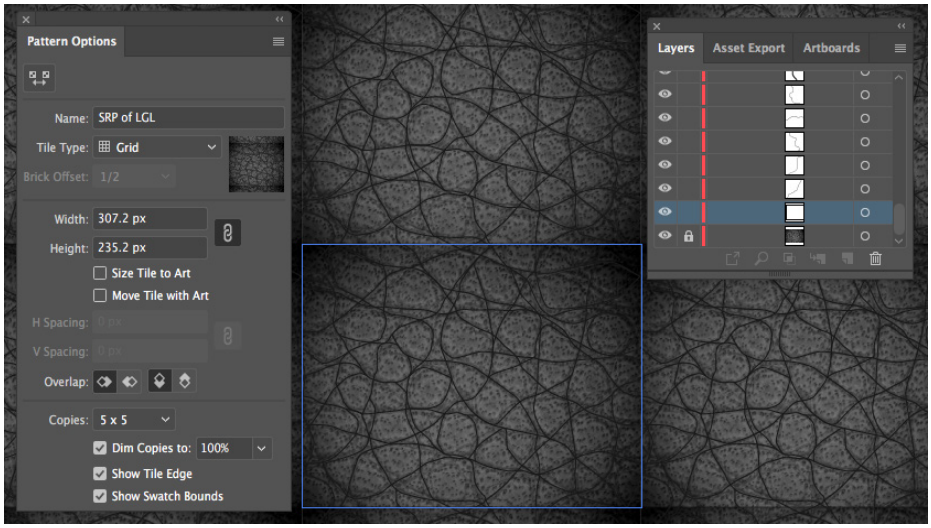

Figure 4. Extact skeleton of wrinkles in AI pattern editing mode

With the observation of wrinkles, the widths of the them are observably changeful. In order to generate this effect, create a calligraphic brush in the Brushes Panel with the parameters as Angle=45°, Roundness=35% and Size=2 pt. Select all the created paths and click the new brush in Brushes Panel, resulting in the paths turning into diverse wrinkles immediately.

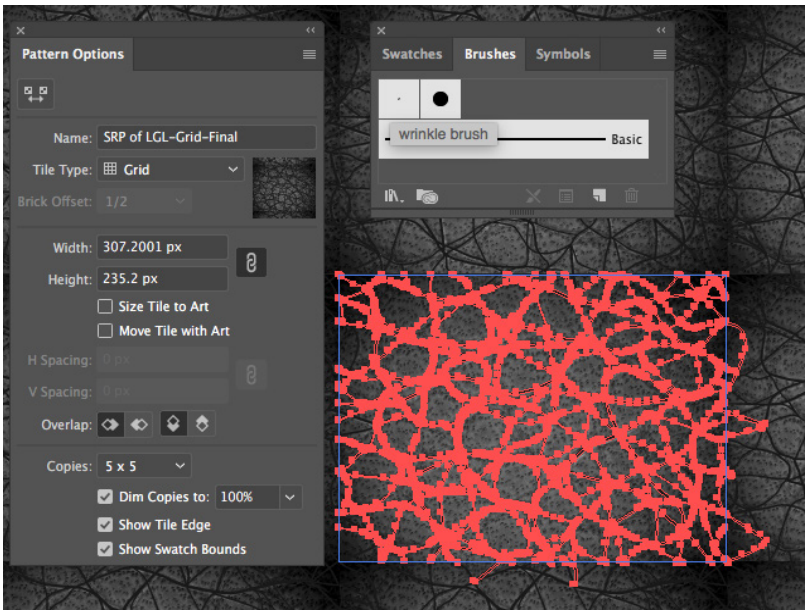

Figure 5. Simulate wrinkles of LGL using paths and calligraphic brush

With the aim of simulating more stereoscopic LGL surface effect, highlighting is an essential element. Select all the wrinkles, make a copy of them (Cmd/Ctrl + C) and paste in back (Cmd/Ctrl + B). Click the Transform Panel, add 2 px each on the X Value and Y Value and change the Fill Color into R=255, G=25 and B=255. Go to Pathfinder (Cmd/Ctrl + Shift + F9) and check the Unite option to create a compound shape. Open the Transparency Panel, set the Blending Mode as Overlay with Opacity=50%. Go to Effect > Stylize > Feather and set the Radius=2px. The setting of this process can create a more natural highlight effect and in addition, the overlay blending mode will eliminate the effect of highlights on the wrinkles of adjacent tiles.

Generate Pores of LGL Surface

The pores reveal uneven features on the LGL surface while utilizing the Symbol Sprayer Tool could express this feature quickly. First, enlarge the referencing image in order to observing the details of the pores. Use the Pen Tool to outline one of the pores' shape. Fill the gradient from white to black, adjust the angle consistent with the angle of the highlight by using the Gradient Tool whose type is radial; Stroke in white and use the wrinkle brush that was created earlier; set the Blending Mode as Overlay with Opacity=70%. Feather it with the Radius=1.5px and drag it into the Symbols Panel, naming it Pore. These parameters can be seen in the Appearances Panel in Figure 6. The setting of this process can create a more natural pore effect.

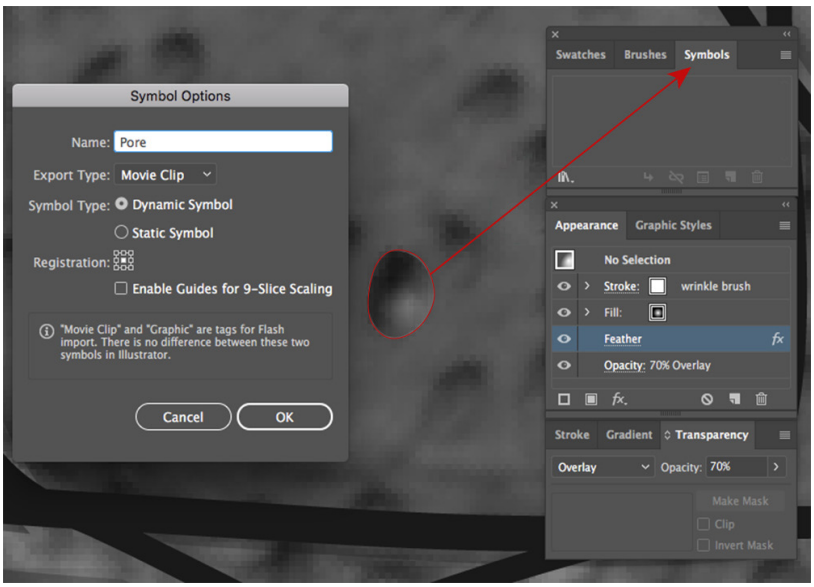

Figure 6. Simulate pores symbol of LGL referring to the realistic feature

Select the Pore symbol created earlier and use the Symbol Sprayer Tool (shift + S) and other subtools to spray and adjust the pores. Double click the Symbol Sprayer Tool and set the parameters of Intensity and Symbol Set Density while keeping the other options as default. With the purpose of keeping the integrity of all pores, do not spray them on or outside the left and top edge of the boundary box, Press the Option/Alt key and use the Symbol Sprayer Tool to erase them when it happens; however the Pore symbol can be sprayed beyond the right and bottom edge while the excessive portions appear inside the boundary box on the opposite direction simultaneously. Use the Symbol Shifter, Scruncher and Sizer Tool to adjust the size and density of the pores. This process can be accomplished in a few steps in order to adjust the pores with different sizes separately as well as show different density.

Finally, delete the raster scanning stereomicroscope image in the last layer and fill the rectangle at penultimate layer color with any RGB, except with the same color as the wrinkle. Highlight and click on the Done button. The new seamless pattern has been saved in the Swatches panel. Save it in the root directory, allowing it to be used as a fill for any objects in AI in the future.

Generate Tiles of LGL Surface Used in Other Software

The format of PNG, which owns transparent background, is necessary in order to expand the application of QCP of LGL in other software such as texture mapping of a three-dimensional design. Drag the new pattern from the Swatches panel to the artboard where several tiles will splice together. Ungroup these objects select the rectangle, which acts as the boundary box in the center, and bring it to the front (Cmd/Ctrl + shift

+]). Select all of the objects, go to Pathfinder (Cmd/Ctrl + shift +F9), and click on Crop option. Objects outside the boundary box will be deleted directly and the parameters of the highlights and pores should be set again as Blending Mode is Overlay, Opacity=70%. After go to Effect > Stylize > Feather, and set the Radius=1.5px. Delete the entire highlight if the pattern tile is used in three-dimensional software. Finally, go to File > Export, and export the tile as PNG format.

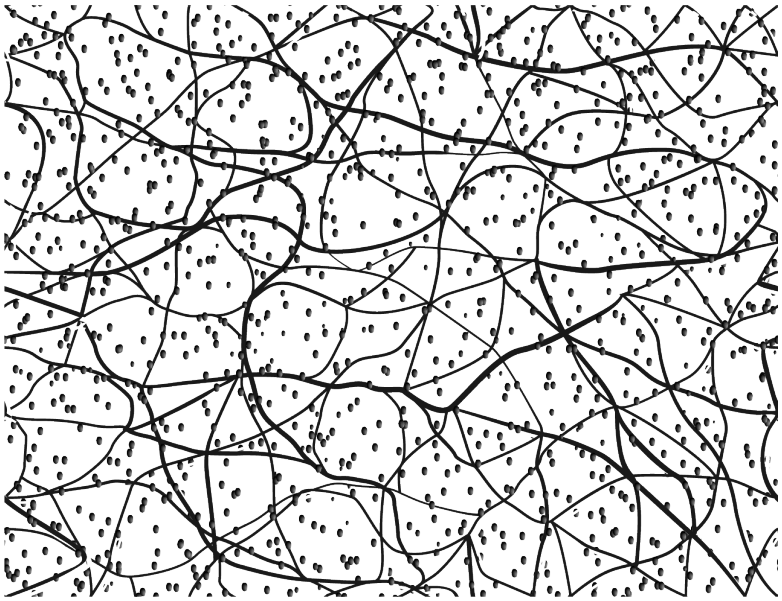

Figure 7. PNG pattern tile exported from AI with transparent background

RESULTS

Based on the stereomicroscope image of LGL, the method of generating Grid type QCP of LGL in AI using the Pattern Editing Mode could simulate the stereoscopic characteristic of LGL surface easily and quickly.

Except for Grid tile, the position of pattern tiles could be offset horizontally, vertically, or hexagonally using the type of Brick by row, Brick by column, Hex by column, and Hex by row in the Pattern Option panel, which could generate more varied QCP of LGL.

Besides the finding that designers can modify and transform the scale, the angle of litchi grain conveniently resulting from the properties of vectorial graphics made in AI could simulate various appearances of LGL surface. Moreover, the other format files exported from AI could be used for texture mapping and rending with high resolution in three-dimensional leather products design.

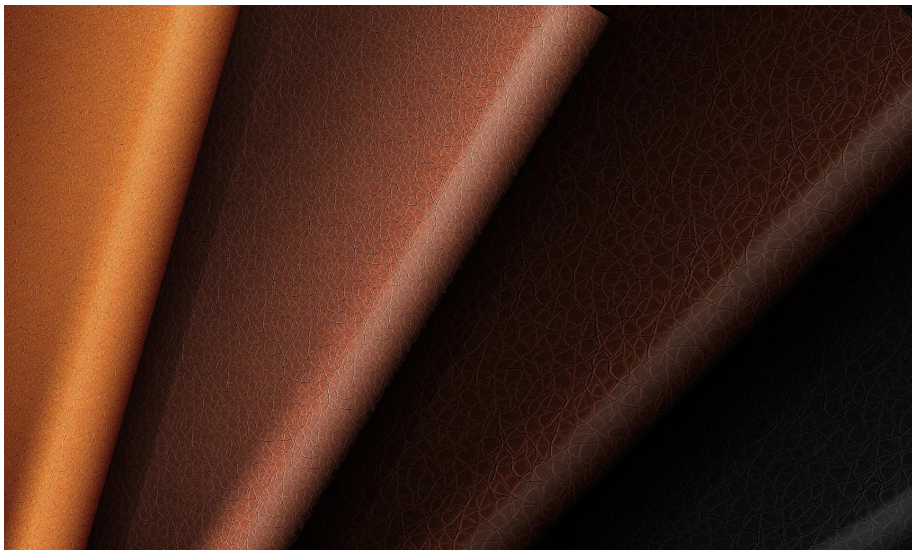

Figure 8. Different appearances of LGL filled with QCP generated in AI

DISCUSSION

The main goal of this study was to attempt to find a way to simulate the LGL products with realistic appearances efficiently. When comparing our results with studies by Miyata *et al*., a method for generating leather texture by means of particle simulation and blobby model were introduced [4, 8, 11]. This method initiatively generated a cell arrangement pattern using a 3D particle model while the detailed surface geometry was then created by applying a blobby model. Users could create various types of realistic leather textures with ease by simply choosing a cell arrangement type and selecting directionality for each section, along with inputting control parameters in the texture generator.

Similar with the methods of Miyata, Sakurai *et al*. described a method for procedural leather texture generation focusing on structural leather elements and based on Voronoi diagrams and mass-spring model [7, 12, 13]. They explicitly tried to simulate realistic leather with a continuous surface by forming pores and sulci by modifying the nodes of the diagram and applying radial basis function, respectively.

Although the work of research discussed above have provided solutions to solve these issues, it has been very difficult for leather products designers to design an algorithm that is both efficient and capable of generating a high quality continuous LGL tile, as well as input it to professional and generic software to use. The methods introduced in this study adopted the generic software with the Pattern Making Mode, which consists of Grid Tile, Brick Tile, and Hex Tile and could create various surface appearances of LGL quickly and effectively without using an algorithm. In addition, this method comes with all the advantages of vectorgraph properties, such as large-scale coverability, transformability, and easy-modifiability.

There were also limitations in this study. First and most importantly, the repetition of LGL patterns looked apparent and distracting when objects were zoomed out to a certain degree. This resulted from wrinkles that should be compensated and adjusted when creating the QCP using any Tile type, as only one portion of the LGL surface was referenced. Several stochastic algorithms were introduced to non-periodically tile the object with a small set of Wang Tiles [14], consisting of square tiles with color-coded edges, in order to create large expanses of complex patterns without an obvious repetitive feature [15]. In addition, with blur texture on the surface of LGL, the captured image shows thick or thin texture and color difference, as it was difficult

to capture precise features with the observance of the naked eye, even though the referencing image was under the stereomicroscope. Some researchers use the canny edge detection operator and watershed algorithm [16] to extract the texture of the leather image. Canny operator can effectively extract the main texture, while the watershed algorithm can fully express the texture details. These methods can effectively extract the texture information from the leather image.

Future work in this study could combine the advantage of generating QCP in AI, algorithm design, and texture extraction methods in order to simulate surface of LGL without obvious repetitive trail when zoomed out it in any degree. Furthermore, future work is needed to simulate surface of LGL precisely according to the data calculated by the texture extraction methods.

CONCLUSION

The difficulty of simulating realistic LGL surface limits the creations of leather products designers. Fortunately, the application of generating QCP in Pattern Editing Mode created by AI solved this issue without using any algorithm. The generations of QCP used in LGL products design sketch were no longer time consuming and the surfaces of LGL did not appear to be artificial as the simulation referencing the scanning LGL sample image under 10 times the stereomicroscope. The efficiencies of creation, modification and transformation could be improved as well as the pattern tile exported from AI, which showed excellent effect when mapping texture in three-dimensional software.

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THE DEVELOPMENT OF SHOE DESIGN AND FOOTWEAR SECTOR IN BULGARIAN GEOGRAPHY FROM THE PRE-MILESTONE PERIODS TO THE PRESENT

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Received: 27.12.2018 Accepted: 24.03.2019 https://doi.org/10.24264/lfj.19.1.7

THE DEVELOPMENT OF SHOE DESIGN AND FOOTWEAR SECTOR IN BULGARIAN GEOGRAPHY FROM THE PRE-MILESTONE PERIODS TO THE PRESENT

ABSTRACT. The footwear has an important role in human life from the past to the present due to its ability to protect the human foot and provide comfortable walking. In time, different nations have created their own national shoes, and these national shoes have varied and changed in accordance with the relevant climate and geographic conditions. In the Bulgarian people, the production of its own shoes has gained momentum since the 17th century. Footwear industry in Bulgaria was been formed as sector and good developed due to time of national government from 1947-1980 years. Then after the revolution in 1990 year the factories were privatized. The aim of this study is to investigate the structure of shoes designed in Bulgarian geography in terms of aesthetics and comfort in the historical process and the status of the shoe industry since 2000s to the present.

KEY WORDS: footwear design, Bulgarian footwear industry

DEZVOLTAREA SECTORULUI DE PROIECTARE ȘI FABRICARE A ÎNCĂLȚĂMINTEI ÎN SPAȚIUL GEOGRAFIC AL BULGARIEI DIN PERIOADA PREISTORICĂ PÂNĂ ÎN PREZENT

REZUMAT. Din trecut până în prezent, încălțămintea a jucat un rol important în viața omului datorită abilității acesteia de a proteja piciorul și de a oferi confort în timpul mersului. În timp, diferite națiuni și-au creat propriile modele specifice de încălțăminte, acestea variind și schimbându-se în funcție de condițiile climatice și geografice relevante. La poporul bulgar, producția de încălțăminte proprie a luat avânt încă din secolul al XVII-lea. Industria de încălțăminte din Bulgaria a luat naștere ca sector și s-a dezvoltat sub guvernul național în perioada 1947-1980. Apoi după revoluția din anul 1990, fabricile s-au privatizat. Scopul acestui studiu este de a investiga structura încălțămintei proiectate în spațiul geografic bulgar în ceea ce privește estetica și confortul în procesul istoric și statutul industriei de încălțăminte din anii 2000 până în prezent.

CUVINTE CHEIE: designul încălțămintei, industria de încălțăminte din Bulgaria

LE DÉVELOPPEMENT DU SECTEUR DE LA CONCEPTION ET LA FABRICATION DE LA CHAUSSURE DANS LA RÉGION GÉOGRAPHIQUE DE LA BULGARIE DE LA PÉRIODE PRÉHISTORIQUE JUSQU'À PRÉSENT

RÉSUMÉ. Du passé au présent, la chaussure a joué un rôle important dans la vie humaine en raison de sa capacité à protéger le pied et à offrir un confort pendant la marche. Au fil du temps, les différentes nations ont créé leurs propres modèles de chaussures, et ces modèles de chaussures nationales ont varié et ont changé en fonction des conditions climatiques et géographiques pertinentes. Chez le peuple bulgare, la production de ses propres chaussures a pris de l'ampleur depuis le XVIIe siècle. Le secteur de la chaussure en Bulgarie est né en tant que secteur et s'est développé sous le gouvernement national de 1947 à 1980. Après la révolution de 1990, les usines ont été privatisées. L'objectif de cette étude est d'étudier la structure des chaussures conçues dans l'espace géographique bulgare en termes d'esthétique et de confort dans le processus historique et le statut de l'industrie de la chaussure depuis les années 2000.

MOTS CLÉS : conception des chaussures, industrie de la chaussure bulgare

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INTRODUCTION

With the development of human needs, the design of shoes responding to the aesthetic demands of human has been on the agenda. In the first era, the shoes meet the needs of human dressing and protection from cold, nowadays they respond to the search for aesthetics. Man has always acted in his life taking into account his health. This was reflected in the primitive shoe designs in the pre-milestone periods. Instead of shoes, the primitive people formed the soles from the barks or tree leaves and tied them with various fibers to their feet. Later on, people used skins of the killed animals to wrap their feet and tied them to their feet by thin leather ropes or muscle fibers. People, who succeeded in leather tanning as a result of various experiments over time, dyed the leathers by using red, purplish or other eye-catching colors in leather making. Such shoes were costly, and only the rulers or tribal leaders are known could afford them. Today, examples of these shoes are seen in archaeological museums.

The use of the footwear, its aesthetic aspect, and the materials used to emphasize the economic privilege, status, and reflection of the culture. The footwear strengthened its position as a garment through the historical period and took an active role in the designs [1].

In ancient Greece, Homer's heroes Iliad and Odyssey wore bronze sandals and gods wore sandals made of gold. At that time, both men and women were wearing sandals. These sandals were pinned on the foot with a leather band and the sole was cork.

As time passed, people discovered the leather making operations; the processed leather also showed a great effect on the structural development of the footwear. Cultural and technological development of the society, traditions and aesthetic expectations of the community, geographic climatic conditions showed a similar effect [2].

In time, different nations have created their own national shoes, and these national shoes have varied and changed in accordance with the relevant climate and geographic conditions. Therefore, one aim of this study is to examine the aesthetics and comfort of the shoes in the Bulgarian geography.

THE DEVELOPMENT OF FOOTWEAR PRODUCTION IN BULGARIAN GEOGRAPHY

Reliable data from the nearest periods are available about Thracians. The leaders of the communities used to wear individual shoes on both legs. Both shoes have separate soles (Figure 1 c). It has worked on three different structures. The sandals belonged to women and the clothes carried by women were covered, soft home shoes, boots as high-heeled winter shoes were known. After the ancient Thracians, Greeks and Romans wore such asymmetrical shoes with the different right and left pairs. This is a demonstration of the high culture of those nations. Careful handling of these shoes is proof of the aesthetic value given to the shoes by the nations [3].

In some excavations, shoes with gilt and stitched shoes from the 3rd century BC were found. These shoes were found in the tombs of the Thracians. The image of the shoe made on a ring of that period constitutes evidence for the aesthetic approaches of the Thracians to shoes.

It is said that the production of shoes and slippers was accepted in the cities of Stara Zagora, Karlovo and Tarnovo in the 1600s as the beginning of the shoe craft. These shoes are of the type where the upper parts of the shoes are attached to the soles by stitching. The main users of these shoes were the Turkish people living in the area. They called them in Arabic terms: "Imenii" and "Kalevri". It is estimated that they were transported by Turks from Middle Asia during their migration on the Balkan Peninsula. Later in Bulgaria, shoes were bought and sold by traders from Vienna, Bucharest, and Istanbul, and these are the shoes without the front ridge, attached to the base with the wooden nails, which were called brogan. The craftsmen

who produce these shoes have also begun to be called cobbler or shoemakers. Shoemakers have privileged among the administrators of the state and have more rights. At that time leather shoes (galoshes) which were worn on the winter shoes were produced. These galoshes were manufactured according to the form of the other shoes and were attached to the other shoes with wooden nails during the fall period. Dry intestines were placed between two shoe layers to prevent water from passing [2]. It is understood that in the 21st century Bulgarian researchers contributed to the clothing industry more 300 years ago with subjective methods regarding the humidity and heat comfort, and shoe designs were made taking into account the health and comfort of the human.

With the arrival of the Slavs in this territory, "Balkan charik" have found a wide area of use. This type of shoes was widely used by the villagers until the 1930s. One of the wearers of the "Balkan charik" was Ömer Seyfettin, one of the authors of the Constitutional monarchy of the Ottoman Empire. In the article of Mehmet Güneş for him it was written that "He passed the time during the day following the Bulgarian commissioners on the mountains with the Mauser in his hands, cartridge cross-belt on his chest and with the "Charics" on his feet; nights spending in khans or at the border police stations reading and writing letters to his friends in the light of oil lamps or fires [4].

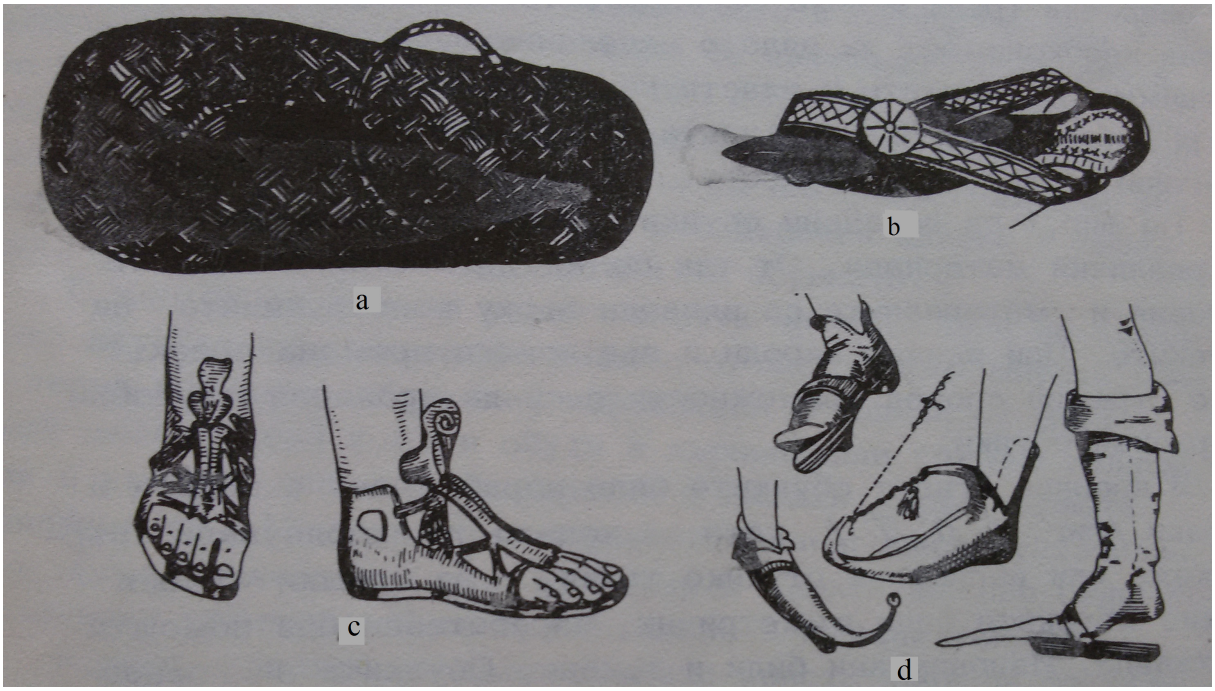

Figure 1. Shoe Models of the Ancient Times: a) Egyptian sandal (BC XIII century), b) Egyptian boat (III century BC), c) Asymmetric Thracian shoe, d) Medieval shoes [3]

The cheap cost of the "Charik" and fit sizes of them have been an example for the production of similar ones nowadays. On the Figure 2 was shown a photograph taken in the 1936 year of Bulgarian Turkish man named Arif Omer Ali, who was "Charik" master and was living in Bulgarian "Ludogorie" region. The shoes which can be seen worn on his foot are chariks, which he made by traditional techniques known by his ancestors. The "Charik" is produced from one piece of the leather and processed with a slight lifting of the front, which allows the fingers to move freely. Due to the curves in the nose and the heel of the shoe, the feet are firmly placed on the soles of the shoe, and as the body balance and the weight are evenly distributed, the soles

are rubbing evenly. Thus, the sole is stepped more widely. The pressure in the equal areas of the foot is balanced. Thanks to the straps and strings to tighten, the shoe fits nicely on the foot, reducing friction on the sole of the shoe. These three rational elements provide the structural characteristics of today's footwear processing. Achieving a suitable twist in the heel part has only become possible in the last 1980s. Thus, new shoes in a form similar to the sole of the "Charik" are designed.

After the formation of the Bulgarian State, the Khans and the leaders carried various kinds of ornamented, colourful and glittering shoes in accordance with the traditions remaining from Thracians and the Roman examples. With the development of different arts and handicrafts, the city master started to wear similar shoes suitable for that period. When the Balkan peoples connected to the Ottoman Empire escaped from being a principality and turned into new governments after the First World War, the production of shoes and handicrafts have been developed in the form of customized production.

After the 1900s, two types of shoemaking in Bulgaria are developing, and these are based on handcraft or manual products and

Figure 2. Photograph of Bulgarian Charik Master Arif Ömer Ali with "Chariks" on His Foot

manufacture by factories. This period was called capitalism and the first fabrication production began in 1908 in the enterprises named Yantra and Progres established in the Gabrovo town. After the Second World War, the socialist republic, which was established in Bulgaria, seized and nationalized all private enterprises (making it the property of all the public).

Footwear industry in Bulgaria was been formed as sector and good developed due to time of national government. In 1947 year were nationalised 18 small manufactories and developed. In 1952 all footwear production were concentrated in 3 big production factories [5]. New craft cooperatives have been organized. The largest cooperative named "Deveti Septemvri" (9th September) was founded in Sofia. Later, large governmental factories were established in Sofia, Filibe (Plovdiv) and Gabrovo [2]. These footwear enterprises were enlarged and reorganized with engineering-based studies and the production areas were leather shoes with the rubber soles and semi-fabricated products. From 1960 to 1980 years was been done plane reconstruction of production forces and was been put into practice current technologies with high productive machinery. The main aim of the socialist republic was to offer a comfortable life for the working class and to form and maintain the existence of the republic by prioritizing their health. As a result of this policy from 1947 to 1990, the number of shoe varieties suitable for large masses was low but ergonomic, healthy shoes with leather upper, standardized according to the anatomical foot structure of the people were produced and used.

My visits to Bulgaria from the 2000s and my observations on the garment sector are very challenging. After the forced migration of a large part of the Turkish population to Turkey in 1989, the collapsed economy in Bulgaria has experienced the second decline since the companies have been relayed for the third time in 2010s and mainly sold to European investors with the scrap prices. In 2010-2013, it was seen from the university visits and training made in the scope of Erasmus Program in Bulgaria that the leather and textile productions were decreased very much and the production of footwear was almost not in the good situation [6]. The main reason for this is that the people migrated to other developed countries in the

European Union to find a job and the purchasing power of the consumers in the local market is addressed by cheap and mostly artificial leather shoes from China [6].

In the national governmental period, the development of footwear in the light industry branches in Bulgaria has also been seriously improved in the context of engineering education, while the present situation is very thought-provoking for Bulgaria.

FOOTWEAR PRODUCTION IN BULGARIAN IN LAST 5 YEARS

The latest data for footwear was been taken from WTO-UNCTAD-ITC trade in services database, based on OECD, IMF, EUROSTAT, UNSD, and national data, (Commercial services trade, balance of payments based statistics, June 2018). As can be seen at graph charts in Figure 3. for export and import, the Bulgarian economy has small grown of the years between 2012-1013 and good growth in 2015. In 2015 years all off trade with word biggest countries like Russia, China and E.U. were decreased; only trade with Switzerland increased. Then in 2016 and 2017 years export and import volumes of Bulgarian economy are increased.

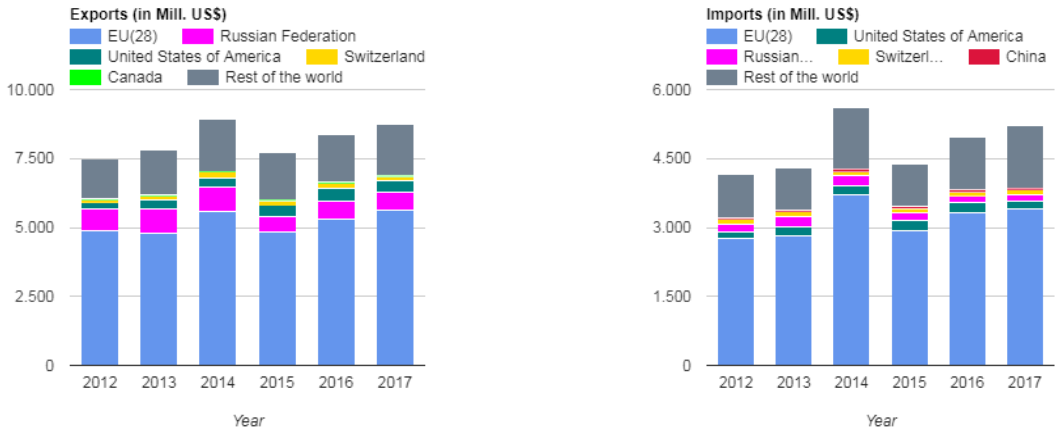

Figure 3. Export And Import Levels of Bulgaria Between 2012-2017 Years [7]

Table 1 shows the situation of export for "Footwear, Gaiters And The Like; Parts Of Such Articles" [8]. For footwear, gaiters and the like products situation was similar to the general economic situation of the Bulgarian economy between 2013-2017 years period. According to trademap.org the export of "Footwear, Gaiters And The Like" from Bulgaria in the 2014 year increased by 21 250 000 $ and 8,1 % than in the 2015 year decreased 47330000 $ and 16,7 %. In 2016 year decreased 11456000 $ and % 4,85. In 2017 increased by 9070000 $ and 4 % but just it is lower than the export value of the 2014 year.

CONCLUSION AND RECOMMENDATIONS

From the 17th century to the present day, it is seen that in Bulgaria are produced shoes, suitable for the anatomical foot structure of the people and aesthetics in the design as well as comfort was at the forefront. And also, the footwear has been an indicator of social status throughout history. Generally, the more the economic level of people increases, the more the number and type of shoes they use are increased. Today's globalization conditions have also led to serious changes in the economic structures and business areas of countries. In that, production in all industrial areas including handicrafts and shoemaking in Bulgaria has been declined considerably. It would not be wrong to say that for the last 10 years Bulgaria has been impoverished and transformed into a state of tourism and retirees. It is a painful fact to mention that the population residing in Bulgaria in the last 30 years has fallen by half. Policies should be developed to generate employment by taking into consideration not only the EU's main objectives and incentive policies for production sites but also the areas where Bulgaria has a trained workforce. In the

Table 1: The Exported Footwear Value of Some Main Producer Countries and Bulgaria Between 2013-2017 Years [8]

Exporters	Exported value in 2013 (1000 $)	Exported value in 2014 (1000 $)	Exported value in 2015 (1000 $)	Exported value in 2016 (1000 $)	Exported value in 2017 (1000 $)
World	128949458	141843403	133803512	130191067	144385644
China	50761328	56248574	53509469	47202913	48185818
Viet Nam	8721913	10690489	12438847	13476379	20767911
Italy	11788762	12290849	10494224	10707969	11315309
Germany	5137252	5815306	5231008	6036408	7614737
Belgium	5130632	5584602	5415641	5967638	6591733
Indonesia	3860394	4108448	4507024	4639859	4911848
France	2933247	3215640	3172570	3396740	3700207
Netherlands	3416248	3623613	3048115	3263366	3426153
Spain	3148885	3689282	3420928	3089709	3187520
Hong Kong, China	4688789	4341253	3916437	3139030	2901176
India	2609804	2990733	2771020	2747900	2785993
Portugal	2361753	2523549	2117759	2178049	2271471
United Kingdom	1899789	2104166	2211092	2161956	2160210
Austria	980745	1067987	893279	843707	871977
Romania	1771201	1879864	1463504	1448138	1523998
Poland	940700	1023193	1046558	1211561	1487886
United States of America	1391432	1455212	1463618	1367459	1432136
Brazil	1263257	1237604	1114316	1164794	1278009
Slovakia	1261681	1369904	1137422	1079202	1155788
Czech Republic	817241	894321	818747	907174	1107073
Panama	1135091	1120121	971026	864894	67909
Bulgaria	262176	283426	236096	224640	233710

Bulgarian parliament, incentives should be raised in order to revitalize the footwear sector, which is a branch of the apparel industry, and to generate the production of footwear for the needs of the local population; and by creating employment in this sector to support the prevention of the migration of the Bulgarian people. For the country with the present academic staff and with more know-how in this area than in many producer countries such as China, Thailand or Turkey, increasing the country's budget for education and academic studies will be in the benefit of its people in the long term.

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TECHNOLOGY OF REDUCING CR(VI) ON LEATHER PROCESSING USING MIMOSA AS RETANNING AGENT

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Received: 18.09.2018 Accepted: 21.03.2019 https://doi.org/10.24264/lfj.19.1.8

TECHNOLOGY OF REDUCING CR(VI) ON LEATHER PROCESSING USING MIMOSA AS RETANNING AGENT

ABSTRACT. Hexavalent chromium or Cr(VI) is toxic. Therefore, it is necessary to prevent or minimize its existence. This study aims to explain the effect of using mimosa as a retanning agent on the reduction of Cr(VI) content in goat crust skin. The post-tanning process was done by the process of 1st retanning, neutralization, fatliquoring, 2nd retanning and fixing. The retanning process 2 was performed with three treatments, 0% of mimosa, 3% of mimosa and 6% of mimosa. All the data were analyzed by the One Way ANOVA then followed by the Duncan Multiple Range Test. The results obtained were the decrease of hexavalent chromium content with the addition of mimosa during the retanning process. The use of 3% of mimosa is more effective to reduce the formation of Cr(VI) than 6% of mimosa. It can be said that the use of mimosa as a retanning agent can reduce the formation of Cr(VI).

KEY WORDS: Cr(VI), leather processing, mimosa, retanning agent

TEHNOLOGIE PENTRU REDUCEREA CONȚINUTULUI DE CR(VI) LA PRELUCRAREA PIEILOR UTILIZÂND MIMOSA CA AGENT DE RETĂBĂCIRE

REZUMAT. Cromul hexavalent sau Cr(VI) este toxic. Prin urmare, este necesar să se prevină sau să se reducă la minimum existența acestuia. Acest studiu își propune să explice efectul utilizării agentului de retăbăcire mimosa asupra reducerii conținutului de Cr(VI) din pielea de capră nefinisată. Procesul de post-tăbăcire a fost realizat prin procesul de retăbăcire 1, neutralizare, ungere, retăbăcire 2 și fixare. Procesul de retăbăcire 2 a fost efectuat cu trei tratamente, 0% mimosa, 3% mimosa și 6% mimosa. Toate datele au fost analizate utilizând metoda One Way ANOVA, efectuând apoi testul Duncan (metoda comparațiilor multiple). S-a obținut scăderea conținutului de crom hexavalent după adăugarea de mimosa în timpul procesului de retăbăcire. Utilizarea a 3% mimosa este mai eficientă în reducerea formării de Cr(VI) decât 6% mimosa. Se poate spune că utilizarea agentului de retăbăcire mimosa poate reduce formarea de Cr(VI).

CUVINTE CHEIE: Cr(VI), prelucrarea pieilor, mimosa, agent de retăbăcire

TECHNOLOGIE DE REDUCTION DU TENEUR EN CR(VI) SUR LE TRAITEMENT DU CUIR EN UTILISANT MIMOSA COMME AGENT DE RETANNAGE

RÉSUMÉ. Le chrome hexavalent ou Cr(VI) est toxique. Par conséquent, il est nécessaire d'empêcher ou de minimiser son existence. Cette étude vise à expliquer l'effet de l'utilisation du mimosa en tant qu'agent de retannage sur la réduction de la teneur en Cr(VI) de la peau de chèvre en croûte. Le processus de post-tannage a été effectué par le processus de retannage 1, neutralisation, nourriture en bain, retannage 2 et fixation. Le processus de retannage 2 a été réalisé par trois traitements avec mimosa, 0%, 3% et 6%. Toutes les données ont été analysées par One Way ANOVA puis par Duncan Multiple Range Test. On a obtenu la diminution de la teneur en chrome hexavalent avec l'ajout de mimosa au cours du processus de retannage. L'utilisation de 3% mimosa est plus efficace pour réduire la formation de Cr(VI) que 6% mimosa. On peut dire que l'utilisation de mimosa en tant qu'agent de retannage peut réduire la formation de Cr(VI).

MOTS CLÉS : Cr(VI), traitement du cuir, mimosa, agent de retannage

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INTRODUCTION

Nowadays, the environment is in danger day by day. This is because of the hazardous chemicals that are used in the factories. One of the factories that might have a negative impact on the worse environment is the tannery industry. Tannery uses so many chemicals on leather processing. Waste treatment is needed to protect nature. One of the most dangerous forms is Cr(VI). Cr(VI) just appear on the wrong processing on leather making.

Cr(III) as a sulphate salt (green color), as a tanning agent, is entirely different in character from Cr(VI) on the orange color. Cr(VI) is highly toxic and as an oxidizer. Cr(VI) should not be used in the tanning industry. Cr(VI) is present in pigments/colors and the oxidation results of Cr(III) with oxidizing bleaching agents such as H_2O_2, $KMnO_4$, fish oil and others [1].

Types of skin that require high density require the type of oil that can penetrate deeply into the skin. Fatliquoring agent with the type of fish oil or it is derivative or sulphited type (sulfonated oil) character has SO_3 bound ± 6 - 7% [2]. Sulphited oil is more stable against changes in pH or minerals/salts so that sulphited oil will provide better penetration and lubrication than sulphated oil [3]. However the use of sulphited fish oil can trigger the formation of Cr(VI), therefore it is necessary to add tara or quebracho (1-3%). The excessive use of those will affect the handle of leather [4].

Cr(VI) has a dangerous impact to the environment, that is why the chemical content Cr(VI) must not be used. It also has to be made sure that there is no chemical that change Cr(III) to Cr(VI). There are so many reasons why Cr(III) becomes Cr(VI), for example using fish oil, high temperature, oxidation of the process, etc. The conditions above must be avoided.

There is vegetable tanning agent that can avoid Cr(III) become Cr(VI). Tara is a vegetable tanning agent belonging to the pyrogallol tanning group. Tara is used in the chrome tanning process separately and in combination with myrobalan and protein hydrolysate. Tara is found to be inefficient when used individually in the chrome tanning process, however, when used in combination with myrobalan it plays a more effective role in controlling the oxidation of trivalent chromium to hexavalent chromium [5].

Because of the positive impact of using the vegetable retanning agent, there is a need to know about the effect of mimosa as one of the vegetable retanning agent on the reduction of the level of Cr(VI).

EXPERIMENTAL

Materials and Methods

Instruments

Drum process, knife, pH indicator, bucket, and scales.

Materials

Wet blue goat skins, H_2O, Surfactant, Formic Acid, Rokytan RHP, Sodium Format, Sodium-Naphthalene (Tanigan PAK), $NaHCO_3$, Sulphited fish oil, Naphthalene sulfonate (Coralon OT), Mimosa, Preventol Cr.

Post-Tanning Process

A post-tanning process was started by washing the wet blue, then drain, 1st retanning, washing, neutralization, drain, and rinse. Next process was fatliquoring, 2nd retanning, fixing, drain and rinse. Treatment was done by making different treatments for using mimosa in the retanning process 2. Treatment 1 without the use of mimosa (0% mimosa), Treatment 2 using 3% mimosa, and treatment 3 using 6% mimosa. Each done by 3 repetitions.

Data Analysis

Data were analyzed with IBM SPSS statistic 22. The analysis used was the One Way ANOVA then followed by the Duncan Multiple Range Test. Further results from crust skin were analyzed using FTIR (Fourier Transmitted Infra Red).

RESULTS AND DISCUSSIONS

Chromium Cr(VI) Content

Results in Table 1 showed that hexavalent chromium mean content in each treatment was significantly different (P≤0.01). Hexavalent chromium means content of Treatment 1 was 8,9 ± 0.13 mg/kg, Treatment 2 was 4,58 ± 0.02 mg/kg and Treatment 3 was 6,15 ± 0.06 mg/kg. It can be said that the addition of 3% of mimosa is

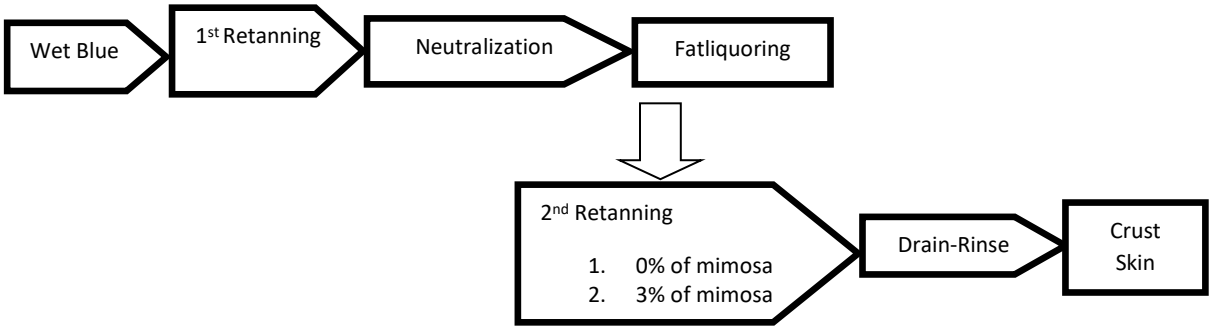

Figure 1. Diagrams of Post-Tanning Process

more effective to decrease Cr(VI) levels than the use of 6% of mimosa. The addition of retanning agent from vegetable can reduce the amount of Cr(VI) in the skin, better at lowering the level of Cr(VI) than without using mimosa. This was very important because the presence of Cr(VI) in the skin was an indication of the presence of toxins. Leather that will be used as goods used by humans must be free from toxic substances and allergic effects.

Table 1: Hexavalent Chromium Cr(VI) Mean Content (mg/kg)

	Treatment 1	Treatment 2	Treatment 3
Wetblue	14,57	14,57	14,57
Crust	8,9 ± 0.13[a]	4,58 ± 0.02[b]	6,15 ± 0.06[c]
Percentage of reduction	38.91%	68.56%	57.79%

a,b,c: different superscript in the same line showed the highly significant difference (P≤0.01)

Percentage of reduction of Cr(VI) on Treatment 2 (3% of mimosa) was 68.56%. It was better than the other treatments. Suitable retanning process can afford lasting antioxidant protection. One percent of vegetable tanning agent (on wet blue weight), applied in the retanning process, is sufficient to meet the most demanding specifications. In order to ensure that the leather resists to an accelerated ageing process without forming Cr(VI), the protection conferred by this 1% will be sufficient for many skins/leather. But for other kinds of leather it will be necessary to increase the offer of vegetable extract to 2-3% depending on the fatliquoring agents, the thickness of the skin/hide, the dyeing process and the type of finishing [6].

Chestnut and mimosa tannins immobilized on chrome shaving matrices have been used directly as adsorbents for the recovery of Cr(VI) from polluted aqueous systems. Experimental studies indicated that immobilized tannin adsorbents can efficiently remove hexavalent chromium from water and raw shavings [7].

Cr(III) is assumed to be retained within the leather, whereas Cr(VI) is soluble [8, 9] that chromate Cr(VI) is considered to be a more potent allergen, and that Cr(VI) compounds are able to induce allergy and dermatitis at lower exposure levels than most Cr(III) compounds [10-12].

Mimosa can reduce Cr(VI) through adsorption mechanism. The mechanism by which metal ions are adsorbed onto different tannin resins has been a matter of considerable debate. Different studies have reached different conclusions. These include ion-exchange, surface adsorption, chemisorption, complexation, and adsorption–complexation. It is commonly believed that ion-exchange is the most prevalent mechanism. Metals react with phenolic groups of the tannin resins to release protons with their anion sites to displace an existing metal [13].

The addition of natural and bioproducts such as ascorbic acid, gallic acid, myrobalan, tara and protein hydrolysate in the pre tanning, tanning, wet finishing process carried out the chrome tanned leather on the formation of

hexavalent chromium. The results imply that the Cr(VI) content of the wet blue leathers and crust leathers are below the detection limit. Myrobalan and tara can be used effectively in controlling the Cr(VI) in leathers. Tara is a vegetable tanning agent belonging to the pyrogallol tanning group. Tara is used in the chrome tanning process separately and in combination with myrobalan and protein hydrolysate. Tara is found to be inefficient when used individually in chrome tanning process, however when used in combination with myrobalan it plays more effective role in controlling the oxidation of trivalent chromium to hexavalent chromium [5].

Water resistant shoe upper leather in the form of crust or dyed leather did not contain Cr(VI) even after being subjected to extreme treatments. This leather was retanned with mimosa. In general vegetable retannage plays a significant role in avoiding chromate formation. Besides mimosa, quebracho, chestnut, and tara also showed a positive influence even when the leathers were exposed to extreme conditions like heat and UV radiation. Tara is particularly effective, on some leathers an offer below 1% was sufficient to suppress chromate formation [14].

FTIR Analysis

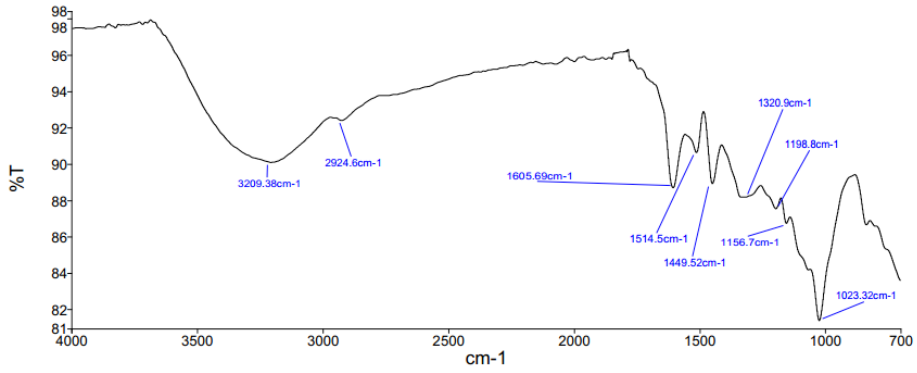

Figure 2. FTIR spectrum of mimosa

FTIR spectrophotometry was used to identify the functional groups contained in mimosa. The spectra is shown in Fig. 2. The strong band at 1023 cm^{-1} is characteristic of C–C, C–H, C–O and aromatic ring vibrations [15]. The presence of aromatic rings was further confirmed by two bands of aromatic C–H in-plane bending (1157 cm^{-1} and 1199 cm^{-1}) [16, 17] and a band of aromatic C=C stretching (1514 cm^{-1}) [18]. CH bands were detected at 1321 cm^{-1} and 2925 cm^{-1} corresponding to CH deformation [19] and CH_3; CH_2 stretching, respectively [20]. Kassim *et al*. (2011) argue that the broad and strong band observed at the region of 3200-3600 cm^{-1} attributes to OH stretching of hydrogen-bonded structures, while in this research it was found at 3209 cm^{-1} [21].

Fig. 3 shows the FTIR spectra of crust skins with various concentrations of mimosa used in the 2nd retanning process. Functional groups of mimosa were detected in spectra of crust skins treated using mimosa concentrations of 3% and it of 6%. A similarity of those spectra with the spectrum of crust skin treated 0% of mimosa is observed in this result. This is due to the similarity of functional groups containing in mimosa and in wet blue goatskin. Mimosa contains polyphenolic compounds [22] while wet blue goatskin contains collagen. Those two materials have hydroxyl (OH) and methyl (CH_3) groups. Therefore, bands of these groups were found in spectra of untreated and treated wet blue skin with the mimosa.

The successful of Cr(VI) reduction using mimosa as retanning agent was proved by the presence of C=O stretching vibration around 1735-1740 cm^{-1}. This carbonyl (C=O) group is resulted from oxidation of hydroxyl group in

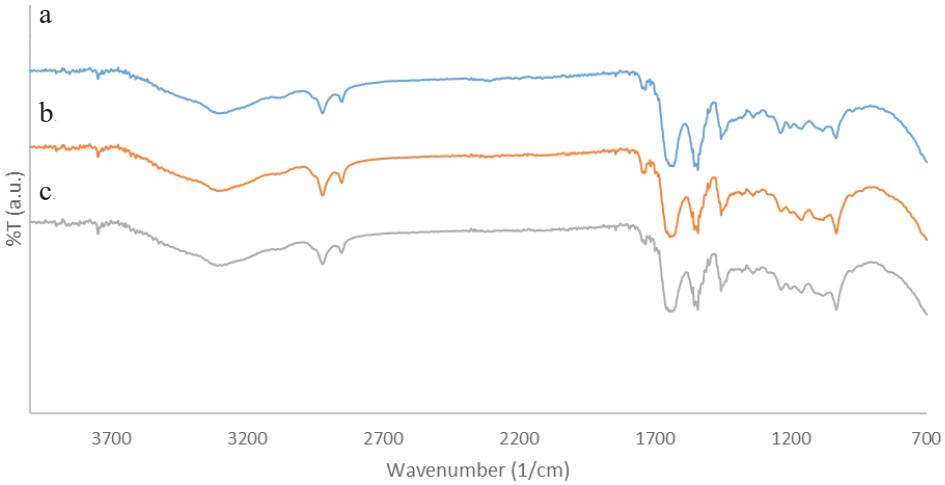

Figure 3. FTIR spectra of crust skins with various mimosa concentrations used in 2nd retanning process (a) 0%; (b) 3% and (c) 6%

mimosa as a consequence of Cr(VI) reduction. Thus, this band is not detected in the mimosa FTIR spectrum. Furthermore, the forming of carbonyl groups leads the decrease of hydrogen bonds in mimosa. It is known from the alteration of OH band size around 3200-3600 cm^{-1}, which is being narrow since the adding of mimosa. This explains that hydrogen bonds decrease for C–OH oxidation forming C=O. Moreover the sharp bands at 2850-2930 cm^{-1} appeared in corresponding to the CH_3 and CH_2 stretching vibration. It is more clearly observed because OH broadband overlap does not occur in this spectra. This phenomenon also confirms the decrease in hydrogen bonding.

FTIR spectra shows the influence of mimosa concentration used in the 2nd retanning process to functional groups contained in the material. Crust skin treated by 3% of mimosa (Treatment 2) has the sharpest C=O band detected in this spectra. This shows that crust skin treated by 3% of mimosa has the most amount of C=O describing the most amount of Cr(VI) reduced. Therefore, the optimum concentration of mimosa used as retanning agent is obtained at 3%.

CONCLUSIONS

Cr(VI) is a very dangerous and toxic substance. However, in its development, not least the leather industry produces Cr(VI) in its leather products. Therefore, capable material was needed in reducing the formation of Cr(VI). The addition of the vegetable retanning agent, in this case, mimosa can reduce the formation of Cr(VI). The optimum concentration of mimosa used as retanning agent to reduce the amount of Cr(VI) is obtained at 3%.

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Co-funded by the Erasmus+ Programme of the European Union

28 January 2019, Portugal

Fashion World's Challenges - Looking for Qualification, Occupations …and the right skills in the TCLF sectors

"For many years our first priority was to win customers and to keep our mill busy. Now our first priority is to find (and retain) skilled employees". This brief quote of Simon Cotton, CEO of Johnstons of Elgin, Scottish knitwear manufacturer sums up superbly the main challenge that European Textile, Clothing, Leather and Footwear (TCLF) companies are struggling to overcome every day.

The re- and upskilling of the existing TCLF workforce and the difficulty of finding new talents with right skills were the main topics discussed at the two first public events "*Fashion World's Challenges - Looking for Qualifications and Occupations*" organised within the 4-year Erasmus+ project Skills4Smart TCLF 2030 last week in Portugal. Both seminars brought together, national and international experts and industry stakeholders to discuss the future of the workforce in Fashion industries. On 22nd January 2019, the first conference, focusing mainly on the Textile and Clothing sectors, took place at CITEVE premises (Portuguese Technological Centre for Textile and Clothing) in Vila Nova de Famalicão, while the next day, CTCP (Portuguese Footwear Technology Centre) hosted in S. João da Madeira the second event involving mainly companies, VET providers and stakeholders of the Leather and Footwear industries.

Both events drove to similar conclusions and highlighted the urgency of taking actions. We are living in an age in which the pace of change is incredibly rising, digitalisation and most advanced technology are affecting the way of working, the retirement wave of experienced workers is intensifying, traditional jobs are destroyed and at the same time replaced and recreated, the number of students in vocational training and educational system is continuously diminishing…and the TCLF sectors have still not found sustainable solutions for this complex situation. As speakers clearly explained in these last days, "Lifelong learning should be promoted in each company. We should make our sector more attractive and explain, above all to the younger generations, the opportunities existing in our sector (Miguel Pedrosa Rodrigues, Pedrosa & Rodrigues). "Robotics, automation, digitalisation are already a reality in our industries – why not using them to attract the youngsters? The technology is extraordinarily helpful in supporting the work of people, it will never replace the workers." (Ricardo Cunha, ITA). "MOOCs, tutorials and other digital devices are also great teaching materials, but they will never replace training. For example, it is like learning how to drive a car, you will need always somebody showing and explaining you how to drive - you can not learn it directly from a book. People will always be at the core of the training" (Rui Moreira, AMF). Nevertheless, "sectoral vocational education and training needs to be reinforced or redeveloped. The most difficult part is updating the curricula to match the different industry needs. All industry stakeholders, including trade unions and national associations should actively participate in the process" (Ana Maria Damião, National Agency for Qualification and Education). Indeed, "an intense collaboration among all sectoral stakeholders and exchanges of best

practices should be promoted at all levels of governance" (Gonçalo Santos, APIC Secretary General). The Porto area benefits from a robust support by the community and political authorities. Fernando Freire de Sousa, António Leite and Adelaide Dias, respectively from Norte Portugal Regional Coordination and Development Commission, Institute for Employment and Professional Training, and Municipality of Vila Nova de Famalicão reconfirmed their willingness of continuing their programs and schemes related to the TCLF clusters, as for instance: training free of charge for TCLF workers, promotion of the transition from school to work and of the TCLF careers, as well as the active involvement of all parties of the community in the educational and working environment.

This is of course a clear example of best practice in the TCLF sector, and this is where our Skills4Smart project comes in - sharing knowledge and best practices in order to anticipate skills needs, improve the employability and the training of right competences are our main goals. In the coming months, the S4TCLF partnership will be busy at developing a new Sectoral Skill Strategy (WP5), a new attractiveness campaign of TCLF careers (WP6) and 8 new curricula for 8 TCLF occupations (WP7). *So, let us get back to work and stay tuned!*

For more information about the project:
- Visit the project website at http://www.s4tclfblueprint.eu
- Write to info@s4tclfblueprint.eu
- Follow us on Twitter @Skills4TCLF and on Facebook @skills4smartTCLF.

Project Details:

Project Title: Skills4Smart TCLF Industries 2030
Project Reference: 591986-EPP-1-2017-1-BE-EPPKA2-SSA-B
Programme: ERASMUS+ (Sector Skills Alliances for implementing a new strategic approach to sectoral cooperation on skills ("Blueprint")
Project duration:
01st January 2018 – 31st December 2021
Project Partners:
1. EURATEX, Belgium – Textiles & Clothing, Project coordinator
2. CEC, Belgium - Footwear
3. COTANCE, Belgium - Leather
4. CIAPE- Centro Italiano per l'Apprendimento Permanente, Italy
5. CITEVE- Centro Tecnológico das Indústrias Têxtil e do Vestuário de Portugal, Portugal
6. CNDIPT- Centrul National de Dezvoltare a Invatamantului Profesional si Tehnic, Romania
7. COBOT, Belgium
8. CTCP, Centro Tecnológico do Calçado de Portugal, Portugal
9. HMA - Hellenic Management Association, Greece
10. FUNDAE - Fundación Estatal para la Formación en el Empleo, Spain
11. IVOC, Belgium
12. INESCOP- Instituto Tecnologico del Calzado y Conexas, Spain
13. OPCALIA, France
14. PIN - Soc. Cons. A r.l. – Servizi didattici e scientifici per l'Università di Firenze, Italy
15. Politecnico Calzaturiero, Italy
16. SPIN360, Italy
17. TUIASI- Universitatea Tehnica Gheorghe Asachi din Iasi, Romania
18. Lodz University of Technology, Poland
19. UPC- Universitat Politècnica de Catalunya, Spain
20. PIRIN-TEX EOOD, Bulgaria
21. Marzotto, Italy

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

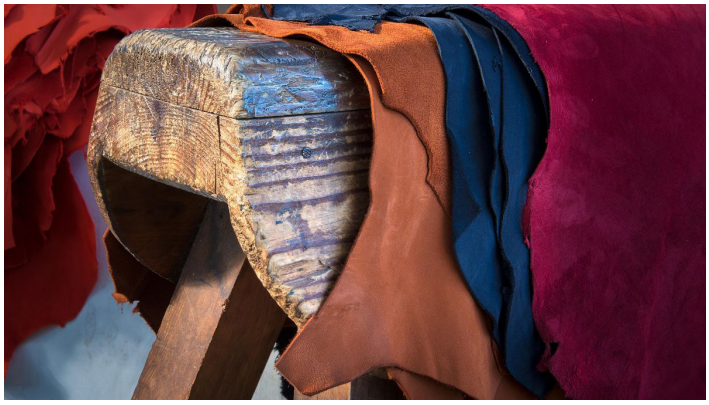
Co-funded by the Erasmus+ Programme of the European Union

COTANCE NEWSLETTERS

Starting with January 2019, the COTANCE Council will issue a monthly ***COTANCE Newsletter*** with the purpose of **promoting an improved image of leather** to relevant decision makers and domestic stakeholders including Members of the European and National Parliament, Governmental authorities, Ministerial officers, Customers of the leather industry, Brands, Retail chains, Relevant NGOs, Designers, etc. The monthly newsletters present topics that tell the truth about a controversial aspect or a fact that is not well known by the general public to bring about a better understanding of leather and the European leather industry, as well as a positive predisposition to legislate in favor of the leather industry. The first three newsletters are given below and are available in seven languages at https://www.euroleather.com/index.php/newsletter.

NEWS 1/2019 - January 2019

Where does Leather come from?



Where does leather come from?' **is a great question to start 2019.**

Over Christmas, my 16-year-old niece asked for a new jacket, to go to college. As you probably know that it is impossible to buy clothes for teenagers, so she was given the money to go and buy one. When I asked what kind of jacket, she said she would buy a synthetic one because, - and I quote - "poor animals" if she purchased a leather garment, referring to the animals which she thought were bred and killed for their skins or hides. The younger generation, who embrace the importance of recycling in their everyday life, somehow do not understand that leather is the oldest example of recycling on record.

So why does leather have such a negative image with the younger generation? What are we and our fashion partners not doing right?

So, I opted to explain where leather comes from and to discuss with her the misconceptions or fallacies that I have heard so often.

In short, I gave her a quick overview of how leather came to exist and why it remains relevant today.

- ***It is one of the oldest crafts known to mankind.*** 170,000 years ago, our hominid ancestors used the skins of the animals they hunted to protect themselves from the weather, as totems or amulets, for rudimentary musical instruments and even to carry their belongings whilst they roamed the lands. They learned to prevent them from rotting by tanning them, and over the centuries, the use of tanned skins and hides has evolved into a well-respected industry. Tanneries are key in this recycling chain, converting a waste product of the meat industry into a valuable material that generates jobs and wealth, in particular for local economies.

- ***Are furs also considered leather?*** No, but due to a lack of understanding, a lot of confusion arises. Furs are not by-products of the food industry; fur animals are primarily farmed for their pelts. Animal activist groups gain from this confusion and sometimes promote it. Sadly, misinformation is not something that we can control, and it is not unusual for consumers to believe that furs and leather are one and the same thing.

- ***Are more animals bred and slaughtered due to the tanning industry?*** No. The tanning industry relies almost exclusively on the meat industry.. As a matter of fact, statistics show that as people in developing nations are becoming wealthier, they are eating more animal protein (meat) and thus there are more skins and hides produced. With the exception of a small amount of exotic leather, all skins and hides processed in Europe come from the food industry.

- ***Does the EU leather industry slaughter animals for their skin?*** No. Nearly 100 per cent of the skins and hides processed by European tanneries are by-products of the food industry. If the tanning industry did not exist, the food industry would have to dispose of them. There are really just two alternatives for this, both highly polluting: landfill or incineration. By making leather, these hides and skins are transformed into a highly versatile and natural product for fashion garments, footwear, upholstery and even safety garments for fire-fighters and race-drivers.

- ***The tanning industry pollutes rivers, contaminates the atmosphere and is more dangerous to the environment than fossil fuel products, such as synthetic materials.*** Not true. In the past, as in most industries, concepts such as environmental protection or sustainability were not a business priority. Things have changed! Fortunately, greater awareness of the importance of environmental sustainability are now at the top of the agenda for most nations. As for all industries, there is always room for improvement, but great steps in technology, knowledge-sharing, investment in R&D and strict environmental policies have aided tanneries in the EU to become world leaders in terms of eco-friendliness and sustainability.

- ***There is a lot of media coverage regarding animal cruelty at abattoirs.*** It is true that recently we have seen media coverage about animal abuse in different slaughterhouses throughout Europe. These unfortunate events are isolated incidents and strongly condemned by all the European Tanning associations, their members, COTANCE along with society at large. Throughout Europe, slaughterhouses are regulated and there are laws against cruelty to animals. It is important to note that many tanneries put animal welfare at the forefront of their corporate sustainable philosophy.

Dear niece,

leather is a strong durable, versatile product which, thanks to sustainable tanning processes, can be transformed into jackets, bags and shoes…. Look around you. After eating your roast beef for lunch, you are laying on a nice leather sofa that is 12 years old and still has a beautiful patina; the car you came in has leather upholstery…You recycle your soda cans, plastic bottles, paper, so why not take one step further and think also of making your contribution to the recycling of hides and skins? Why not get a leather jacket designed and made in Europe with European leather? If you look after it well, your jacket will last for many years to come and get better every time you wear it.

What do you think about leather now?

edited by

COTANCE

in collaboration with

CURTIDORES ESPAÑOLES
SPANISH TANNERS

NEWS 2/2019 - February 2019

What is Leather?

Leather is a material almost as old as mankind. A wearable natural second skin, it has provided protection, warmth and elegance to mankind for thousands of years. Is this material still up-to-date?

The first humans needed to hunt for meat (protein, iron). Even if sustainability was unknown to them, they wasted nothing of their prey as animals could provide much more than food. Horns, claws and hooves were used as amulets, needles or weapons. Later, they learned how to use the skin and hair. They discovered that skins washed in a pond with old wood did not rot on their shoulders, as others did. They learned how to treat them and turn them into leather. In time, they became more proficient in drying, salting and tanning, making their new second skin soft, durable and strong against the wind and bad weather.

Our leather comes from the animals we hunt (such as deerskin, wild boars, etc) and from animals we rear for the production of food (cattle, sheep, goat, rabbits and certain fish). Their hide or skin is a residue that tanners recover and recycle.

The tanning process has evolved over the centuries and become environmentally conscious, as well as safer for tannery workers (look at the video below). The places in the world where the processing and working conditions are unacceptable are fewer and fewer. The International Council of Tanners (ICT) and all its members reject and condemn these practices that do not in any way accurately represent the modern leather industry and its products.

Something has not changed though: we humans still try to make the most of slaughtered animals and avoid wasting any of their by-products, especially their skins. Today leather is still a very appealing material. Genuine leather transports moisture and regulates body temperature, making it comfortable to wear.

When a material has such great properties, it's bound to be imitated. So, beware of fakes that free-ride the good name and reputation of leather. Such substitutes are not leather and it is illegal to call them leather in EU Member States and other countries. Their characteristics do not come close to the performances of leather in terms of breathability, durability, sustainability and beauty!

When you buy leather, we want you to buy leather – real leather - nothing else!

edited by

COTANCE

in collaboration with

VDL
Verband der Deutschen Lederindustrie e.V.

Leather - for life's journey

The scent of leather is gentle and at the same time intense and exciting. This fragrance reminds me of beautiful moments in my life. Leather, so simple, natural and sensual, is both cosy and stimulating.

Does this mean that leather is only for older people with memories? Definitely not! The unmatched experience of leather is something that everyone can enjoy.

Why do people love leather? Paula, an enthusiast hiker, told me that she appreciates how, after a long walk, her feet don't hurt thanks to her leather shoes. Chris stated that he likes it when, after brushing, his leather loafers shine again. Anthony, a bike-freak, confessed that he is happy when he wears leather gloves while cycling, and his sister, Carla, said that she loves leather because it saved her life when she fell off her motorbike on a rainy day. Samantha loves dancing and wearing her leather jacket on the dance floor, makes her feel cool! My uncle enjoys the smell and sounds of the leather in his vintage car, and my niece loves the rich grip from the leather steering wheel of her cabrio.

Leather is a natural material that we instinctively engage with in a way that materials made of plastic, synthetic fibres or other imitations of leather cannot replicate. And whenever we touch leather, it's intense, it stimulates our senses. What moments come to my mind? The day my father sitting in his old leather seat smiled at me when I told him that I had graduated. The first kiss in her father's leather fitted car when she drove me back home after a night out. Looking at the kids watching TV from the leather sofa with their mother by my side.

What is your unforgettable "leather moment"?

edited by

COTANCE

in collaboration with

VDL Verband der Deutschen Lederindustrie e.V.

leather UK

News Release from the IULTCS

26 February 2019

Jakov Buljan Announced as Recipient of the IULTCS Merit Award 2019

It is with great pleasure that IULTCS announces that Mr Jakov Buljan has been chosen as the winner of the prestigious IULTCS Merit Award for Excellence in the Leather Industry.

The IULTCS was founded for the purpose of encouraging the technology, chemistry and science of leather on a worldwide basis. It is therefore appropriate that we recognise the achievements of those of stature in our industry who have contributed significantly to our global understanding of the leather industry and its by-products. The IULTCS Merit Award is given biennially by the IULTCS Executive to an individual, whose past or current endeavours have had an extraordinary impact on our industry and provide an example for others to follow. Jakov Buljan fits this profile perfectly.

Having left the University of Zagreb, Croatia in 1966 with a degree in biochemistry Buljan then continued to spend his entire professional career in leather industry – commencing with a position as works manager at CIBALIA, Vinkovci, Croatia, one of the largest European producers in goat and hair sheep. He introduced important innovations in drying and milling resulting in higher output and quality. Subsequently he held various senior managerial positions, including in the joint venture tannery in India.

His dynamic style, field experience and language skills in 1983 brought him to Vienna, Austria to work for the United Nations Industrial Development Organization, UNIDO, where he worked as a project manager until his retirement in 2003, but he remained as active as ever.

During his tenure with UNIDO Buljan launched new initiatives with emphasis on projects dealing with environmental issues in many developing countries where more than 50 Effluent Treatment Plants were designed, constructed or supervised under Buljan's leadership.

Training and dissemination of information have always been a high priority on his agenda. Thus, he was the organizer and lecturer of UNIDO workshops in many countries; also re-knowned for his meticulous preparation of background papers and project reports he frequently appears as technical editor, author and / or co-author of a number of technical papers and studies, manuals, brochures and videos. Probably the most widely referenced publication that appears in so many leather congresses internationally is "Mass Balance in Leather Processing," co-authored with Reich and Ludvik, which was presented at the IULTCS Congress in 1997.

The Merit Award will be presented to Jakov Buljan during the XXXV IULTCS Congress in Dresden from 25-28 June 2019.

NATIONAL AND INTERNATIONAL EVENTS

INTERNATIONAL CONFERENCE "INNOVATIVE SOLUTIONS FOR SUSTAINABLE DEVELOPMENT OF TEXTILES AND LEATHER INDUSTRY"
23-24 MAY 2019, ORADEA, ROMANIA

International Conference "Innovative solutions for sustainable development of textiles and leather industry" will bring worldwide researchers and practitioners to share and discuss the latest scientific concepts and technological developments in Textile, Leather and Leather substitutes, Management and Marketing. It also intends to promote sharing ideas and emerging technologies, as well as to foster research and development collaborations amongst academia, research institutions & relevant industries.

Papers can be submitted on the following topics:

1. Textiles
Smart Textiles
Technical Textiles
Textile Design & Fashion design
Fibres, Yarns & Fabrics
Technology, Machinery & Equipment
Innovation of Industry Chain of Textile and Apparel
Testing & Quality Control
Composite Materials
Surface Treatment of Fibers and Fabrics
Computational Modelling and Simulation
Dyeing, Finishing & Printing
Energy Saving and Emission Reduction

2. Leather and Leather substitutes
Machinery& Equipment
Systems and Technologies
Materials
Biomaterials
Environment
Clean Innovative Technologies in Leather Making

3. Management and Marketing
Innovative process management for SMEs in the fashion industries
Cost monitoring and other economical intelligence tools
Labour risk: equipment, infrastructures, awareness Clustering and international cooperation
Political, industrial and commercial competitiveness studies and measures.
Marketing policies and methodologies
E-Commerce and B2B strategies
Monitoring methods in fashion trends

More information: http://textile.webhost.uoradea.ro/Conferinta/2019/index.html

THE 12TH INTERNATIONAL SYMPOSIUM ON FLEXIBLE ORGANIC ELECTRONICS (ISFOE19) 1-4 JULY 2019, THESSALONIKI, GREECE

The 12th International Symposium on Flexible Organic Electronics (ISFOE19) takes place on 1-4 July 2019, in Thessaloniki, Greece.

ISFOE is the biggest world-class scientific & technology event on Flexible Organic Electronics (OEs), promoting Research, Technology and Innovation in OE nanomaterials, Manufacturing Processes, Devices, Applications and Solutions. ISFOE19 provides an interdisciplinary forum for front-line scientists, engineers, people from industry and policy makers to discuss and exchange ideas on the hottest topics and progress in the field of OEs.

Abstract submission deadline: **27 March 2019**.

More information: https://www.nanotexnology.com

XIXTH INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE SGEM2019 28 JUNE - 7 JULY, 2019, ALBENA, BULGARIA

The International Multidisciplinary Scientific GeoConferences SGEM bring together Scientists, Researchers, Educators and Practitioners representing Academies, Universities, Research and Educational Institutions, Companies, Government Agencies and Consulting Organizations from all over the world to exchange ideas, to define the research priorities in the fields of GeoSciences. The overall objective is to propose potential solutions of problems related to the global changes, to contribute to the integration of environmental consideration into the decision-making process - hoping to ensure that present consumption will not compromise the ability of future generations to meet their own needs.

Full paper submission: **15 May 2019**.

More information: https://www.sgem.org

4TH INTERNATIONAL CONGRESS ON BIOMATERIALS AND BIOSENSORS (BIOMATSEN) 12-18 MAY 2019, OLUDENIZ, TURKEY

The “4th International Congress on Biomaterials and Biosensors (BIOMATSEN)” will be held on May 12-18, 2019 in the stunning Convention Centre of one of the largest international resort in Turkey right in the heart of Blue Lagoon (Oludeniz) area.

BIOMATSEN intends to be a global forum for researchers and engineers to present and discuss recent innovations and new techniques in Biomaterials and Biosensors. In addition to scientific seminars, a wide range of social programs including boat cruises and visits to historical places will be available.

The Organizing Committee also encourages companies and institutions to showcase their modern products and equipment in the conference area.

More information: http://www.biomatsencongress.org/

2019 IEEE PES INNOVATIVE SMART GRID TECHNOLOGIES EUROPE (ISGT-EUROPE) 29 SEPTEMBER - 2 OCTOBER 2019, BUCHAREST, ROMANIA

The 2019 IEEE PES Innovative Smart Grid Technologies Europe (ISGT-Europe) is sponsored by *IEEE Power & Energy Society (PES)* and *University POLITEHNICA of Bucharest,* Romania. It will be held at University POLITEHNICA of Bucharest, Romania from September 29 to October 2, 2019. This year conference theme is "New Businesses for Energy Transition".

ISGT Europe 2019 will feature keynotes, plenary sessions, panels, industry exhibits, paper and poster presentations, and also tutorials by worldwide experts on smart grid and related technologies. Researchers, practitioners and students worldwide are invited to submit papers for consideration to be presented at the conference and to discuss the latest trends and emerging and innovative technologies for grid modernization.

The IEEE ISGT Europe conference is one of the two IEEE PES flagship conference organized in Europe and has established a strong reputation in the last years. It focuses on industrial and manufacturing theory and applications for the wide use of information and communication technologies and integrated renewable and distributed energy resources on the electric grid.

More information: http://sites.ieee.org/isgt-europe-2019/

7TH INTERNATIONAL CONFERENCE ON SUSTAINABLE SOLID WASTE MANAGEMENT 26-29 JUNE 2019, HERAKLION, CRETE ISLAND, GREECE

The Conference aims to address the significant issue of sustainable solid waste management through the promotion of safe practices & effective technologies. The Conference focuses mainly on modern solid waste technologies. It aims to stimulate the interest of scientists and citizens and inform them about the latest developments in the field of municipal solid waste management. Separation at source, Biological Treatment, the treatment at central facilities, waste prevention, biowaste utilization, recycling promotion, Waste-to-energy technologies & energy recovery, smart technologies for waste management, sludge management, agricultural and livestock waste, management of specific waste streams (construction & demolition waste, waste from electrical and electronic equipment, etc.), biotechnology, Best Available techniques, symbiosis networks, energy consumption and saving, carbon footprint and water footprint, zero-waste initiatives, plastics and bioplastics, marine litter constitute main conference subjects. Special attention will be drawn to the valorization prospects & the products from solid waste, such as: biofuels, compost, materials, etc. It is also our ambition to strengthen the link of the applied research with industry. Hazardous waste & Household hazardous waste also constitute target area of the conference. Emphasis will be placed on circular economy in all key action areas (production, consumption, waste management, secondary raw materials, innovation, investment & monitoring) and all priority sectors (food waste, plastics, biomass and bio-based-products, construction & demolition waste, critical raw materials), as well as waste management issues and resource efficiency in islands and generally isolated and remote areas.

The Conference will provide an opportunity to bring together scientists & professionals from government departments, industries, Municipalities, private institutions, research & education institutions, being a forum for the exchange of the most recent ideas, techniques & experiences in all areas of solid waste management. A special full one-day workshop will also focus on representatives of local authorities and municipalities in order to promote integrated solid waste management schemes.

Deadline for submission of full papers: **30 April 2019**.

More information: http://www.heraklion2019.uest.gr/

THIRD INTERNATIONAL CONFERENCE ON ADVANCED MATERIALS
9-11 AUGUST 2019, KERALA, INDIA

This conference will be one of the big International meetings exclusively dedicated to the Advanced Materials for Power Engineering.

The conference is to emphasize the recent advances in interdisciplinary research on processing, morphology, structure and properties of advanced materials for power engineering and their applications in various fields. This symposium will bring together a panel of highly-accomplished experts in the field of Advanced Materials for Power Engineering. Talks will encompass basic studies and applications and will address topics of novel issues, difficulties, and breakthroughs in the field of Advanced Materials for Power Engineering.

The conference will feature keynote addresses, a number of plenary sessions, invited talks and contributed lectures focusing on specific tenets of Power Engineering. Additionally, there will be several poster sessions, and awards for four best poster presentations.

Deadline for the submission of abstract: **30 June 2019**.

More information: http://www.power.macromol.in/

THE 5TH INTERNATIONAL CONFERENCE ON STRUCTURAL ADHESIVE BONDING (AB2019)
11-12 JULY 2019, PORTO, PORTUGAL

The 5th International Conference on Structural Adhesive Bonding 2019 will take place in Porto, Portugal, 11-12 July 2019. This conference is held every two years in Porto. The conference is chaired by Lucas F. M. da Silva and co-chaired by R. D. Adams (University of Oxford, UK). The focus is on structural bonding but all relevant areas of bonding are welcome: Fundamental aspects of adhesion; The science and technology of surfaces; Advances in adhesive materials; Mechanical properties of bonded joints; Innovative designs and applications; Testing and standardization; Industrial aspects; Quality procedures; Environmental and ecological aspects.

Submission of papers: **12 July 2019**.

More information: https://paginas.fe.up.pt/~abconference/ab2019/

THE 10TH INTERNATIONAL CONFERENCE AND EXHIBITION ON 3D BODY SCANNING AND PROCESSING TECHNOLOGIES (3DBODY.TECH 2019)
22-23 OCTOBER 2019, LUGANO, SWITZERLAND

3DBODY.TECH 2019 - The 10th International Conference and Exhibition on 3D Body Scanning and Processing Technologies will take place on 22-23 October 2019, in Lugano, Switzerland.

The success of the 9th edition of 2018 with about 250 attendees, with over 80 presentations and with more than 20 exhibitors confirmed again 3DBODY.TECH Conference & Expo as the most important

international event for the sectors related to 3D body scanning and processing technologies. With the 10th conference and exhibition of 2019, we will continue the role as the world leading technical and scientific platform dedicated to these specific fields.

3DBODY.TECH Conference & Expo provides a platform of eminent professionals, entrepreneurs, academicians and researchers across the globe to present, learn and discuss the latest in 3D body scanning and processing technologies. The multidisciplinary character of 3DBODY.TECH makes it unique and not comparable to any other meeting related to 3D body technologies.

Authors wishing to present their works at the conference are invited to submit their extended abstract until **30 April 2019**.

More information: https://www.3dbody.tech/2019/

LESHOW ISTANBUL - 2ND LEATHER AND FASHION FAIR
16-18 JANUARY 2020, ISTANBUL, TURKEY

LeShow Istanbul is the most prestigious and comprehensive international leather & fashion exhibition on the territory of Turkey, in what bona fide gathers and interlocks the manufacturers, wholesalers, fashion retail shops, designers and consumers of the global leather goods & fashion industries in a professional platform.

LeShow Istanbul embodies a niche fashion show event in what proffering high standard sensibility and warm atmosphere.

During the Exhibition, not only the international export platform will be exclusively supported by the special buyers' delegations programs associated with the rich data & profound experience of the 21 years old reputable LeShow Moscow, but also it will constitute an immense occasion to present LeShow Istanbul to the global leather & fashion sectoral markets.

LeShow Istanbul, in which will be held for the first time between dates of January 16-18, 2020 in ICC-Istanbul/TURKEY, is aimed to move confidently towards becoming a world famous organization linking the world's ever growing leather & fashion sectoral markets by offering unique occasion to present the latest leather & fashion specialties to acclaim of professional buyers.

More information: http://leshowistanbul.com/english/index.html

THE FOURTH WORLD LEATHER CONGRESS
16 JULY 2019, NEW YORK, USA

The fourth World Leather Congress is planned to take place in four months time – the day before the Summer Lineapelle New York, on Tuesday 16 July. The joint hosts are Leather Industries of America (LIA) – who provided the current ICT President, Lisa Howlett - and the United States Hide Skin and Leather Association (USHSLA) and the Congress is organised under the auspices of the International Council of Tanners (ICT), with the administrative assistance of Lineapelle/UNIC.

The first World Leather Congress in November 2011, held in Rio de Janeiro, was very much the brainchild of Wolfgang Goerlich, who was President of ICT from 2010 to 2014.

This was followed in September 2015 by the second World Leather Congress organised by UNIC, the Italian Tanners' Association, in Milan, under the ICT Presidency of Rino Mastrotto.

Then in August 2017, Richard Pai who was ICT President for 2016-18 and also President of TILA (Taiwanese International Leather Association) headed the organisation of the third World Leather Congress, jointly with the China Leather Industry Association (CLIA).

The theme of this 4th Congress will be "Leather in Everyday Life." While the first three congresses were focussed mainly on the industry and its supply and distribution chain, this one – especially being located in New York – is focussed on the consumer, consumer products and design.

With the growing emphasis on the power of the consumer, we believe that it is important for the Congress in New York to look at leather and leather products from the viewpoint of the consumers and their interests – increasingly buying products that are ethical, sustainable and consumer friendly.

More information: www.worldleathercongress.com

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Presentation of Papers

The scientific papers should be presented for publishing in English only. The text of the article should be clear and precise, as short as possible to make it understandable. As a rule, the paper should not exceed fifteen pages, including figures, drawings and tables. The paper should be divided into heads and chapters in a logical sequence. Manuscripts must meet high scientific and technical standards. All manuscripts must be typewritten using MS Office facilities, single spaced on white A4 standard paper (210 x 297 mm) in 11-point Times New Roman (TNR) font.

Paper Format

Title. Title (Centered, 12 pt. TNR font) should be short and informative. It should describe the contents fully but concisely without the use of abbreviations.

Authors. The complete, unabbreviated names should be given (Centered, 10 pt. TNR font), along with the affiliation (institution), city, country and email address (Centered, 9 pt. TNR font). The author to whom the correspondence should be addressed should be indicated, as well as email and full postal address.

Abstract: A short abstract in a single paragraph of no more than 200-250 words must accompany each manuscript (8 pt. TNR font). The abstract should briefly describe the content and results of the paper and should not contain any references.

Keywords. Authors should give 3-5 keywords.

Text

Introduction. Should include the aims of the study and results from previous notable studies.

Materials and Methods. Experimental methods should be described clearly and briefly.

Results and Discussions. This section may be separated into two parts. Unnecessary repetition should be avoided.

Conclusions. The general results of the research are discussed in this section.

Acknowledgements. Should be as short as possible.

References. Must be numbered in the paper, and listed in the order in which they appear.

Diagrams, Figures and Photographs should be constructed so as to be easy to understand and should be named "Figures"; their titles should be given below the Figure itself. The figures should be placed immediately near (after or before) the reference that is being made to them in the text. Figures should be referred to by numbers, and not by the expressions “below” or “above”. The number of figures should be kept to minimum (maximum 10 figures per paper).

Tables. Should be numbered consecutively throughout the paper. Their titles must be centered at the top of the tables (12 pt. TNR font). The tables text should be 9 pt. TNR font. Their dimensions should correspond to the format of the Journal page. Tables will hold only the horizontal lines defining the row heading and the final table line. The tables should be placed immediately near (after or before) the reference that is being made to them in the text. Tables should be referred to by numbers, and not by the expressions "below" or "above". The measure units (expressed in International Measuring Systems) must be explicitly presented.

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References should be numbered consecutively throughout the paper in order of citation in square brackets; the references should list recent literature also. Footnotes are not allowed. If the cited literature is in other language than English, the English translation of the title should be provided, followed by the original language in round brackets. Example: Handbook of Chemical Engineer (in Romanian), vol. 2, Technical Press, Bucharest, 1951, 87.

We strongly recommend that authors cite references using DOIs where possible. DOIs are persistent links to an object/entity and can be used to cite and link to any article existing online, even if full citation information is not yet available. DOIs should always be displayed as full links. Example: Onem, E., Cin, G., Alankus, A., Pehlivan, H., Mutlu, M.M., Utilization of Chestnut Shell Wastes as a Dyeing Agent for Leather Industry, *Revista de Pielarie Incaltaminte* (*Leather and Footwear Journal*), **2016**, 16, 4, 257-264, https://doi.org/10.24264/lfj.16.4.1.

Citation of Journal Articles: all authors' names (surname, name initials), abbreviated journal title, year, volume number, issue number, full page reference, e.g.: Helissey, P., Giorgi–Renault, S., Renault, J., *Chem Pharm Bull*, **1989**, 37, 9, 2413-2425.

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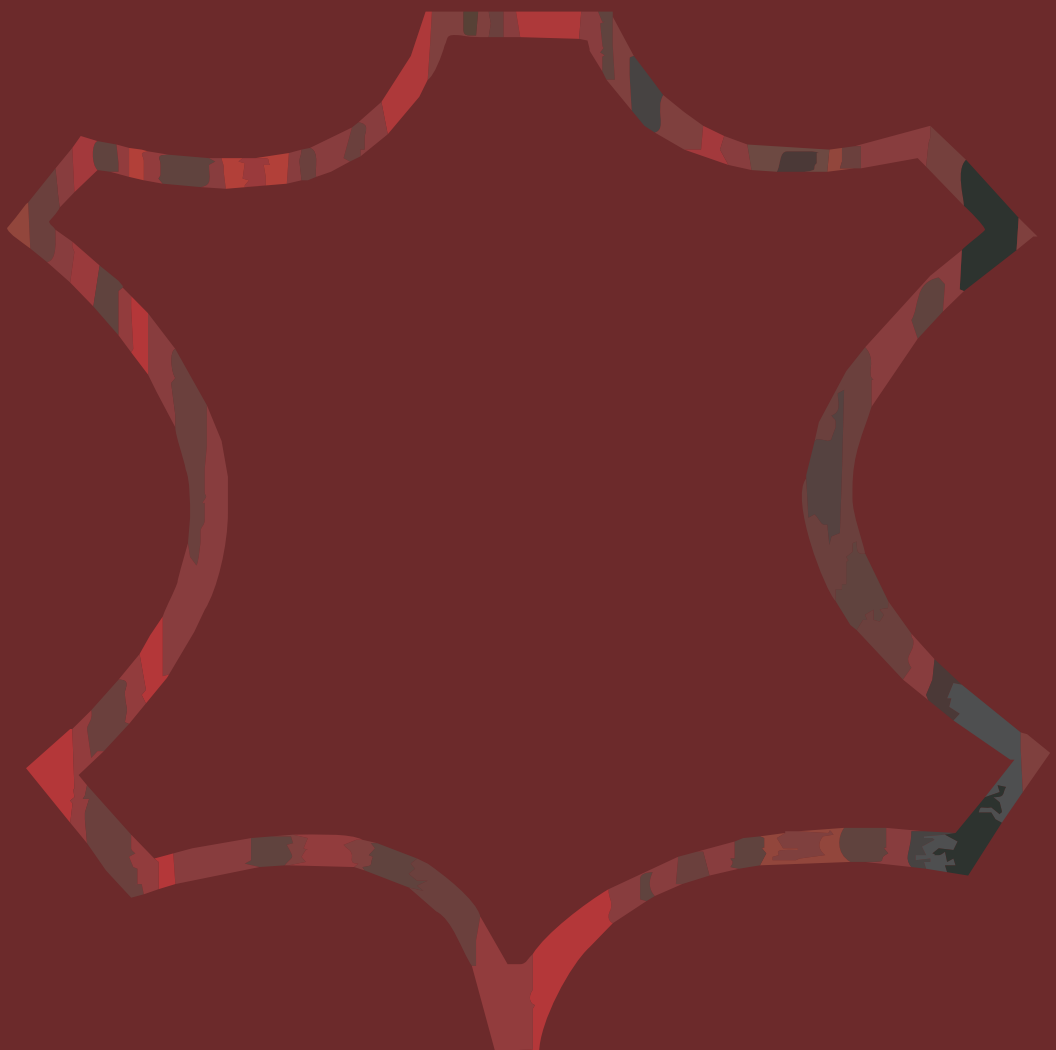

ISSN 1583-4433

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