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BASS-MODELING FOR FAST FASHION LADY'S SHOES BASED ON CONSUMER BEHAVIOR

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BASS-MODELING FOR FAST FASHION LADY'S SHOES BASED ON CONSUMER BEHAVIOR

ABSTRACT. Fast fashion is prevalent in the retail industry, however, plotting its life cycle becomes problematic as that feedback from sales record is even considered to be late for them. So, variables in the process of consumer behavior are potential ones for life cycle assessment of fast fashion products. Currently, most studies of Bass model chose the sales data, but whether the Bass model can also be applied for those in consuming process has not been evaluated; meanwhile, if the modeling based on consumer behaviors such as attention and fitting are available, we can project forward in time and make predictions much earlier than those based only on sales. Therefore, we developed a special system and it was used to collect the attention and fitting records. Our results show that only moderate Bass-fitting results were found for individual-level data; while, good to excellent results could be obtained for the accumulated data. Further, a moderate to good correlation was found between the sales and attention on one hand, and sale and fitting on the other. Regression models including Bass Model equations could be applied to predict the sales by either the attention or the fitting data. Overall, variables of consumer behavior, such as attention and fitting, were found to be suitable for Bass Modeling; further they were found to be good indicators to predict sales. These efforts advanced the time required to predict the sales trend of fast fashion sandals and make the predictive protocols more reliable.

KEY WORDS: LCA, RFID, attention-fitting-buying model, attention and fitting, off-line retailing

MODELUL BASS APLICAT ÎN CAZUL PANTOFILOR DE DAMĂ ÎN REGIM DE MODĂ RAPIDĂ PE BAZA COMPORTAMENTULUI CONSUMATORILOR

REZUMAT. Moda rapidă este predominantă în industria de vânzare cu amănuntul, însă, trasarea ciclului său de viață devine problematică, întrucât feedback-ul provenit din înregistrările de vânzări este considerat întârziat în acest caz. Așadar, variabilele în comportamentul consumatorului sunt variabilele potențiale pentru evaluarea ciclului de viață al produselor de modă rapidă. În prezent, majoritatea studiilor care utilizează modelul Bass au selectat datele din vânzări, dar nu s-a analizat dacă modelul Bass poate fi aplicat și în cazul procesului de consum; în același timp, dacă modelele bazate pe comportamentele consumatorilor sunt disponibile, cum ar fi atenția și potrivirea, putem proiecta în timp și face predicții mult mai timpuriu decât doar pe baza vânzărilor. Prin urmare, s-a dezvoltat un sistem special și a fost utilizat pentru colectarea înregistrărilor privind atenția și potrivirea. Rezultatele noastre arată că s-au găsit doar constatări moderate utilizând modelul Bass pentru datele la nivel individual, în timp ce rezultate bune și excelente s-au obținut pentru datele acumulate. Mai mult, s-a găsit o corelație moderată până la bună între vânzări și atenție pe de o parte, și între vânzare și potrivire pe de altă parte. Modelele de regresie, inclusiv ecuațiile modelului Bass, ar putea fi aplicate pentru a prezice vânzările fie prin intermediul datelor legate de atenție, fie de potrivire. În general, variabile ale comportamentului consumatorului, cum ar fi atenția și potrivirea, s-au dovedit a fi adecvate pentru modelul Bass; în plus, s-a dovedit că sunt indicatori buni pentru a prezice vânzările. Aceste eforturi au scurtat timpul necesar pentru a prezice tendința de vânzare a sandalelor de modă rapidă și au făcut protocoalele predictive mai fiabile.

CUVINTE CHEIE: LCA, RFID, model atenție-potrivire-cumpărare, atenție și potrivire, vânzare cu amănuntul off-line

MODÈLE DE DIFFUSION DE BASS POUR CHAUSSURES FEMME À LA MODE RAPIDE BASÉ SUR LE COMPORTEMENT DU CONSOMMATEUR

RÉSUMÉ. La mode rapide prévaut dans le secteur de la vente au détail. Toutefois, il est difficile de tracer son cycle de vie, car le retour d'information concernant les ventes est considéré tardif. Ainsi, les variables dans le processus de comportement du consommateur sont des variables potentielles pour l'évaluation du cycle de vie des produits de la mode rapide. Actuellement, la majorité des études qui en utilisent le modèle Bass ont choisi les données de vente, mais on n'a pas encore évalué si le modèle Bass pouvait également être appliqué pour le processus de consommation; dans le même temps, si la modélisation basée sur les comportements des consommateurs est disponible, tels que l'attention et l'ajustement, nous pouvons nous projeter dans le temps et faire des prévisions beaucoup plus tôt que juste en fonction des ventes. Par conséquent, nous avons développé un système spécial qui a été utilisé pour collecter les enregistrements d'attention et d'ajustement. Nos résultats montrent qu'on a trouvé seulement des résultats modérés en utilisant le modèle Bass pour les données au niveau individuel; tandis que des résultats bons à excellents ont été obtenus pour les données accumulées. De plus, une corrélation modérée à bonne a été trouvée entre les ventes et l'attention d'une part, et entre la vente et l'ajustement de l'autre. Des modèles de régression comprenant des équations du modèle Bass pourraient être appliqués pour prédire les ventes en fonction des données d'attention ou d'ajustement. Dans l'ensemble, les variables du comportement du consommateur, telles que l'attention et l'ajustement, ont été jugées appropriées pour le modèle Bass; en outre, ils se sont révélés être de bons indicateurs pour prédire les ventes. Ces efforts ont permis de gagner du temps pour prédire la tendance des ventes de sandales à la mode rapide et rendre les protocoles prédictifs plus fiables.

MOTS CLÉS : ACV, RFID, modèle attention-ajustement-achat, attention et ajustement, vente au détail hors ligne

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INTRODUCTION

Success in the fashion apparel industry by brands such as ZARA [1], GAP [2] and UNIQLO [3] has deeply changed world fashion patterns. All of those companies created a new business model which was called “Fast fashion”. Fast-fashion is featured as highly fashionable product design and short production and distribution times [4]; meanwhile, a shorter life time of either usage or prevalence [5] is also one of its features. The key principle of fast fashion is the ‘fast’, not only in the design and distribution process, but also in the marketing. Usually, information from the market feedback is mainly from the sales record, questionnaire from costumers or investigation from specialists. However, with exception of the sales data, the above two approaches are subjective; although the sales are considered as the objective data which has been widely used in the nowadays products’ evaluation, it represents the final choice after several key events in the consuming behavior, such as researching, attention and fitting activities and it means that the time to obtain the sales record is later than that of attention and fitting.

In this study, three areas of theoretical foundation are considered: Fast Fashion Theory, Life cycle assessment and modeling technologies, and Consumer Behavior Theory.

In the theory of Bass model, two indicators are available: one is “innovators”, another is “imitators” [6]. Innovators usually indicate that consumers seldom involve repeat purchases, because new generations will quickly replace previous ones; while “imitators” imply that the followers will repeat purchase products which are bought by pioneer groups. In terms of this classification, fast fashion belongs to innovator-style, thereby, it is not only emphasizing the enhanced design, but also the quick response either in the producing or in the marketing period. The relationship between the enhanced design and quick response was discussed by Cachon *et al*. [7], who established a series of mathematical models for evaluating the value of the traditional, quick response, enhanced design and fast fashion systems. Their findings proved that fast fashion can be defined as a combination of the quick response and enhanced design; each of this pair of systems is complementary rather than mutually exclusive. Other literature studies were mainly focused on market strategies for fast-fashion management [3, 8-9].

There are several ways to define the life cycle of a product [10]: some refer to the process from the conceptual design to the manufacturing process and then to the product entering and exiting the market [11]; while others merely focus on the sales section, calculating from the first promotion in the market to its exit [12]. Fortunately, nowadays such process can be quantified by Life Cycle Assessment (LCA) protocols [13-15]. A large number of products have been assessed in terms of life cycle [16]. Protocols for LCA can be achieved in the following ways: an analogy method [17], sales growth rate [18], a penetration method [19] and mathematical modeling [20]. Further, several types of algorithms were proposed to fit the curves of sales [21, 22]. For instance, the Comperz Model [8] was used to predict daily consumption of products; while those with a shorter life cycle might be assessed by the Bass or Modified Bass Model [6, 23, 24]. Thereby, according to the LCA, retailers can master the rhythms of the product and make as much profit as possible.

A consumer’s behavior involves the strategy developed and actions used before making the purchase decision [25]. Both psychology and physiology are involved in the consumption process. Psychological aspects involve price comparison, decision making and anticipation of buying; whereas, physiology [26] involves the physical actions and movement of consumers. Theoretically, a consumer’s behavior is a direct response to a product, which can be depicted as: attention-fitting-buying process. A consumer first learns about products from his or her interests [27, 28]; then utilizes their knowledge and life experience to further comprehend them; afterwards, they make a judgment and establish an attitude regarding the product. This process can be quantified in terms of attention paid by the consumer, fitting, and the final buying decision.

Effective attention plus good fitting experiences would contribute toward the final action of purchase. Thereby, adding the attention-fitting-buying into modeling process of fast-fashion products makes the recognizing and plotting of life cycle for them much earlier and it would timely assist managerial strategy making, such as deciding the time to design a new generation to replace an older or declining one. Unfortunately, current literature did not include any studies focusing on the consumer behavior process such as attention or fitting. Research questions were asked: if we obtain the attention and fitting information and build the quantified model with the help of the factors of attention and fitting, we can project forward in time and make predictions much earlier than those based only on sales. Further, if the regression formula between the attention and sale or the fitting and sale are to be obtained, sales could be predicted by the attention or fitting records, which are earlier than those of sales.

Hence, in this study, we first aim to achieve data collection from the consumer behavior process by a special developed system which is installed at the offline-stores and is used for recording attention and fitting data. Then we are to develop Bass Models with those consumer behavior factors, where attention-fitting-buying model is proposed. Further, correlations between attention-sales and fitting-sales are to be explored and regression formulas involving the Bass Model are to be established. Finally, a sensitive method to evaluate fast fashion shoe products is to be built. Hypothesis was proposed here (1): Consuming behaviors such as attention and fitting are available in the Bass modeling process; (2): Sales of fast-fashion sandals could be predicted by Bass models based on either the attention or the fitting record.

METHODS

In this study, ladies' sandals were set as our research target, since this style of footwear is fashion sensitive and commonly used in a relatively short and specific period — summer. Both the consumers' behavior of attention to a product and their fitting activities, as well as the sales in 77 offline stores installed with data acquisition systems were obtained. These shops were a famous Chinese footwear brand which has more than 4000 offline retailers over the Chinese mainland and whose annual footwear sales revenue was more than 3 billion Yuan (0.6 billion USD). The data acquisition period was set between May and December 2017 (7 months), and this period was the whole sales cycle for ladies' sandals.

Three kinds of parameters of consumer behavior were defined in this study: focusing attention on the product and fitting activities (consumer behavior), sales records (the result of consumer behaviors). Consumer behavior was recorded by the RFID systems, which were composed of a recorder and a label. The recorder was located underneath the showing pad and fitting areas, where the shoes were labeled by their RFID card. If the recorder noted that the labeled shoe was removed (that is, the consumer paid attention to the product then picked up the shoe to examine it closely) for at least 10 seconds, it would be considered a successful attention record. Similarly, when the consumer wore the labeled shoe in the fitting area for more than 10 seconds, the recorder in the fitting zone would consider this action as a successful fitting. The sales records were exported from the company's sales software system. The whole data acquisition period was done in accordance with the business opening time of the retailers (10:00-21:00).

Accumulated Attention (AA) can be calculated by the sum of each attention record (AT) in a k period, and its mathematical formula is shown as:

$$AA_k = \sum_{i=1}^{k} AT_i \quad (1)$$

where, the i is one day within the collecting period, i=1, 2, 3..., I, k; k is the whole product data collection time; ATi is the individual attention paid by a consumer to a product in an exact time;

Similarly, Accumulated Fitting (AF) can be calculated by the sum of each fitting record (FT) in a k period, and its mathematical formula is shown as:

$$AF_k = \sum_{i=1}^{k} FT_i \quad (2)$$

where, the i is one day within the collecting period, i=1, 2, 3..., I, k; k is the whole product data collection time; FTi is the individual fitting made by a consumer to a product in an exact time;

Accumulated Sales (AS) can be calculated by the sum of each sale record (SA) in a k period, and its mathematical formula is shown as:

$$AS = \sum_{i=1}^{k} SA_i \quad (3)$$

where, the i is one day within the collecting period, i=1, 2, 3..., I, k; k is the whole product data collection time; SAi is the individual sale at an exact time;

Attention, fitting, and sales data were used in the Bass Modeling and the mathematical formulas of the Bass Model are shown below:

$$n_{(t)} = m\frac{p(p+q)^2 e^{-(p+q)t}}{\left[p+qe^{-(p+q)t}\right]^2} \quad (4)$$

$$\mathrm{N}_{(t)} = m\frac{1-e^{-(p+q)t}}{1+\frac{p}{q}e^{-(p+q)t}} \quad (5)$$

where, n(t) is the predicted individual attention/fitting/sales and N(t) is the predicted aggregated attention/fitting/sales; t determines the time; the parameters of m, p, and q indicate the potential buyers, innovative factor and simulative factors individually; p >0, q >0.

First of all, AT, AF and AS were computed according to Eq. 1-3; then, this data was explored in order to eliminate singular values (statistical outliers) or abnormal records; afterwards, parameters of attention, fitting and sale were set by the Bass Model. Amplitude (maximum values minus minimum values), peak value and time to peak value were used to quantify each fitting curve of the Bass Model.

One sample K-S model was first used to explore the normal distribution of the data and all the data was found to be in normal distribution; then, relationships between AA and AS and AF and AS were made according to a non-linear regression model; accordingly, the Bass Model was involved in the regression model. All statistical models were operated under the SPSS, with a significance level of 0.05 and a confidence interval of 95%.

RESULTS

Fitted Bass Models are shown in Table 1 and Figure 1. These indicate that all individual variables had moderate reliability (all R^2 lower than 0.5). The maximum daily attention for fashion sandals was 175 times, and it took 52 days to become popular – a state which lasted for 8 days – and that the amplitude was 124 times. In terms of individual fitting, the daily maximum fitting was 75, which required 49 days to reach the peak that was maintained for 13 days; while the amplitude was 53 times. For sales, in the whole period, the maximum sales per day was 6 pairs, which lasted 56 days; but this peak occurred much earlier than that of either attention or fitting and took 19 days to be reached.

Table 1: Bass Models for Individual-level Variables

Variables	m	p	q	Typical BASS model $n_{(t)} = m\frac{p(p+q)^2 e^{-(p+q)t}}{\left[p+qe^{-(p+q)t}\right]^2}$	R^2
Attention	23323.5	0.005	0.02	$n_{(t)} = \frac{0.07e^{-0.025t}}{\left[0.005+0.02e^{-0.025t}\right]^2}$	0.400
Fitting	10257.4	0.005	0.02	$n_{(t)} = \frac{0.03e^{-0.025t}}{\left[0.005+0.02e^{-0.025t}\right]^2}$	0.482
Sales	7696.5	0.006	0.02	$n_{(t)} = \frac{0.003e^{-0.026t}}{\left[0.006+0.02e^{-0.026t}\right]^2}$	0.466

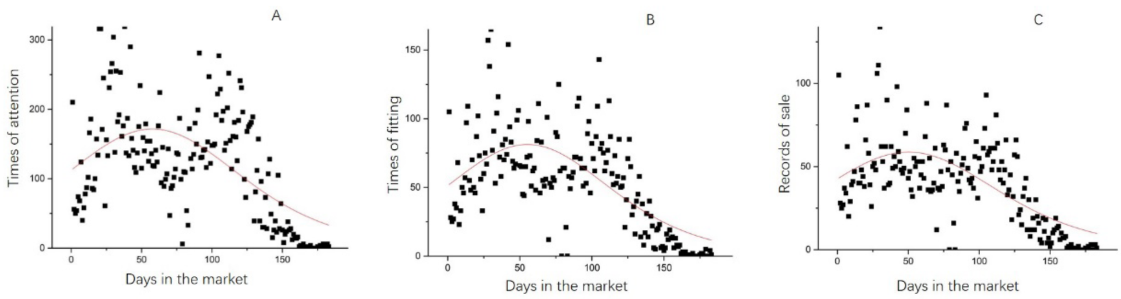

Figure 1. Bass Model for Individual Sales (C), Attention (A) and Fitting variables (B)

The aggregated Bass Models in the Table 2 indicate that all those accumulated variables had excellent fitting reliability (all R^2 higher than 0.9). The accumulated curve shows (Figure 2) that the maximum attention for fashion sandals was 21816 times on the 154th day, after which the increase ratio was less than 0.5%; we defined this point as the turning point. Similar findings were obtained for accumulated fitting, where in the 153rd day, its growth rate was less than 0.5% and the relative maximum fitting times were 9357. In terms of accumulated sales, the 143rd day was the turning point and the maximum value was 7105 pairs.

Table 2: Bass Models for the Accumulated Variables

Variables	m_1	p_1	q_1	Typical BASS model $N_{(t)} = m_1\frac{1-e^{-(p_1+q_1)t}}{1+\frac{p_1}{q_1}e^{-(p_1+q_1)t}}$	R^2
AA	24187.3	0.005	0.02	$N_{(t)} = 24187.3\frac{1-e^{-0.025t}}{1+4e^{-0.025t}}$	0.993
AF	10400.1	0.005	0.02	$N_{(t)} = 10400.1\frac{1-e^{-0.025t}}{1+4e^{-0.025t}}$	0.996
AS	7865.7	0.006	0.02	$N_{(t)} = 7865.7\frac{1-e^{-0.026t}}{1+3.3e^{-0.026t}}$	0.996

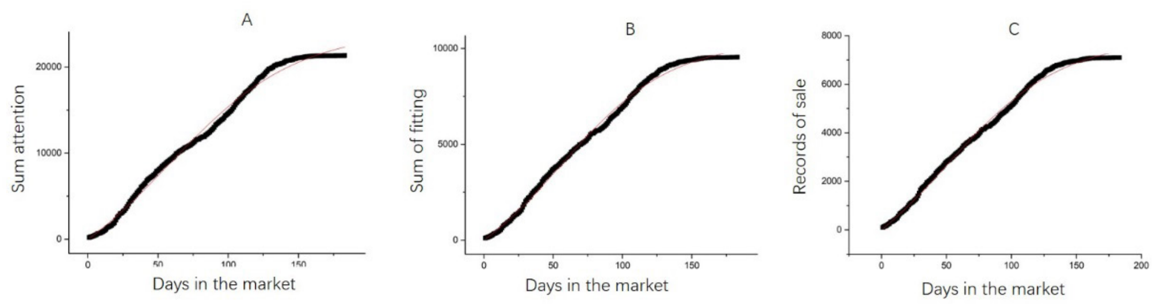

Figure 2. Bass Model for Accumulated Sales (C), Attention (A) and Fitting (C) variables

Non-linear correlations between individual sales and attention, and sales and fitting were found and a moderate to high R^2 was obtained for them (Table 3 and Figure 3); while a much higher R^2 was obtained for the accumulated variables (Table 4 and Figure 4). These correlations could be understood in terms of accumulated sales – if 2000 attentions and 1000 fittings were made by the consumers, we could postulate that 4760 pairs of fashion sandals would be bought. In another case for accumulative sales, if 1 million attentions and 1 million fittings were made by the consumers, we could postulate that 0.472 million pairs of sandals would be bought in total. Therefore, according to the above correlations, sales could be predicted by either the attention or the fitting data.

Table 3: Correlation between the Individual Sales-Attention and Sales-Fitting

Correlation	Intercept	B_1	B_2	Fitting model $y = \text{Intercept} + B_1 x + B_2 x^2$	R^2
Individual Sales -Attention	0.8	0.4	-0.0004	$y = 0.8 + 0.4x - 0.0004x^2$	0.784
Individual Sales -Fitting	1.2	0.7	-0.0002	$y = 1.2 + 0.7x - 0.0002x^2$	0.957

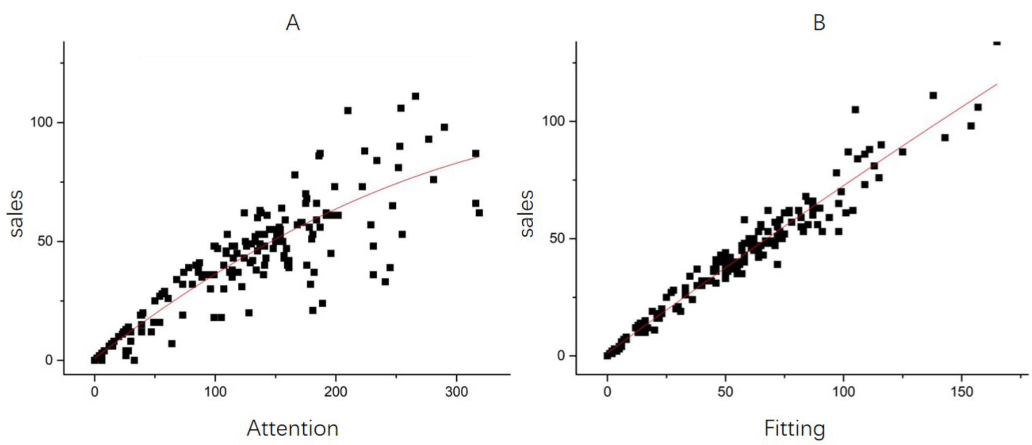

Figure 3. Non-Linear Correlation between Individual Sales and Attention (A) and Fitting (B) Variables

Table 4: Correlation between Accumulated Sales and Attention and Fitting

Correlation	Intercept	B_1	B_2	Fitting model $y = \text{Intercept} + B_1x + B_2x^2$	R^2
Accumulated Sales and Attention	61.1	0.4	0	$y = 61.1 + 0.4x$	0.999
Accumulated Sales and Fitting	125.9	0.7	0	$y = 125.9 + 0.7x$	0.999

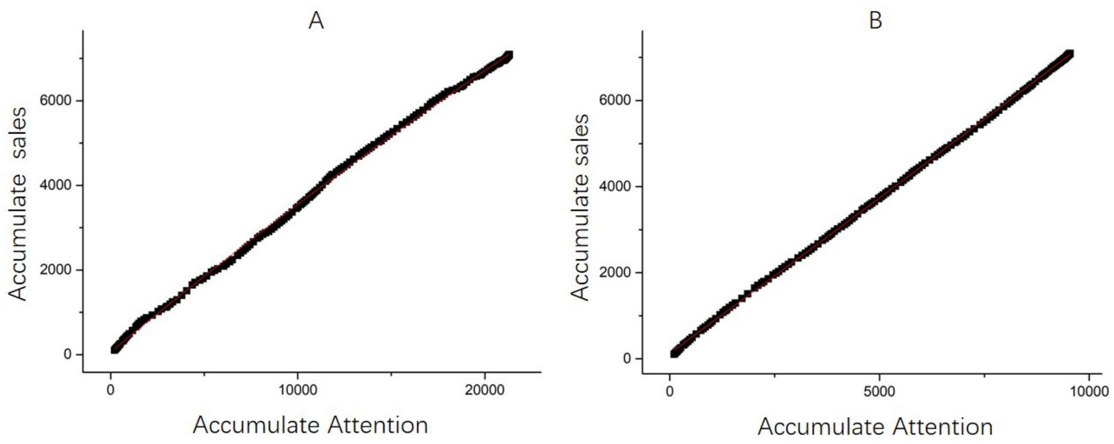

Figure 4. Linear Correlation between Accumulative Sales and Attention (A) and Fitting (B) Variables

DISCUSSIONS

Similar to our study, LCA protocols can be applied to the internet. On the internet, by monitoring the IP addresses, online consumer behavior can be monitored on aggregate [29]; moreover, with the help of artificial intelligence (AI) algorithms that seek to comprehend human characteristics, determining the habits of consumer behavior and recommending products has a realistic basis (Tedesco). However, the fundamental infrastructure is that of big data, and critical technologies are those of data acquisition for analyzing consumer behavior. In this study, we first developed a RFID system to achieve such data; then, based on this data, we further studied consumer behavior. According to our results, the protocol used to collect the attention and fitting data was found to be reliable and could be applied in other fast-fashion product research.

Guo [24] used aggregate market data in Bass Modeling to provide a distinct, dynamic, and local perspective on consumer purchasing behavior across the entire life cycle of a product. Similarly, in the course of our research, we performed a case study where complete seasonal data for fashion sandals was recorded and variables of attention, fitting and sales were used to establish the LCA model for fashion sandals. Results show that only moderate Bass-fitting results were found for individual-level data; while, good to excellent results could be obtained for the accumulated data. Further, a moderate to good correlation was found between the sales and attention on one hand, and sale and fitting on the other. Regression models including Bass Model equations could be applied to predict the sales by either the attention or the fitting data.

Although positive outcomes were achieved, limitations exist and shall be considered in the further application of our protocols: we shall define the initial value for the aggregated Bass Model and that value shall be at least ten-thousand level. A value of less than 10000 attention or fitting records might result in unreliable predicted sales. Therefore, our Bass Model is suitable for a group or a large company which has a series of retailers; however, those with a single shop or simple data could not benefit from our models. In terms of further research, we will be focusing on the method to quantify the psychological variables in the consuming behavior, so as to evaluate the possibility of Bass modeling. Combining the physiological and psychological quantification, a complete consuming behavior for fast-fashion products could be established.

CONCLUSIONS

In this study, we first approved that the Bass modeling for consuming behavior is available; it also meant that other variables in the consuming process, even the psychological indicators would be modeled. Moreover, our RFID-based smart recording system is cheap and easy to install and it could be applied in the fast fashion apparel and footwear industry. Further, we discussed the correlations between the attention and sales, and fitting and sales; good to excellent regression reliability was found for these regression models, which implies that sales of fast-fashion products could be predicted based on the attention or the fitting data. Thereby, the theoretical domains of Bass model and traditional consuming behavior are extended.

Overall, we introduced the attention, fitting, and sales variables in the modeling of fast fashion sandals in China; and two Bass Models including the use of individual and accumulated market data were established. Overall, variables of consumer behavior, such as attention and fitting, were found to be suitable for Bass Modeling; further they were found to be good indicators to predict sales. These efforts advanced the time required to predict the sales trend of fast fashion sandals and make the predictive protocols more reliable.

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PERFORMANCE ASSESSMENT OF GREEN PRACTICES IN LIMING WITH REDUCTIVE POTENTIAL CHEMICALS FOR ENVIRONMENTAL SUSTAINABILITY

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PERFORMANCE ASSESSMENT OF GREEN PRACTICES IN LIMING WITH REDUCTIVE POTENTIAL CHEMICALS FOR ENVIRONMENTAL SUSTAINABILITY

ABSTRACT. Leather processings involved in isolation in pre-tanning stages generate large volumes of solid wastes and high strength wastewater which are major source of environmental pollution characterized by chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), chromium (III) and phenolics with high pH, strong odor and dark brown color. Leather industry wastewaters with high organic content and pollution load are generated from pre-tanning processes. Conventional pre-tanning process utilises chemicals which attributes to 50-60% of pollution load and alkaline effluent discharge of 70-80% toxicity. In our study, the best practices modelling and eco-compatible process shifts were the objectives for the decrement in high pollution load of large effluent portion for leather industry. Soaking, immunization and liming processes were carried out with reductive chemical additives and surfactants, fibre opening auxiliaries, enzyme based and enzyme assisted chemicals in the factories as an eco-friendly designed recipe. Studies were conducted in Bursa Leather Park, Turkey. The results revealed the advantages of time saving, cost effectivity and minimized pollution load compared to conventional process. Moreover, the designed process uses lower amount of alkaline chemicals and water, gives a very high quality pelts with open grain and yield in 50-55% lime split output with 2.2-2.4 mm thicknesses.
KEY WORDS: leather, liming, wastewater, environment, sustainability

EVALUAREA PERFORMANŢEI PRACTICILOR ECOLOGICE ÎN OPERAŢIA DE CENUŞĂRIRE UTILIZÂND SUBSTANŢE CHIMICE CU POTENŢIAL DE REDUCERE PENTRU SUSTENABILITATEA MEDIULUI

REZUMAT. Procesele individuale de prelucrare a pielii în etapele dinaintea tăbăcirii generează volume mari de deşeuri solide şi ape uzate, care reprezintă sursa majoră de poluare a mediului caracterizată prin consum chimic de oxigen (CCO), consum biologic de oxigen (CBO), total solide dizolvate (TDS), total solide în suspensie (TSS), crom(III) şi compuşi fenolici cu pH ridicat, miros puternic şi culoare maro închis. Apele uzate din industria pielăriei cu conţinut organic şi poluant ridicat sunt generate din procesele anterioare tăbăcirii. În procesul convenţional de pre-tăbăcire se folosesc substanţe chimice care reprezintă 50-60% din cantitatea de poluanţi şi de efluenţi alcalini cu 70-80% toxicitate. În studiul nostru, modelarea celor mai bune practici şi schimbările procesului eco-compatibile au reprezentat obiectivele pentru reducerea cantităţii ridicate de poluanţi din efluenţii care provin din industria de pielărie. Procesele de înmuiere, imunizare şi cenuşărire au fost realizate cu aditivi chimici reductivi şi tensioactivi, auxiliari pentru deschiderea fibrelor, substanţe chimice pe bază de enzime şi asistate de enzime, utilizând o reţetă ecologică. Studiile au fost efectuate în Bursa Leather Park, Turcia. Rezultatele au relevat avantajele economisirii timpului, eficienţa costurilor şi încărcarea minimă a poluării în comparaţie cu procesul convenţional. Mai mult decât atât, procedeul conceput utilizează o cantitate mai mică de substanţe chimice alcaline şi apă, se obţin piei gelatină de înaltă calitate, cu fibre deschise şi cu un randament de 50-55% piei şpalt cenuşărite cu grosimi de 2,2-2,4 mm.
CUVINTE CHEIE: piele, cenuşărire, ape uzate, mediu, durabilitate

ÉVALUATION DES PERFORMANCES DES PRATIQUES ÉCOLOGIQUES DANS L'OPÉRATION DE PELANAGE UTILISANT DES PRODUITS CHIMIQUES À POTENTIEL D'OXYDORÉDUCTION POUR LA DURABILITÉ DE L'ENVIRONNEMENT

RÉSUMÉ. Les processus individuels de traitement de la peau au stade du prétannage produisent de grands volumes de déchets solides et d'eaux usées, qui représentent la principale source de pollution environnementale caractérisée par la demande chimique en oxygène (DCO), la demande biologique en oxygène (DBO), les solides dissous totaux (SDT), les total des solides en suspension (TSS), le chrome (III) et les composés phénoliques à pH élevé, à forte odeur et de couleur marron foncé. Les eaux usées très polluantes contenant des matières organique, provenant de l'industrie du cuir, sont générées par les processus antérieurs au tannage. Dans le processus de prétannage classique, on utilise des produits chimiques représentant 50 à 60% de la quantité de pollution et des effluents alcalins avec une toxicité de 70 à 80%. Dans notre étude, la modélisation des meilleures pratiques et des changements de processus respectueux de l'environnement ont été les objectifs en raison de la réduction de la pollution générée par les effluents de l'industrie du cuir. Les processus de trempage, d'immunisation et de pelanage ont été réalisés avec des additifs chimiques réducteurs et tensioactifs, des auxiliaires d'ouverture de fibres, des produits chimiques à base d'enzymes et assistés par enzymes, en utilisant une recette écologique. Les études ont été menées dans le Leather Park Bursa, en Turquie. Les résultats ont révélé les avantages du gain de temps, de la rentabilité et de la charge de pollution minimale par rapport au processus conventionnel. De plus, le procédé conçu utilise une plus petite quantité de produits chimiques alcalins et d'eau, permet d'obtenir des peaux en tripe de haute qualité, à fleur ouverte, et donne un rendement de 50 à 55% de peaux en croûte d'une épaisseur de 2,2-2,4 mm.
MOTS CLÉS : cuir, pelanage, eaux usées, environnement, durabilité

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INTRODUCTION

The tanning industry worldwide produces a significant amount of solid wastes and effluents, environmental concerns about discharge and escalating landfill costs are becoming increasingly serious problems for industry and management alternatives regarding overall consideration based on multi-spot. Due to the fact that 1 ton of wet salted hides yields in 200 kg of finished leather and requires 15-50 m^3 water consumption along with the usage of 500 kg process chemicals, the production emanating 800 kg wastes including tanned solid wastes of 250 kg, non-tanned wastes of 350 kg and discharged wastes of 200 kg in the process water of 15-50 m^3 [1].

Due to both environmental concerns caused by the industrial individuality and pollution emanating inherently from the material itself structure and also global stringencies in many places all over the world have constrained to relocate the industry to designated leather parks along with the implementation of Common Effluent Treatment Plants (CETPs) [2]. In liaison with the globalization and emerging trade unities and also their impacts, cleaner production was adopted and the industry has been obliged to stand out against the enforcement of stringent regulations.

As we know, the traditional loosening fibers process, leather liming (lime, sodium sulfide, etc.), is operated to achieve the objective of the leather loose fibers by means of decomposing the fiber in the high pH of the water. This process produces high-pH value of sewage, which is rich in lime, sulfide, biological oxygen demand, chemical oxygen demand, lipidic saponification or emulsion matter, protein, hair degradation products, organic nitrogen, ammonia nitrogen salt, and so on. Especially for the lime used in this procedure, its large dosage contributes hugely to a great deal of solid sludge.

To bring the tanning industry more in line with present environmental thinking, various methods have been devised to reduce impacts. Big efforts have been made to reduce pollution load, decrease process time and get improvement in the product quality [3, 4]. Other methods of cleaner process in leather-making are tested synchronously [5, 6]. Efforts from researchers and scholars are insistently carried out to reduce leather pollution [7-14]. However, serious betterments could not be achieved until now.

Bursa Specialized Leather and Mixed Organized Industrial Zone called as BIDOSB in abbreviation is the Pioneer Leather Park located in southern Marmara region in Turkey (Figure 1). In the region 200 tons of hides are processed daily, that is one fifth of Turkey production annually. Once in the first time of relocation it was designed just for resettlement of the tanneries in Bursa Province, but later as a consequence of high logistic prices of Tuzla Leather Park, majority of the biggest tanneries in Turkey moved their facilities in this region. However, the infrastructure and common treatment plant capacity which was designed by taking into consideration of the first facility layouts remained incapable of the treatment of newly need-based capacity. Due to full capacity running of the several biggest tanneries which process raw hides to wet-blue, the increasing flow rates and changing the regime of the effluent gave rise to decrease the efficiency of infrastructure and facilities and required to take measures for adequate and efficient treatment. For this reason management of CETP practices are of main importance now and prerequisites are to be taken into consideration. There are 5 control points before CETP entree unit and the last adjustment in equalization tank. But above all the cleaner processing attempts, best available techniques and eco compatible interventions were our main goals for now and so sustainable forth.

Figure 1. Bursa Leather Park

METHODOLOGY

Nowadays, as a key sector, leather industry has a new challenge to deal with: to minimize its environmental impacts by evaluating throughout the production process under a new point of view, that is, detecting inefficiencies and discovering that an additional economic benefit can also be achieved by reducing pollution generation. Expensive end-of-pipe treatment and retrospective clean up should be overcome and complemented with pollution prevention measures in order to reduce costs and risks, and gain competitiveness.

There is one practical and reasonable approach for low level waste (LLW) in any industry; that is, waste minimization at source. Minimization is so applicable in the process in-line and source reduction practices reduce or eliminate waste generation. So it comprises environmentally sound recycling practices. This minimization at source and internal recycling as priorities leads to product and process redesign, adopt new technologies and good housekeeping.

With this respect, our work was to suggest a set of recommendations to subsidize the practitioners in implementing initiatives promoting environmentally friendly measures to be adopted. It includes environmentally viable methods to practice in-line and to modify it according to the analytical results. We focused on beamhouse processes and traced back to the process parameters considering the analyses.

A process recipe was set by some preliminary trials and after some modification it was incorporated into a guideline for any private company to use their own chemicals. According to the properties of chemical used and treatments, the variables such as water, liming auxiliary, reductive surfactant, enzyme (keratinase), sodium hydrosulphide, sodium sulphide and lime were studied. The variables applied in the designed recipe, their impacts and the remarks are seen in Table 1. Process guidelines for both conventional and eco-recipe were provided in Table 2 and Table 3. Soaking, immunization and liming processes were applied in one-bath with eco-friendly way to reduce the process water.

Table 1: Variables, impacts and remarks of the process

Variables	Impacts	Cautions
Water	Continuous phase in dispersion, appropriate mechanical action	Volume of pollution load, wrinkles along with increasing mechanical action.
Liming Auxiliaries	Good dispersion of primary lime and other particles	Good and appropriate swelling, clean-up of soluble materials and epidermal deposits.
Reductive surfactants	Improves loosening of epidermis, scud and the removal of natural pigment.	Allows a significant reduction of the sulfide and reduces pollution and alkalinity.
Keratinase	Degradation of soft keratin and loosening of hair root	Low COD, less sludge, reduced nitrogen.
Sodium hydrosulphide	Milder effect on break-down of disulfide bonds (S-S) of cystine causing keratin degradation	Increases the pH, alkalinity. Total destruction of keratin and thereby increased sulphide and soluble colloids in effluent.
Sodium sulphide	Stronger break-down of disulfide bonds (S-S) of cystine causing keratin degradation	Increases the pH, alkalinity with high swelling and veinness. Increased sulphide and soluble colloids in effluent.
Calcium hydroxide	Opening-up and Collagen hydrolysis	Relaxed leathers with loosened grain, necks' and shanks' wrinkles. Collagen fibers become finer and shorter, which allows obtaining emptier leathers.

Table 2: Basic recipe for soaking and liming process

Process	Chemicals	Percentage (%)	Temp (^{0}C)	Run (Min.)	Stop (Min.)	Remarks
Pre-soaking	Water	300	26			2 rpm
	Soda ash	0.2				
	Bactericide	0.1				
	Surfactant	0.2		30 30	30 40	Dirt and dung removal
Soaking	Water	200	26			1.5-2 rpm
	Surfactant	0.8		30 30 30 120	30 30 30	
	Bactericide	0.1		60	40	Drain
	Water	200	26	60		Drain
Liming	Water	200	26			
	Sodium sulphide	1.5				
	Lime	6.0		30		
	Sodium sulphide	1.5		30		2 min/60 min T: 14 hour
	Water	10	26-27	60		Hairs and epidermal residuals removed

Table 3: Eco-friendly designed recipe

Process	Chemicals	Percentage (%)	Temp (^{0}C)	Run (Min.)	Stop (Min.)	Remarks
Pre-soaking	Water	100	26			1.5-2 rpm
	Soda ash	0.2				
	Bactericide	0.1				
	Surfactant	0.1		20 30	30 40	Dirt and dung removal
Soaking	Water	100	26			1.5-2 rpm
	Surfactant	0.5				
	Degreasing agent (Non-ionic emulsifier)	0.2		30 180	40	
	Soaking enzyme	0.3		20		
	Reductive auxiliary	0.3-0.4		60		
	Bactericide	0.1		60	40	Entirely soaked
Immunization	Soda ash	0.3-04		60		
	Sodium sulphide	0.1				
	Reductive auxiliary	0.15-0.20	26.5	60		Loosening of pulp. 4 Be’, pH:9.5 If necessary drain well and add 50% water
Liming	Liming auxiliary	0.7-1	26-27			
	Enzyme (Keratinase)	0.4				
	Non-ionic emulsifier	0.3-0.4		60		
	Lime	1.0				
	Sodium hydrosulphide	1		90		
	Lime	0.5				
	Sodium sulphide	0.4		60	60	
	Lime	0.5				
	Sodium sulphide	0.4				
	Lime	0.5		40	60	5 min/30 min T: 12 hour
	Water	40		60		Hairs and epidermal residuals removed

Studies were performed in the factories which are active in Bursa Leather Park. After conventional and new designed processes, analyses of electrical conductivity according to SM 2510 B standard process, total suspended solids (TSS) to TS EN 872, total dissolved solids (TDS) to SM 2540 C, chemical oxygen demand (COD) to SM 5220 B, oil & grease to SM 5220 C and total Kjeldahl nitrogen (TKN) to SM 4500 Norg B were applied in the wastewaters. Moreover, total sulphide and total chromium analyses were carried out in equalization tank with SM 4500-S-2 D and ISO 11885 methods, respectively. Thus, how pollution load changes with the new production way in the industrial zone and performance assessment of green practices in liming process was evaluated.

RESULTS AND DISCUSSION

Water is crucial for life and also used in many industrial processes and the industrial sectors take up an average of 22% of the globally used water. With regard to the increasing concern with environment and sustainability, it is vital that natural sources should be inherited to next generations. Leather industry is one of the primary sector with a high water usage and such excessive usage, resulting from adoption of traditional processing methods and equipments lead to acute water availability and effluent treatment problems [15].

Leather industry worldwide is recognized as a serious environmental threat due to its own pollutive potential including salinity, organic load (chemical oxygen load or demand, biological oxygen demand), inorganic matter, dissolved, suspended solids, ammonia, total kjeldahl nitrogen (TKN), specific pollutants (sulfide, chromium, chloride, sodium and other salt residues) and heavy metals etc. [16]. A part of the leather processing, solid and gaseous wastes are also discharged into the environment. Among the numerous phases of the tanning process, the beamhouse phase represents 83% of the BOD_5, 73% of the COD, 60% of the suspended solids, 68% of the salinity and 76% of the total polluting charge produced during the manufacturing process of hides. Besides, in the beamhouse, the traditional unhairing process with sodium sulfide and lime is responsible for most pollution. Consequently, the development of an alternative unhairing process, characterized by a lower environmental impact than the traditional, represents a priority in the leather research field.

Liming involves the use of alkaline medium (e.g. lime) to condition raw hides and skins. The aim is to remove the hair, flesh and splitting up of the fibre bundles by chemical and physical means [17, 18]. The process not only removes epidermal structures; but also brings about the removal of non-structural protein of the pelts by a certain swelling and plumping. As the term implies leather is made or marred during liming. So, the process modifies the skin fibre for subsequent penetration of other processing chemicals such as tannins and other leather building auxiliaries. Hence; since 1880s neither the process was changed nor improved because of refraining from low quality characteristics. However, the use of this chemical combination generates large volumes of waste that constitutes major source of pollutants amounting to more than 65-70% in combined tannery effluent [19, 20]. Its effluents composed of both organic, inorganic matter and containing metals make the treatment very complicated and expensive. If this wastewater is not properly treated before discharge it may adversely affect the ecology of agricultural land.

Parameters and properties of the conventional process wastewater before the betterment studies were provided in Table 4. Table 4 also shows the analytical results after betterment studies, betterment ratios were given compared to the conventional process.

Table 4: Parameters and analytical results from the process wastewaters and betterments

Parameters	Conventional process results	Results after betterment studies	Betterment ratio
Conductivity (mS/cm)	73	59	19.17%
TSS (mg/L)	31,520	24,660	21.76%
TDS (mg/L)	69,768	64,960	6.89%
COD (mg/L)	58,984	38,976	33.92%
Oil/Grease (mg/L)	650	565	13.07%
TKN (mg/L)	3,417	2,927	14.34%

Indicated results from equalization tank before and after betterment studies were provided in Table 5. Results after betterment studies and conventional process were compared. Betterment ratios were calculated according to the differences of the values between conventional process and eco-friendly designed process.

Table 5: Indicated results from equalization tank before and after betterment studies

Parameters	Conventional process results	Results after betterment studies	Reference values	Betterment
Conductivity (mS/cm)	11.71	8.16	8	30.32%
TSS (mg/L)	2,867	1,950	3,000	31.98%
COD (mg/L)	4,998	3,356	5,500	48.92%
Oil/Grease (mg/L)	320	254	668	20.63%
TKN (mg/L)	389	358	120	7.97%
Sulphide (mg/L)	110	82	95	25.45%
Total chromium (mg/L)	138	77	100	44.2%

Liming has utmost sensitivity. It is the key process of the leather production and directly affects the final leather quality. In case small changes in the process are not applied in a proper way, next processes are not carried out as they should be and leather can be destroyed. That is why, the industrial players never give up from the conventional ways for this process. Different applications as less water utilization, keratinase applications, minimum chemical dosages etc. make the process highly risky. In our study, this vital conditions have been taken into consideration and variables have been conscientiously selected with the sensitive works.

Results showed the considerable betterments after our eco-designed recipe. The highest enhancement in process wastewaters and equalization tank was provided on COD levels. Conventional process had 58,984 mg/L and results after eco-friendly applications were 38,976 mg/L in COD with 33.92% betterment ratio. This ratio was 48.92% in equalization tank with 4,998 mg/L and 3,356 mg/L COD levels, respectively. Table 5 indicated that all the parameters related to pollution load were reduced under the reference values. TSS, TKN, sulphide, oil/grease and total chromium results showed the satisfactory betterment grades with the acceptable distances to the limitations. Only conductivity was over the reference value, but it was also decreased from 11.71 mS/cm to 8.16 mS/cm.

In addition, not only these parameters decreased but also the wastewater treatment charge and the transport charge for tannery sludge was also reduced. Moreover, tons of wastewater and pollution load will be minimized in the industrial zones by less usage of process water and less dosage chemicals via eco-designed recipe. Filtration application was not applied in our study, but in case of this application as well, betterment attained would be much higher than the current case. Our studies are going on the filtration applications for the process and channel waters.

CONCLUSIONS

Tanning industry produces a significant amount of solid wastes and effluents. As a well-known fact, while removing undesired substances and ingredients out of the structure and isolation in leather processing and thereby; facilitating the reactions between chemicals and skin/hide protein, its pollution load is final and highlighted agenda which needs to be overcome by introducing sustainable cleaner technologies. Novel and environmentally friendly techniques and processing ways for leather industry were highly demanded and forced by the governments after strict environmental stipulation norms. Our study provided the minimized pollution load for leather industry by creating eco-friendly designed process. Cleaner processing attempts, available techniques and eco-compatible interventions will generate the sustainable future for the industry.

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PLANTAR PRESSURE ANALYSIS OF VOLLEYBALL PLAYERS BASED ON GAIT FEATURES

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PLANTAR PRESSURE ANALYSIS OF VOLLEYBALL PLAYERS BASED ON GAIT FEATURES

ABSTRACT. Due to long-term intense training, volleyball players are more likely to suffer from high pressures in some places of the sole than ordinary people. Sustained exposure to such a high pressure will lead to foot eversion/inversion and different degrees of sports injuries, posing a serious threat to the sports career. Gait features have long been recognized as a major impactor of plantar pressure, but have not been applied to analyze the plantar pressure of volleyball players. To make up for the gap, this paper introduces gait features to the plantar pressure analysis of volleyball players. Professional volleyball players and ordinary people were separately allocated to the test group and the control group, and subjected to contrastive test. The gait features were recorded by a special device. On this basis, the author analyzed the plantar pressure collected in the test, trying to disclose the effects of gait features on plantar pressure and disease of volleyball players. The research results show that: (1) Volleyball players differ greatly from ordinary people in gait features; (2) The uneven distribution of plantar pressure is a major cause of plantar diseases of volleyball players; (3) Changing the gait features helps make the distribution of plantar pressure more uniform, and thus effectively control the risk of plantar diseases. This paper innovatively introduces gait features into the analysis on plantar pressure of volleyball players, and proves that plantar pressure distribution varies with gait features. Of course, gait features are not the only influencing factors of plantar pressure. The future research will explore the other factors that affect the plantar pressure of volleyball players.
KEY WORDS: Gait features, plantar pressure, sports injuries, volleyball

ANALIZA PRESIUNII PLANTARE LA JUCĂTORII DE VOLEI PE BAZA CARACTERISTICILOR MERSULUI

REZUMAT. În urma antrenamentelor intense pe termen lung, jucătorii de volei sunt mai susceptibili să sufere de presiuni mai ridicate în unele zone ale tălpii decât oamenii obişnuiţi. Expunerea susţinută la o presiune atât de ridicată va duce la eversiunea/inversiunea piciorului şi la leziuni sportive de diferite grade, reprezentând o ameninţare serioasă pentru cariera sportivă. Caracteristicile mersului au fost recunoscute de mult timp ca un factor important al presiunii plantare, dar nu au fost aplicate pentru a analiza presiunea plantară la jucătorii de volei. Pentru a compensa decalajul, această lucrare introduce caracteristicile de mers în analiza presiunii plantare la jucătorii de volei. Jucătorii de volei profesionişti şi oamenii obişnuiţi au fost împărţiţi în grupuri de test şi grupuri martor şi au fost supuşi unui test de contrast. Caracteristicile mersului au fost înregistrate cu un dispozitiv special. Pe această bază, s-au analizat valorile presiunii plantare colectate în test, în încercarea de a dezvălui efectele caracteristicilor mersului asupra presiunii plantare şi leziunilor jucătorilor de volei. Rezultatele cercetării arată că: (1) jucătorii de volei diferă foarte mult de oamenii obişnuiţi în ceea ce priveşte caracteristicile mersului; (2) distribuţia inegală a presiunii plantare este o cauză majoră a leziunilor la nivel plantar la jucătorii de volei; (3) modificarea caracteristicilor mersului contribuie la uniformizarea distribuţiei presiunii plantare şi, astfel, la controlul eficient al riscului de leziuni la nivel plantar. Această lucrare introduce în mod inovator caracteristicile mersului în analiza presiunii plantare la jucătorii de volei şi dovedeşte că distribuţia presiunii plantare variază în funcţie de caracteristicile mersului. Desigur, caracteristicile mersului nu reprezintă singurul factor care influenţează presiunea plantară. Cercetările viitoare vor explora alţi factori care afectează presiunea plantară la jucătorii de volei.
CUVINTE CHEIE: caracteristicile mersului, presiune plantară, accidentări sportive, volei

L'ANALYSE DE PRESSION PLANTAIRE DES JOUEURS DE VOLLEYBALL À PARTIR DES CARACTÉRISTIQUES DE LA MARCHE

RÉSUMÉ. Après un entraînement intensif à long terme, les joueurs de volleyball sont plus susceptibles que les gens ordinaires de subir des pressions plus fortes dans certaines zones de la plante du pied. L'exposition à une pression aussi élevée entraînera une éversion/inversion du pied et des blessures sportives à des degrés divers, représentant une menace sérieuse pour la carrière sportive. Les caractéristiques de la marche sont reconnues depuis longtemps comme un facteur important de la pression plantaire, mais elles n'ont pas été appliquées pour analyser la pression plantaire chez les joueurs de volleyball. Pour compenser cet écart, cet article présente les caractéristiques de la marche dans l'analyse de la pression plantaire chez les joueurs de volleyball. Les joueurs de volleyball professionnels et les gens ordinaires ont été divisés en groupes de test et en groupes de contrôle et ont subi un test de contraste. Les caractéristiques de la marche ont été enregistrées avec un appareil spécial. Sur cette base, les valeurs de pression plantaire recueillies lors du test ont été analysées afin de révéler les effets des caractéristiques de la marche sur la pression plantaire et les blessures des joueurs de volleyball. Les résultats de la recherche montrent que : (1) les joueurs de volley-ball diffèrent considérablement des gens ordinaires en termes de caractéristiques de marche ; (2) la répartition inégale de la pression plantaire est une cause majeure de blessure plantaire chez les joueurs de volleyball ; (3) la modification des caractéristiques de la marche contribue à l'uniformité de la répartition de la pression plantaire et, ainsi, à la maîtrise efficace du risque de blessures au niveau de la plante plantaire. Cet article introduit de manière innovante les caractéristiques de la marche dans l'analyse de la pression plantaire chez les joueurs de volleyball et prouve que la distribution de la pression plantaire varie en fonction des caractéristiques de la marche. Bien entendu, les caractéristiques de la marche ne sont pas le seul facteur influant sur la pression plantaire. Des recherches futures exploreront d'autres facteurs qui affectent la pression plantaire chez les joueurs de volleyball.
MOTS CLÉS : caractéristiques de la marche, pression plantaire, blessures sportives, volleyball

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INTRODUCTION

The foot is under greater pressure than any other organ in human body. During motion, different parts of the foot carry varied degrees of pressure. For an adult, the pressure on foot is on average 1.5 times the body weight when he/she is walking, and will grow to 3~4 times the body weight when he/she is running [1]. The pressure on foot, especially the plantar pressure, can reflect the motion state of the body. So far, plantar pressure has mainly been explored from the perspective of gait, which directly affects the distribution of plantar pressure [2]. Of course, the distribution is also influenced by many other factors [3]. By analyzing plantar pressure, it is possible to evaluate the healthiness of our gait, and prevent injuries in fitness programs and competitive sports. As a result, the distribution of plantar pressure has become the focal point of foot research, and a major concern in important fields like sports mechanics and rehabilitation.

Due to long-term intense training, volleyball players are more likely to suffer from high pressures in some places of the sole than ordinary people. Sustained exposure to such a high pressure will lead to foot eversion/inversion and different degrees of sports injuries, posing a serious threat to the sports career [4]. The threat is particularly high in the sport of volleyball, which requires frequent running and jumping.

Cappozzo (1995) conducted biomechanical analysis of athletes' sole with plantar pressure test system and infrared motion tracking system, revealing significant difference between landing and jumping in plantar pressure distribution [5]. However, the plantar pressure of volleyball players has not been analyzed specifically in the existing research on sports medicine, not to mention the relationship between gait features and plantar pressure or sports injury of volleyball players. To make up for the gap, this paper carefully measures and analyzes their plantar pressure and gait features of volleyball players, identifies the root causes of plantar pressure, and clarifies the relationship between gait features and sports injuries. On this basis, the author put forward suggestions on how to effectively protect the foot.

After exploring various types of sports, Riva *et al*. (2012) concluded that exercise fatigue affects gait, which in turn changes plantar pressure distribution, and that the fatigued gait is highly likely to cause sports injuries [6]. Schmid *et al*. (1997) discovered that gait is greatly affected by motion speed and intensity: the time and carrying capacity of each step change with the increase in motion speed and intensity, pushing up the plantar pressure [7]. Riva *et al*. explored the plantar pressure distribution of players in heel-and-toe walking, pointing out that the midfoot is critical to the body control and exertion. Schmid *et al*. compared athletes with and without knee joint injuries; the results show that injured athletes had more unfavorable distribution of plantar pressure, which comes from the incorrect gait.

METHODOLOGY

Subjects

A total of 47 subjects were selected, including 30 volleyball players and 17 ordinary people. The volleyball players and ordinary people were respectively allocated to the test group and the control group. The two groups were designed to observe the difference between volleyball players and ordinary people in gait features. The test group was further divided into two subgroups: a subgroup of 17 volleyball players with plantar diseases and a subgroup of 13 volleyball players without plantar diseases. The two subgroups help to disclose how the difference in gait features affects the plantar diseases of volleyball players. The 30 volleyball players were selected from a sports school. All of them have been engaging in the sport of volleyball for more than 5 years, and remain active in volleyball training or volleyball matches. The test plan has passed the ethics review by Xichang University (Review No.: 20171207235). The basic and injury conditions of the subjects are listed in Table 1.

Table 1: The basic conditions of the subjects

Groups	Number	Age (year)	Height (cm)	Weight (kg)	Sports life (year)	BMI (kg/m²)
Test group	30	22.47±1.29	197.21±2.46	85.47±11.41	8.25±1.12	19.1±0.89
(1) Injured	17	23.22±1.09	198.35±3.86	87.49±13.59	9.21±1.62	19.4±0.91
(2) Uninjured	13	21.95±1.87	176.26±2.52	84.32±6.78	7.23±2.52	18.9±0.54
Control Group	17	21.85±1.01	177.21±4.52	72.38±8.52	--	21.7±1.01

Test Equipment, Site and Procedure

The experimental equipment includes a plantar pressure tester, two cameras (with tripod) and one laptop. The experiment was carried out on in a quiet room (>40m²) with level ground. The main procedure consists of the following steps:

(1) Calibrate the plantar pressure tester;

(2) Set up the cameras and align them to the test area from two angles, make recordings and provide data for dynamic analysis;

(3) Provide adaptive training to the subjects on barefoot;

(4) The trained subjects walk forward at the normal speed, step on the plantar pressure tester with one foot, and then turn back and step on the tester with the other foot.

The gait data were collected on the afternoon of December 15, 2017. During the collection, each subject was asked to walk, run or jump for 10min in the collection area. The plantar pressure was captured by the tester, and the gait features were tracked by the cameras. After 10min, all collected data were imported to the computer for analysis on gait features and plantar pressure.

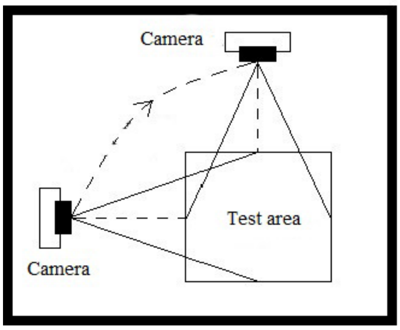


Figure 1. The test site

Division of Plantar Pressure Zones

Human foot has 26 bones, 33 joints and numerous muscles and ligaments [8]. These components form a complex structure that supports body weight, absorbs impact and maintains balance [9-10]. Most scholars have divided the sole into different zones before studying the plantar pressure [11-14]. As shown in Figure 2, the zones include the first toe (Zone 1: T1), the second to fifth toes (Zone 2: T2~5), the first metatarsal bone (Zone 3: M1), the second metatarsal bone (Zone 4: M2), the third metatarsal bone (Zone 5: M3), the fourth metatarsal bone (Zone 6: M4), the fifth metatarsal bone (Zone 7: M5), the midfoot (Zone 8: MF), the medial heel (Zone 9: HM) and the lateral heel (Zone 10: HL). All the above zones were discussed in our analysis.

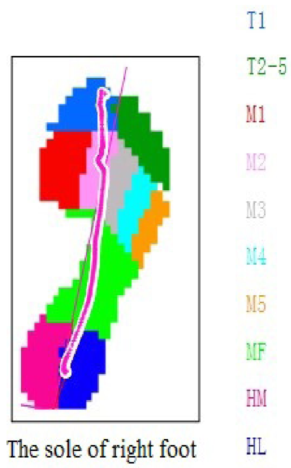


Figure 2. Pressure zones of the foot

EXPERIMENTAL RESULTS AND ANALYSIS

Analysis on Gait Features

The gait features of the test group and the control group are recorded in Table 2.

The data in Table 2 show obvious differences between the test group and the control group in the following gait features: percentage of support phase, step length, motion speed and the sagittal plane motion range of ankle. Compared with ordinary people, the volleyball players had large step length, fast motion speed, and large ankle motion range on the sagittal plane. In addition, the differences were still prominent after data normalization, indicating that they are related to the sports of volley rather than weight and height. Many scholars held that motion speed is positively correlated with the sagittal plane motion range of ankle. However, our experimental results show that the volleyball players had a smaller sagittal plane motion range of ankle, despite their faster motion speed, that is, a faster motion speed does not necessarily lead to a larger ankle motion range on the sagittal plane. This finding can be attributed to the significant different gaits between the players and ordinary people.

Table 2: Comparison between test group and control group in gait features

Parameters	Test Group (N=30)	Injured subgroup (N=19)	Uninjured subgroup (N=11)	Control Group (N=17)
Gait cycle (s)	1.04±0.08	1.02±0.09	1.07±0.09	1.01±0.08
Percentage of support phase (%)	59.32±1.19*	58.13±0.92*	59.96±1.11	63.02±2.06
Step length (m)	1.55±0.08*	1.58±0.09	1.52±0.16	1.24±0.17
Motion speed (m/s)	1.46±0.07*	1.47±0.08	1.44±0.05	1.26±0.15
Maximum knee flexion angle (°)	62.18±4.29	61.39±3.97	63.76±4.75	60.23±6.52
Sagittal plane motion range of ankle (°)	20.67±2.77*	20.63±2.32*	21.22±3.79	23.34±4.09
Sagittal plane motion range of knee (°)	58.75±3.74	57.99±4.03	60.32±3.24	58.87±5.98
Sagittal plane motion range of hip (°)	36.51±2.34	36.03±2.26	37.33±2.31	36.79±6.47

Note: The figures in the table are the mean values of the relevant parameters of each group; the mean values of relevant parameters of each group were compared by nonparametric estimation, and the parameters with significant difference between the two groups were marked with asterisk(s); *P<0.05 (Comparison between the test group and the control group).

It can be seen from Table 2 that the injured subgroup had a much smaller percentage of support phase than the uninjured group, revealing that the percentage should be reduced to control the further pressure damage on the injured parts. Moreover, the uninjured group exhibited a much larger motion range of ankle on the sagittal plane. This is consistent with the results of the comparison between the test group and the control group. The injured and uninjured groups had no major differences in step length and motion speed, which excludes step length and motion speed from the main causes of sports injuries.

Analysis on Plantar Pressure

The plantar pressures of the test group and the control group detailed in Table 3 below.

Table 3: The plantar pressures of the test group and the control group

Pressure zones of the foot (PSI)	Test group (N=30)	Control group (N=17)
Zone 1: T1	3.30±1.05	3.46±1.54
Zone 2: T2~5	0.86±0.53	0.79±0.33
Zone 3: M1	2.63±0.81	2.85±0.72
Zone 4: M2	3.37±1.63*	4.82±1.22
Zone 5: M3	3.36±1.21	3.90±1.36
Zone 6: M4	3.36±1.91*	1.78±0.35
Zone 7: M5	3.03±1.89*	1.23±0.59
Zone 8: MF	3.07±1.24	3.16±0.53
Zone 9: HM	4.62±1.34*	6.37±1.14
Zone 10: HL	4.82±1.12	4.94±1.12

Note: *P<0.05 (Comparison between the test group and the control group); To exclude the impact of weight on plantar pressure, all plantar pressures were the pressure per unit of plantar area calculated by the PSI method.

Comparing the results of the test and control groups, it can be seen that the plantar pressure of volleyball players was distributed evenly across metatarsal bones, but highly uniformly on the second, fourth and fifth toes and the medial heel. This phenomenon deviates far from the agreement among many scholars that the plantar pressure is distributed relatively evenly [15-18]. The deviation reflects the difference between volleyball players and ordinary people in plantar pressure distribution, owing to the special motions (dominated by running and jumping) in the sport of volleyball.

The plantar pressures of the injured and uninjured subgroups are given in Table 4 below.

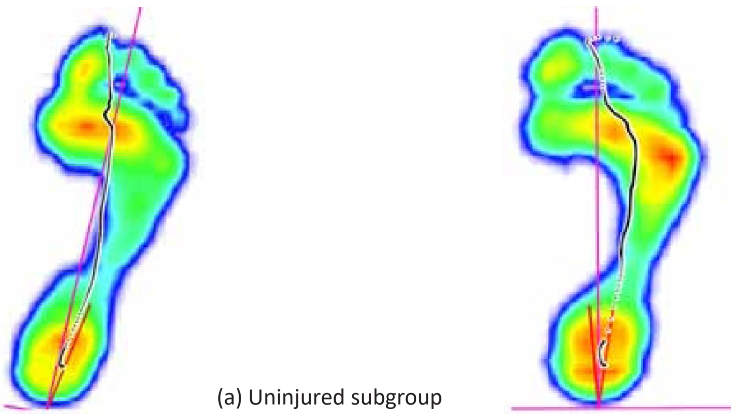
Table 4: The plantar pressures of the injured and uninjured subgroups

Pressure zones of the foot (PSI)	Injured subgroup	Uninjured subgroup
Zone 1: T1	3.06±1.10	3.73±1.08
Zone 2: T2~5	0.99±0.58*	0.63±0.31
Zone 3: M1	1.91±0.95*	3.88±1.21
Zone 4: M2	2.38±0.97*	5.07±1.01
Zone 5: M3	3.77±1.06*	2.64±1.17
Zone 6: M4	4.94±1.21*	1.62±0.45
Zone 7: M5	4.19±1.37*	1.03±0.35
Zone 8: MF	3.41±1.27*	2.47±0.94
Zone 9: HM	4.35±1.28	5.08±1.36
Zone 10: HL	4.91±1.00	4.67±1.34

Note: Compared with the control group *P<0.05; To exclude the impact of weight on plantar pressure, all plantar pressures were the pressure per unit of plantar area calculated by the PSI method.

The injured subgroup suffered from much greater pressure in the second to fifth toes, the fifth metatarsal bone and the midfoot than the uninjured subgroup, and much smaller pressure in the first and second metatarsal bones. The plantar pressure distributions of the two subgroups were plotted into pressure maps (Figure 3), where the orange and red areas indicate high pressure and the green area indicate low pressure. It is generally believed that, the greater and more unevenly distributed the plantar pressure, the higher the risk of sports injuries. In particular, an extremely high pressure often results in arch collapse. These ideas were confirmed by our research results.

Besides the difference in plantar pressure distribution, the injured and uninjured subgroups differed greatly in the gravity pressure line. As shown in Figure 3, the gravity pressure line of the injured subgroup was closer to the peripherals of the sole than that of the uninjured group. This demonstrates a defect in the gait of the subjects in the injured subgroup: in most cases, the external contour of the foot is the main place to withstand pressure. The outward shift in gravity pressure line can also be considered as a sign of protective compensation: the plantar pressure distribution of the injured subgroup reflects the adaptation to the injury; with the shift in gravity pressure line, the lateral of foot starts to carry more pressure, thus reducing the load on the injured places.



(a) Uninjured subgroup (b) Injured subgroup

Figure 3. The gravity pressure lines of the injured and uninjured subgroups

The above differences in plantar pressure were well demonstrated in the plantar pressure curves of Figures 4 and 5. These curves were plotted based on the mean plantar pressure of all members in each group. To exclude the impact of weight on plantar pressure, all plantar pressures were the pressure per unit of plantar area calculated by the PSI method. Specifically, the pressures on the first and second metatarsal bones of the injured subgroup were much smaller than those of the injured subgroup, as evidenced by the decline in curve peaks. In all other zones, the injured subgroup exceeded the uninjured subgroup to different extends in pressure (curve peaks). The pressure growth was particularly obvious on the fourth and fifth metatarsal bones.

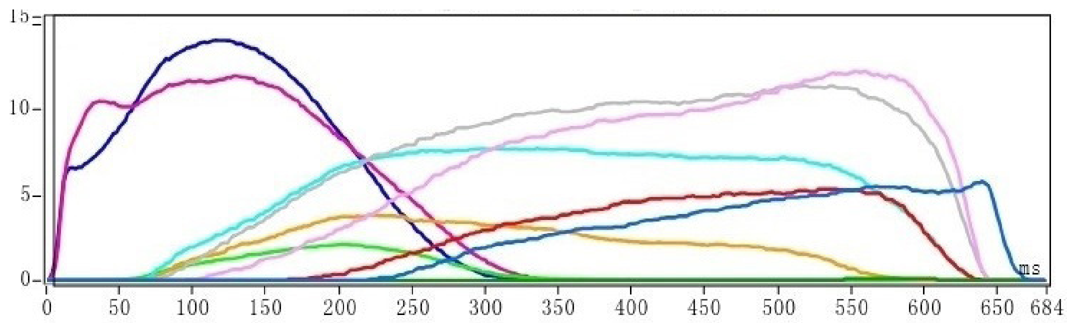


Figure 4. The plantar pressure curve of uninjured subgroup

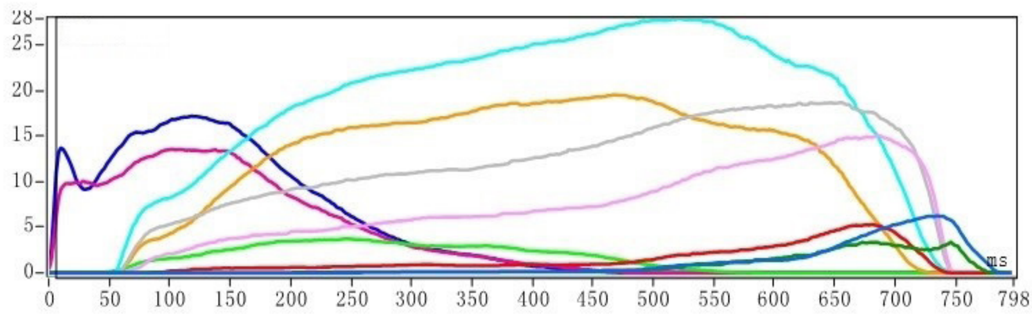


Figure 5. The plantar pressure curve of injured subgroup

SUMMARY

Through the comparative analysis above, it is clear that the plantar pressure distribution of volleyball players has a close correlation with their gait features. Due to the unique gait features, the plantar pressure of volleyball players differs greatly from that of ordinary people, increasing the risk of sports injuries. The volleyball players have significant differences in both gait features and plantar pressure distribution from ordinary people. Moreover, injured volleyball players differ greatly in plantar pressure distribution with uninjured ones.

CONCLUSIONS

Volleyball players are much more likely to get injured than ordinary people, due to their unique distribution of plantar pressure. However, the existing studies have not fully analyzed the causes of the difference between volleyball players and ordinary people in plantar pressure. Neither have they understood if excess plantar pressure could cause foot injury of volleyball players. The lack of relevant research makes it difficult to provide proper measures to prevent foot injury of volleyball players. For the first time, this research introduces gait features into the analysis on plantar pressure of volleyball players, and discloses the root causes of the difference between them and ordinary people in plantar pressure. The author pointed out that, to reduce the risk of sports injuries, the volleyball players should ease their plantar pressure by adjusting gait. The main conclusions are as follows:

(1) Compared with ordinary people, volleyball players have large step length and

fast motion speed, but small range of ankle on the sagittal plane. These are the unique gait features of volleyball players, which leads to the uncommon plantar pressure distribution.

(2) The injured volleyball players have more uneven distribution of plantar pressure than the uninjured. In addition, the plantar pressure of the injured players is borne in areas closer to the peripheral of the foot than that of the uninjured, as evidenced by the outward shift of the gravity pressure line. These results may be attributed to the protective compensation, an adaptive response of the injured players.

(3) The gait features directly bear on the plantar pressure distribution of volleyball players. To effectively reduce the injury risk, the plantar pressure should be distributed more evenly by adjusting the gait features (e.g. avoiding toe-in gait, toe-out gait and foot eversion).

(4) The main contribution of this paper is as follows: For the first time, it is proved that volleyball players have different gait features from ordinary people, and that the special gait features affect the plantar pressure distribution of these players. It is also demonstrated that injured volleyball players differ with non-injured ones in gait features and plantar pressure. The results indicate that gait features are an important cause of injury among athletes. On this basis, the author concluded that it is possible to reduce the occurrence of foot injury among volleyball players by adjusting their gait features.

(5) On limitations, this paper mainly focuses on how volleyball players are affected by gait features and the resulting changes in plantar pressure. In fact, the gait features are not the only influencing factor of the plantar pressure distribution of volleyball players. For example, the various rhythms of steps and techniques of jumping/landing required for volleyball playing may also increase the plantar pressure and cause injuries. The future research will explore other influencing factors of excessive plantar pressure of volleyball players, put forward targeted countermeasures, and verify if gait features could affect the plantar pressure and injury occurrence of players in other sports.

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Used rubber was the main material used to prepare training tennis 18ZB0547.

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A UNIFIED TECHNOLOGY OF CRUST LEATHER PRODUCTION USING POLYMERIC COMPOUNDS DEVELOPMENT

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A UNIFIED TECHNOLOGY OF CRUST LEATHER PRODUCTION USING POLYMERIC COMPOUNDS DEVELOPMENT

ABSTRACT. Nowadays there is a considerable deficit of extractive, material and energy resources. Thus, there is a topical issue of creating, developing and application of ecologically friendly, resource-saving technologies of natural leather development, using modern materials, which are able both to replace toxic reactive chemicals, fully or partially, and maintain the high quality of products. We have developed a standardized technology of crust leather production regarding the tanning and crusting processes, using ecologically friendly polymeric compounds of the new generation. This technology provides a more sustainable use of leather raw materials and chemicals, decreasing the processing length and environmental harm.

KEY WORDS: crust leather, standardized technology, tanning, crusting processes, polymeric compounds

O TEHNOLOGIE UNIFICATĂ DE FABRICARE A PIELII CRUST UTILIZÂND DEZVOLTAREA COMPUȘILOR POLIMERICI

REZUMAT. În prezent, există un deficit considerabil de resurse extractive, materiale și energetice. Astfel, există o problemă de actualitate privind crearea, dezvoltarea și aplicarea tehnologiilor ecologice, care să ducă la economisirea resurselor pentru fabricarea pielii naturale, folosind materiale moderne, care sunt capabile să înlocuiască integral sau parțial substanțele chimice reactive toxice și să mențină calitatea ridicată a produselor. S-a dezvoltat o tehnologie standardizată de producție a pielii crust cu privire la procesele de tăbăcire și prelucrare a pielii în stadiul crust, folosind compuși polimeri ecologici din noua generație. Această tehnologie oferă o utilizare mai durabilă a materiilor prime și a substanțelor chimice în prelucrarea pielii, reducând durata prelucrării și prejudiciul adus mediului.

CUVINTE CHEIE: piele crust, tehnologie standardizată, tăbăcire, procese de prelucrare a pielii crust, compuși polimerici

LE DÉVELOPPEMENT DE LA TECHNOLOGIE UNIFIÉE DE LA PRODUCTION DU CUIR EN CROÛTE EN UTILISANT DES COMPOSÉS POLYMÈRES

RÉSUMÉ. Il existe actuellement un déficit considérable de ressources extractives, matérielles et énergétiques. Ainsi, il y a un problème actuel concernant la création, le développement et l'application de technologies de développement du cuir naturel respectueuses de l'environnement et de l'économie, utilisant des matériaux modernes et capables de remplacer totalement ou partiellement les produits chimiques toxiques et réactifs, et de maintenir la haute qualité des produits. Nous avons développé une technologie standardisée de production de cuir en croûte en ce qui concerne les étapes de tannage et de finissage liquide, en utilisant des composés polymères écologiques de la nouvelle génération. Cette technologie permet une utilisation plus durable des matières premières et des produits chimiques pour le cuir, réduisant ainsi la durée de traitement et les dommages environnementaux.

MOTS CLÉS : cuir en croûte, technologie unifiée, tannage, finissage liquide, composés polymères

INTRODUCTION

Natural leather products have been in high demand for centuries due to such crucial properties as durability, reliability, excellent hygienic properties and attractive visual appearance. To ensure that products had these properties, common leather production technologies applied lengthy leather processing procedures and made extensive use of a range of chemicals, including harmful ones for the environment (e.g. sulphides, mineral and synthetic tanning agents, surface-active substances, dyes, organic solvents etc.) [1-3].

Natural leather is a product of consequent changes and transformations of collagen fibrous structure (collagen is a basic protein of animal skin) [4-5] when running various physico-chemical processes and mechanical operations. Distinctive polyfunctional collagen structure allows to purposefully transform its structure during technology processing, influencing the product's (leather) functional performance and quality level.

Ecological safety of natural leather is a complex index. It ensures the absence of harmful impact on a human and the environment during the production, exploitation and disposal of goods. Technology processes of leather production play an important part in assuring the safety of leather materials. Sustainability of these processes means a clear understanding of collagen structure, justified choice and use of chemicals, minimizing waste and the amount of discharged water [6, 7].

Collagen structure constantly changes during technology processes. This means the destruction of existing links or the formation of new ones, as well as formation of spatial structure and properties of the derma [8]. Tanning plays a very important part here. Tanning is characterized by resistance to high temperature (hydrothermal resistance), microorganisms, shrinking (decreasing of the area), as well as an increase in porosity and its fixation when drying, increase in durability, elongation and deformability [9]. Nowadays 80-90% of common leather production technologies involve tanning with chrome compounds, and extra after-tanning derma structure formation takes place with the help of vegetable tanning agents and those of synthetic origin. Chrome tanning agent use provides excellent physico-mechanical and hygienic properties of natural leather with an appropriate level of hydrothermal and biological resistance [9]. Although tanning is one of the most important processes of leather production, it cannot be considered fully sustainable. This is due to the fact that chrome compounds in solutions are not completely absorbed: approximately 40% of chrome compounds end up in discharged water, which means it needs extra purification. Other drawbacks of chrome tanning are the problem of chrome-containing waste, non-constant properties of chrome compounds during continuous storing, a possible formation of hexavalent chrome. They try to overcome these drawbacks with the help of partial replacement of chrome compounds with other mineral or organic tanning agents, optimizing tanning parameters, multiple uses of tanning solutions, introducing masking off alkali reactive chemicals etc. Taking chrome compounds toxicity into account, there has long been systematic scientific and technological research on replacing these reactive chemicals with more ecologically friendly ones. Despite many works being written in this area of research [10-16], this kind of research is still topical due to the wide assortment of leather materials available.

Crusting processes are aimed at capillary-porous structure fixation of raw material being tanned. Despite the fact that the range of chemicals available for retanning, filling, fatting and dying is wide enough in terms of quantitative and qualitative indices, it is their combined and consecutive administration into one hydraulic liquid that allows for more sustainable use of water and effective bonding with collagen. Such an approach determines a decrease in environmental harm level and quality condition of industrial sewage after dying-fatting processes [10-16].

Thus, natural leather production is a complex technology process, based on numerous consecutive raw material and semi-finished product processing. Various chemicals and substances, which are not completely safe, neither for the environment nor for a human, are used at each stage of a technology cycle. However, the fact that their use is inevitable means the need for more effective impact on the derma structural changes, as well as for reaching high functional performance and quality indices.

Chemicals being used and technological peculiarities of their use determine the safety level of natural leather during their whole life cycle: from production to consumption and utilization. Hence, the analysis of ecological aspects of leather production and of innovative technologies of harmful environmental impact reduction allows us to introduce the guidelines on the formation of safe natural leather for a modern consumer. The research done in this paper is devoted to these issues.

EXPERIMENTAL

Materials and Methods

IR-Spectroscopic Method

We have used an IR-spectroscopic analysis done with a TENSOR 37 spectrophotometer (Brucer, Germany) [17-19] to find the optical density of absorption bands and to identify functional groups of polymeric compounds.

Colorimetric Method

We have used a spectral optical device ULAB 102UV (China) to find the content of chrome compounds in exhausted solutions. Its spectral range of visible and ultraviolet radiation is 200-1000 nm; the tolerance of the transmission ration is ±0.1%; the tolerance of the determination of the wave length is ±1.5 nm. The operational principle is based on the determination of the optical density of the absorption of thermal radiation of transparent solutions, taking into account the typical wavelength of the substance under study [20].

Microscopical Method

The impact of chrome-polymeric tanning on the change of the supramolecular structure of the derma collagen and the way of sedimentation of the chrome tanning agent in the supramolecular structure have been studied with the help of scanning electronic microscopy (SEM) using the device JSM-6490-LV, GEOL (Japan). This method is based on the study of the microobject surface structure by analysing the reflected "electronic image", which helps to monitor the structural elements peculiarities on the atomic-molecular level with high resolution of 1-5 nm ($\times 10$-$\times 10^{-5}$) [21].

Crust Leather Properties Study Methods

Physico-mechanical trial runs and the chemical analysis of the Crust leather have been done using the official IULTCS methods: sampling location (ISO 2417:2016), sample preparation and conditioning (ISO 2419:2012), shrinkage temperature (ISO 3380:2015), strength of surface (ISO 3379:2015), strength and percentage extension (ISO 3376:2011), apparent density (ISO 2420:2002), measurement of thickness (ISO 2589:2016), measurement of area (ISO 11646:2014), determination of tear load (ISO 3377-1:2011), water vapour permeability (ISO 14268:2012).

Reliability of the empirical data obtained is proved by the methods of mathematical statistics (average quadratic variation, multi-criteria generalized objective function Yg) [22]. The margin of error of the test when studying physico-mechanical properties was at most 5%, the one of chemical composition indices was at most 3%.

The Study of Physico-Chemical Properties of Sustainable Polymeric Compounds

Nowadays polymeric compounds play the most important part in natural leather production. They can be used effectively in liquid physico-chemical processes to form the structure and the most important properties of the derma [23-29]. Polymeric compounds include modern polymers based on unsaturated maleic and acrylic acids, which are able to interact with collagen and other materials, common in the production, such as tanning compounds. These acids are also capable of shortening the process cycle, providing a high level of work solution exhaustion, thermal stability, durability and plastic-elastic leather properties [30-32].

In order to develop the universal resource-saving production technology of the Crust leather of chrome-polymeric tanning we have used a range of modern polymeric compounds, which are the certified products of CODYECO S.p.A. company (Italy). They are the derivates of unsaturated maleic (*MA*) and acrylic (*AA1, AA2)* acids. They are non-toxic, highly water-soluble and resistant to the activity of anionic electrolytes [33]. Their structure includes alkanes, alkenes, reactive carboxylic and hydroxylic groups etc.

To replace pickling by polymeric processing, we first studied the effect polymers (unsaturated carboxylic acids derivates) have on the properties of the abated pelt. Processing parameters are the following: polymers consumption (products *MA*, *AA1* and *AA2*) 2.0% of the pelt mass, the temperature is 36-38 °C, the duration is 1.5 hours. The pH level of solutions was for *MA* 6.6, for *AA1* – 5.3, for *AA2* – 4.5, for chrome tannin – 3.0. The control group specimens have been pickled before tanning. The test showed that after polymeric processing hydrothermal resistance of the pelt rose by 2-5 °C, while the tanning process duration fell by 2 times (figure 1). The results obtained can be explained with the effect created by processing conditions, the manner of sedimentation in the collagen structure of the reactive chemicals applied, and the manner of collagen structuring. Due to its chemical nature and physico-chemical properties, polymeric compounds are capable of influencing the tanning process, the structure formation and the Wet-Blue parameters. Taking the data obtained into account, we have conducted further research into the patterns of pickling-free chrome-polymeric tanning using this polymeric material.

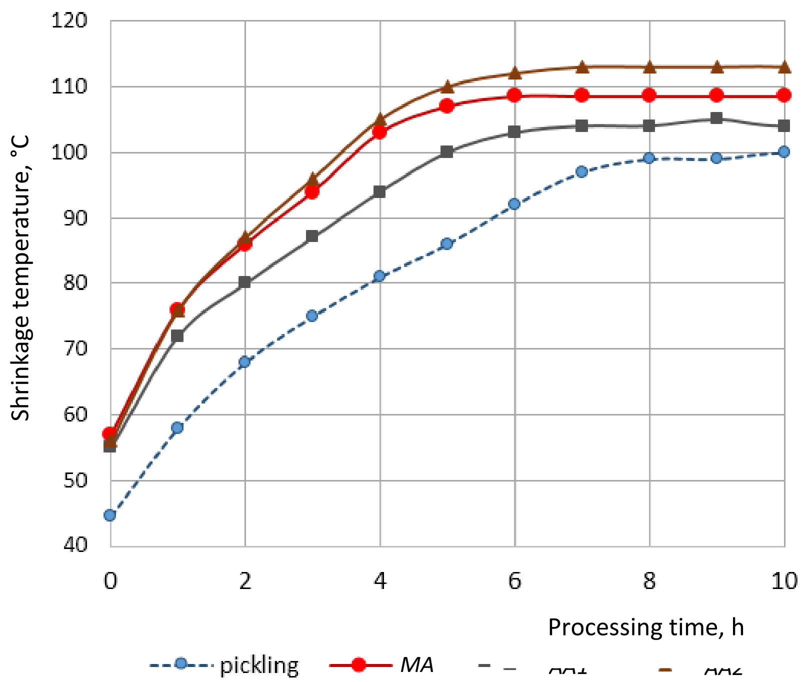


Figure 1. Influence of pretanning treatment on the dynamics of shrinkage temperature changing

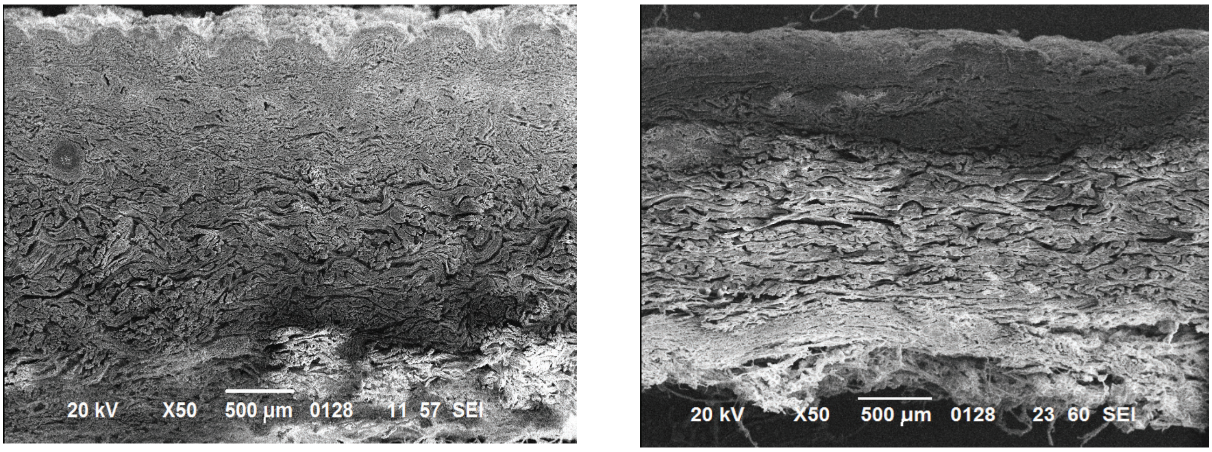
RESULTS AND DISCUSSIONS

Research on the Process of Pickling-Free Chrome-Polymeric Tanning

We have found that as compared with the common chrome-pickling technology, pickling-free chrome-polymeric tanning using the product *AA2* allows us to lower the consumption of chrome tanning agents by 25%, as well as improve consumer properties and cutting qualities of the finished leather product. In addition, durability limit increases by 13.0%, the yield of thickness - by 4.2%, vapour permeability by 2.0 times, the yield of area by 1.5%, grade of quality by 0.5 %. Furthermore, as a result of decreasing the tanning process length by 2.5 times and decreasing the chrome compounds content in discharged chrome-containing solutions by 2.0 times, as well of lowering the content of sulphates by 1.5 times, chlorides by 1.2 times, BOD_5 by 2.0 times, COD by 1.2 times the ecological and energetical load on the environment also goes down [34].

In order to find how polymeric processing influences the structure formation and a tanning agent spread uniformity in the structure of the semi-finished product Wet-blue we have applied scanning electronic microscopy during the experiment.

The figure *2a* shows, that the manner of interlacing of collagen bundles is weak to be noticed on the semi-finished product of chrome-pickling tanning cross-section. Moreover, the voids distribution in the cross-section area is uneven. The uneven distribution of the collagen secondary fibers (bundles) is connected with uneven diffusion of the chrome tanning agent in the derma. In the microphotos of the cross-section of the semi-finished product of the chrome-polymeric tanning we have found a more dense structure. This could be the result of creating more favourable conditions for the diffusion and fixation of tanning chrome compounds in the derma when using polymeric compounds (figure *2b*). Further analysis of the semi-finished product (chrome-polymeric tanning) cross-section microphotos showed more even spread of collagen fibers bundles and more distinct uniformity of interfascicular spaces location in the derma.



a *b*

Figure 2. Microphotos or the derma cross section:
chrome-pickling (*a*) and chrome-polymeric tanning (*b*)

The microscopic research done on the microstructure of the derma of the semi-finished product of the chrome-pickling tannage shows that the combined use of polymeric and tanning chrome compounds improves diffusion and the uniformity of the tanning agent spread in the derma. This, in turn, must have a positive impact on the structure formation and the properties of the leather semi-finished product and the finished leather product.

Crusting Processes Development for the Chrome-Polymeric Tanned Leather Using Polymeric Compounds

The aim of this stage of our study is to find the opportunity to use the polymeric compounds under study during crusting processes. During this test we have used the leather semi-finished product of the chrome-pickling tanning, which has the following properties: the shrinkage temperature is 123 °C, the mass content of humidity is 33.9 %, the mass content of chromium oxide is 5.8% (per completely dry substance), the average thickness is 2.2 mm. The liquid finishing has been performed using the following procedure [35] and the following scheme: washing-neutralization-washing-polymeric processing-dying-fatting-retanning. In addition, the polymeric processing has been performed before dying and using a polymeric compound in the form of *MA* product. The processing conditions (or parameters) are given in the (table 1).

Table 1: Liquid finishing conditions of the semi-finished product of the chrome-pickling tanning

Group	Consumption, %			Temperature, °C
	MA	anionic brown	quebracho tannins	
1	6.0	2.0	2.0	50
2	1.0	2.0	2.0	50
3	6.0	1.0	2.0	50
4	1.0	1.0	2.0	50
5	6.0	2.0	2.0	30
6	1.0	2.0	2.0	30
7	6.0	1.0	2.0	30
8	1.0	1.0	2.0	30
Control	–	2.0	4.0	40

There have not been any complications when using polymeric processing before dying. The finished leather had distinct appearance, as the surface was dyed evenly, they were also soft to the touch, filled, they had pleasant feel. Moreover, we have found that the dye penetrated the derma more deeply.

The results of physico-chemical tests of the leather proved their high hydrothermal resistance (at least 125 °C), durability and excellent plastic-elastic properties, even spread of components in the derma structure. These factors influence positively the yield of area of the leather, as well as the even spread of the durability and elongation to different sides indices. This, in turn, promotes the cutting effectiveness (table 2).

Table 2: The influence of crusting processes using polymeric compounds on the crust leather of the chrome-polymeric tanning properties

Index	Group								
	1	2	3	4	5	6	7	8	Control
Tensile strength, MPa	27.9	30.4	30.6	26.0	19.8	21.2	22.0	22.4	26.6
Strength of surface, MPa	21.7	27.7	23.1	19.9	13.4	15.9	13.7	14.8	16.2
Percentage extension at 10 MPa, %	38.5	38.0	31.0	33.5	42.0	41.5	40.0	42.0	41.5
Porosity, %	45.5	50.0	53.9	51.0	55.4	54.6	54.0	47.1	42.1
Vapour permeability, %	925	73.9	87.1	62.3	94.2	88.3	85.2	78.5	69.5
Staining by dye, %	80.5	61.1	80.9	74.1	95.8	57.4	76.2	49.9	66.6
Yield of: thickness, %	99.0	100.0	92.8	91.5	100.0	92.5	91.0	94.4	92.1
area, %	93.4	96.7	96.7	93.5	91.8	88.6	94.7	93.4	93.3
volume, cm^3/100 g of protein	233	236	217	208	230	199	233	211	231
Generalized objective function Y,r	0.05	0.07	0.05	0.08	0.07	0.09	0.05	0.08	0.10

The positive influence of polymeric processing on other crust leather properties are also worth mentioning. For example, the following properties of the groups under study have been improved as compared with those of the control group: porosity (at 22.2%), relative vapour permeability (at 13.2%), the yield of thickness (at 3.3%), the yield of area (at 0.3%), tensile strength (at 8,1%) and strength of surface (at 37.4%). Despite the fact that the average volume yield of the specimens under test is lower by 4.5 % than that of the control group, its high level (199-236 cm^3/100 g of protein) means the well-formed derma structure as a result of combining the processes of polymeric processing and dying.

The search for the optimal combination of technology factors, which provides the necessary qualities of the chrome leather, have been conducted using the generalized objective function Y,r [23]. The smaller is the index, the better are the qualities of a leather semi-finished product under test. On the basis of the calculations made, we have found that the best leather qualities are formed under the following conditions (group 3): polymers consumption 6.0%, dye consumption 2.0%, the temperature of combined polymeric processing and dying 50 °C, quebracho tannins consumption during retanning 2.0% (Y,r = 0.05); in the control group this index is much worse (Y,r = 0.10).

The Unified Production Technology of the Crust Leather Development

All the natural leather production technologies are developed taking into account the aim of the product, and all the products need to undergo preparatory, pretanning-tanning, dying-fatting, drying-moisturising processes and operations, as well as the last, "finishing" stage. The latter means multiple application of the finishing coat on the leather, as well as fixation, pressing, embossment, cutting of the grain etc. The full finishing cycle limits the possibilities of further design and construction of products using modern methods of various technologies. It has to do not only with the complete finishing cycle but also with the impossibility to apply such methods of decoration as engraving, laser processing, painting, monogram, logo imprinting etc. Once the finishing coat is applied to the surface, it has a negative effect on the constructive elements of the corresponding equipment, because it litters the equipment with pigment and polymeric particles. Moreover, when painting or applying a monogram the dyes adhesiveness decreases due to the difference of film-forming agents, and the presence of wax or lacquer film.

Taking into account everything mentioned above, the topical task is to develop a unified technology of leather production excluding surface finishing, i.e. getting the crust leather material, which would make it possible to use this material when producing various goods of various designated use, both decorative and utilitarian. Finishing should be done using modern design methods and biogenous materials.

The results of the tests described above made us think about integrating the technologies of pickling-free chrome polymeric tanning and liquid finishing using polymeric compounds at tanning and dying stages (figure 3).

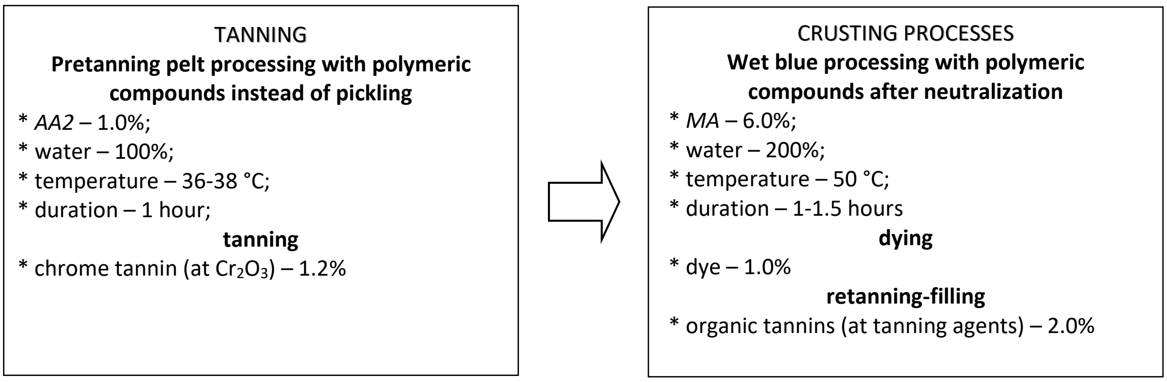


Figure 3. Unified resource-saving technology of the crust leather production using polymeric compounds

After the range of tests, done in laboratories and half-production conditions, we have developed a unified resource-saving technology of the crust leather production using polymeric compounds at the stage of tanning with chrome compounds and the liquid finishing stage (figure 3, table 3).

This technology provides not only the improvement of the quality parameters of leather products due to the more even spread of chemical reagents in the derma structure, increasing and more even spread in different directions of the durability and elongation indices, improving hygienic properties, colour uniformity at daylight, but also promotes the technology processes of tanning and crusting processes intensification, as well as decreases the ecological load on the environment due to more sustainable use of scarce mineral resources such as leather raw materials, dyes, mineral and organic tanning agents. The results obtained could be explained by the fact that the polymeric compounds under study are capable

Table 3: Comparative assessment of the crust leather production technologies

Index	Technology	
	unified	known (tannery"Chinbar"(Kyiv))
Duration of tanning, hours	4	10
Consumption, %: chrome tannin agent (tanning)	1.2	1.6
organic tannins (retanning-filling)	2	4
dye (dyeing)	1	2
Exhaution of chrome solution , %	85.0	73.4
Mass content, % (per completely dry substance) chromium oxide	5.0	4.8
substances, extracted with organic solvents	6.7	5.1
Shrinkage temperature, °C	125.5	124.0
Tensile strength, MPa	2.2	2.1
Strength of surface, MPa	1.8	1.5
Percentage extension at 10 MPa, %	38.5	39.4
Yield of: thickness, %	93.8	92.4
area, %	92.3	92.0
volume, sm^3/100 g of protein	233.0	231.3
Colouring uniformity (ΔE_{D65})	1.98	7.06
Distribution efficiency of tensile strength	0.79	0.69
Distribution efficiency of strength of surface	0.70	0.61
Distribution efficiency of percentage extension at 10 MPa	0.89	0.72
Relative vapour permeability, %	92.5	69.5
Grade of quality, %	93.9	93.1

not only of being sorbed and distributed evenly in the derma structure, due to their structure and properties, but also of interacting with active collagen groups and other chemicals reagents. This leads to the excellent properties of the raw material and the finished product: durability, heat resistance, formedness, plastic-elastic, hygienic, aesthetic and other qualities.

CONCLUSIONS

The research done shows that there is a rationale for using polymeric compounds based on maleic and acrylic acids, and that they have a positive effect on the structure formation and leather properties. We have found that structuring efficiency, improvement of consumer qualities and aesthetic properties of the latter depend on the chrome tanning agent consumption significantly, as well as on polymeric compounds during the tanning and crusting processes.

We have developed a unified resource-saving technology of the crust leather production, using polymeric compounds at the stages of tanning and crusting processes. In addition, tanning includes pre-processing of abated pelt with a polymeric compound based on acrylic acid instead of pickling, which allows us to decrease the duration of the process as well as the tanning agent consumption by 25%. The liquid finishing includes using a polymeric compound based on maleic acid after the neutralization process (before dying), which allows us to decrease the processing duration by 20%, dying agents and tannins consumption by 50%, to increase the grade of quality, to increase the crust leather yield of thickness by 1.4%, by area by 0.3%.

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DECISION MAKING OF PRODUCT QUALITY AND CARBON EMISSION REDUCTION IN FOOTWEAR SUPPLY CHAIN UNDER PRODUCTION CAPACITY CONSTRAINT

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DECISION MAKING OF PRODUCT QUALITY AND CARBON EMISSION REDUCTION IN FOOTWEAR SUPPLY CHAIN UNDER PRODUCTION CAPACITY CONSTRAINT

ABSTRACT. For the supply chain composed of raw material suppliers and footwear manufacturers, considering the limitation of supplier production capacity, this study was based on the balance of raw material production quantity and quality. In this paper, the game theory was used to establish one centralized decision-making model and one decentralized decision-making model. Then, under these two decision-making models, the optimal decision-making problems such as raw material quality and manufacturer carbon emission reduction were studied, and sensitivity analysis was also made through simulation. The research results show that when the quality of the supplied raw materials under these two models is the same, the demand for the products is also the same, and the total profit is relatively larger in decentralized decision-making; when the carbon emission reduction degree of the two decision-making models is the same, the quality requirements for raw materials are higher in the centralized decision-making, but their demand and total profit are relatively low.
KEY WORDS: production capacity, footwear supply chain, game, carbon emission reduction

LUAREA DECIZIILOR PRIVIND CALITATEA PRODUSULUI ȘI REDUCEREA EMISIILOR DE CARBON ÎN LANȚUL DE APROVIZIONARE AL ÎNCĂLȚĂMINTEI ÎN CONDIȚIILE RESTRICȚIONĂRII CAPACITĂȚII DE PRODUCȚIE

REZUMAT. Lanțul de aprovizionare este compus din furnizori de materii prime și producători de încălțăminte și având în vedere limitarea capacității de producție a furnizorilor, acest studiu s-a bazat pe echilibrul dintre cantitatea și calitatea producției de materii prime. În această lucrare, s-a utilizat teoria jocului pentru a stabili un model centralizat de luare a deciziilor și unul descentralizat. Apoi, în cadrul acestor două modele de luare a deciziilor, au fost studiate problemele legate de luarea deciziilor optime, cum ar fi calitatea materiei prime și reducerea emisiilor de carbon ale producătorului, iar analiza de sensibilitate a fost realizată și prin simulare. Rezultatele cercetării arată că atunci când calitatea materiilor prime furnizate în cadrul acestor două modele este aceeași, cererea de produse este de asemenea aceeași, iar profitul total este relativ mai mare în procesul decizional descentralizat; când gradul de reducere a emisiilor de carbon al celor două modele de luare a deciziilor este același, cerințele de calitate pentru materiile prime sunt mai ridicate în procesul decizional centralizat, dar cererea și profitul totale sunt relativ mici.
CUVINTE CHEIE: capacitate de producție, lanțul de aprovizionare al încălțămintei, joc, reducerea emisiilor de carbon

PRISE DE DECISIONS SUR LA QUALITÉ DES PRODUITS ET LA RÉDUCTION DES ÉMISSIONS DE CARBONE DANS LA CHAÎNE D'APPROVISIONNEMENT EN CHAUSSURES DANS DES CONDITIONS DE RESTRICTION DE CAPACITÉ DE PRODUCTION

RÉSUMÉ. La chaîne d'approvisionnement est composée de fournisseurs de matières premières et de fabricants de chaussures. Compte tenu de la capacité de production limitée des fournisseurs, cette étude était basée sur l'équilibre entre la quantité et la qualité de la production de matières premières. Dans cet article, la théorie des jeux a été utilisée pour établir un modèle décisionnel centralisé et un modèle décentralisé. Ensuite, dans ces deux modèles de prise de décision, les problèmes liés à la prise de décision optimale, tels que la qualité de la matière première et la réduction des émissions de carbone du fabricant, ont été étudiés et l'analyse de sensibilité a également été réalisée par simulation. Les résultats de la recherche montrent que lorsque la qualité des matières premières fournies dans ces deux modèles est la même, la demande de produits est la même et le bénéfice total est relativement plus élevé dans le processus de prise de décision décentralisé; lorsque la réduction des émissions de carbone des deux modèles décisionnels est la même, les exigences de qualité pour les matières premières sont plus élevées dans le processus décisionnel centralisé, mais la demande totale et le profit sont relativement faibles.
MOTS CLÉS: capacité de production, chaîne d'approvisionnement en chaussures, jeux, réduction des émissions de carbone

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INTRODUCTION

Supply chain refers to one functional network chain structure based on the core enterprise, starting from the supporting parts, making intermediate products and final products, and finally sending the products to the consumers by the sales network, connecting the suppliers, manufacturers, distributors and end users into a whole. The modernization development of the footwear industry is inseparable from its industrialized operation. In the industrialized operation of the footwear industry, the manufacturing enterprises and suppliers become the main members of the footwear supply chain generally by contracts [1]. In the footwear supply chain, each entity needs to determine the supply price, quantity and quality of raw materials, and maximize the profit while maintaining the coordinated development of the supply chain [2]. Due to the limited capabilities and resources of the supplier, at the same level of effort, increasing production will reduce quality, while improving quality will reduce production. The quality and quantity of raw materials supply in the footwear industry will also affect market demand and price. Then, what is the coordination mechanism of the footwear supply chain under this circumstance? How do manufacturing enterprises and raw material suppliers decide to make production? These are the problems to be solved in this paper.

The coordination mechanism in the supply chain is a series of sequential processes for meeting all of the pre-defined goals for all members to work together and regulate the behaviour of multiple components in the system. The key to supply chain coordination is to design an effective incentive mechanism, enabling these independent decision makers by taking self-interest action to achieve global optimization. Supply chain contracts mainly include the wholesale price contract, revenue sharing contract, quantity discount contract, rebate contract, repurchase contract, and option contracts etc. [3-7]. Reasonable contract design helps to reduce the impact of unfavourable factors such as double marginalization and information asymmetry, thereby improving the overall profit of the supply chain, so that the supply chain can be coordinated and the supply chain competitive advantage can be realized. At the same time, product quality level is an important factor to achieve competitive advantage in the supply chain [8, 9]. In certain specific market environments, some enterprises are shifting their simple price competition strategy to the quality competition strategy [10, 11], that is, they adopt the same price strategy, but provide products at different quality levels for fair competition. At present, there have been some domestic and foreign scholars' research results on supply chain coordination contract model by taking the product quality level into consideration [12-14], e.g., in view of the distribution channel coordination issues when market demand is affected by product quality level and retailer's promotion effort level, Gurnani and Erkoc analysed and compared three different supply chain contracts, and then pointed out that the wholesale price contract is a special form of general franchise contracts, and manufacturers tend to choose personal fixed tax contract rather than general franchise contract when the reservation utility and information asymmetry of retailers are too high; Ma *et al*. considered the situation that the market demand is affected by the retailer's promotion effort level and product quality level, and for the secondary supply chain coordination problem (consisting of single manufacturer and single retailer) proposed a new type of contract to coordinate this secondary supply chain; then the analysis was conducted to obtain the optimal sales effort level, the best quality improvement effort level and the optimal supply chain profit.

Regarding the impact of quality or quantity of raw materials on supply chain revenue, Piramuthu and Zhou, Rahdar and Nookabadi described the relationship between quantity loss and value loss of agricultural products and time with exponential function respectively [15, 16]. Herbon *et al*. described the quality loss of products as the first and second functions of time, focusing on the impact of freshness on consumer utility [17]. Qin *et al*. used two-parameter and three-parameter Weibull functions to consider the quantity and quality losses of products [18]. Cai *et al*. consider the supply chain optimization and coordination problems when the quantity and quality losses of products are endogenous functions of preservation efforts [19]. Hosseini-Motlagh established a supply chain decision model considering the green quality and warranty period of products are two major factors which affect consumers' purchasing behavior [20]. Considering the impact of product quality on supply chain, Taleizadeh *et al*. studied the optimal decision of different channels from the perspective of closed-loop supply chain [21].

It can be seen from the above studies that many scholars have achieved important results in the supply chain, but there have been few studies about the supply chain coordination mechanism issue in the balance of raw material quality and output under the limited capacity of raw material suppliers. Thus, in this paper, based on the studies above, for the supply chain consisting of a shoe manufacturer and a raw material supplier, the quantity and quality of raw material production was balanced under the limited production capacity of suppliers; the game theory was used to establish one centralized decision-making model and decentralized decision-making model for studying the optimal coordination mechanism under these two decision-making models.

MODEL HYPOTHESIS

Raw material suppliers supply the raw materials at the m quality level to the footwear manufacturing enterprises, and the manufacturing enterprises process the raw materials for sale. The carbon emission reduction per pair of shoes is θ . Due to resource constraints of raw material suppliers, the higher the quality level m , the smaller the raw material supply s . Meanwhile, considering both the monopoly and market demand, market demand is determined by the product prices p , m and θ . In the supply chain, all parties make decisions with the goal of maximizing profits: the raw material supplier makes m ; the footwear manufacturing enterprises with strong positions decide the purchase price of raw materials w and θ ; the market determines the retail price p according to the supply and demand relationship. Therefore, in this situation, the supply chain coordination of the footwear industry is a three-stage decision-making process.

Hypothesis 1: Set the functional relation of raw material supply as: $s(m) = a - bm$, where the normal number/positive constant a represents the maximum supply at the lowest quality level, the unit raw material cost is c , and the normal number b indicates that the supply is reduced by b units with each additional unit of quality level. This functional relationship indicates that as the quality of raw materials increases, the supply of raw materials decreases. At quality of raw materials of m , the total cost of quality is $\kappa m^2/2$.

Hypothesis 2: The supply of raw materials is consistent with the number of products in the enterprise supply market. The market product demand is $d(m, \theta, p) = \phi + \lambda m + \gamma\theta - p$, where the normal number ϕ is the market demand base, and the normal numbers λ and γ respectively represent the impacts on market demand when the product quality is improved for raw material suppliers and enterprises. The cost of carbon reduction θ per pair of shoes is $\mu\theta^2/2$. Increasing the quality and cost can also increase the profit. To ensure the improved quality is beneficial to raw material suppliers and enterprises, it's set $\lambda^2 > \kappa$, .

Hypothesis 3: The retail price of each pair of shoes is determined by the supply and demand in market. At $m = 0, \theta = 0$, in order to meet market demand, the supply amount a of raw materials is greater than the market base ϕ. To ensure the demand $\phi - p > 0$ at this time, $\phi > p$, but $p > c$, therefore $\phi > c$.

According to the above hypothesis, the profit π_F of the raw material supplier and the profit π_E of the shoe-making enterprise are obtained:

$$\Pi_F = (w-c)(\phi + \lambda m + \gamma\theta - p) - \kappa m^2/2 \quad (1)$$

$$\Pi_E = (p-w)(\phi + \lambda m + \gamma\theta - p) - \mu \theta^2/2 \quad (2)$$

MODEL ESTABLISHMENT

Centralized Decision-making Model (T Model)

In the centralized decision-making model, the raw material supplier and the shoe-making enterprise are regarded as a decision-making unit, with the goal to maximize the profit of the decision-making unit. According to formula (1) and formula (2), then:

$$\Pi = \max_{(m,\theta)} (\Pi_F + \Pi_E) \quad (3)$$

The second-order condition of formula (3) is: $\frac{\partial \Pi^2}{\partial^2 m} = -\kappa < 0$, $\frac{\partial \Pi^2}{\partial^2 \theta} = -\gamma < 0$, $\frac{\partial \Pi}{\partial^2 \theta}\frac{\partial \Pi^2}{\partial^2 m} - \frac{\partial \Pi^2}{\partial\theta\partial m}\frac{\partial \Pi^2}{\partial\theta\partial m} = \kappa\mu > 0$ so the optimal values m and θ exist, to obtain the maximum of Π. Based on first order condition:

$\frac{\partial \Pi}{\partial \theta} = p\gamma - \theta\mu - c\gamma = 0$ $\frac{\partial \Pi}{\partial m} = (p-c)\lambda - m\kappa = 0$

Then, $= \frac{(p-c)\lambda}{\kappa}$, $\theta = \frac{(p-c)\gamma}{\mu}$. The product price is determined by the supply and demand in the market, that is, $a - bm = \phi + \lambda m + \gamma\theta - p$, and .

$$p^T = \frac{c(\gamma^2\kappa + \lambda(b+\lambda)\mu) + \kappa\mu(a-\phi)}{\gamma^2\kappa + (-\kappa + \lambda(b+\lambda))\mu}$$

Thus, $m^T = \frac{\lambda\mu(a+c-\phi)}{\gamma^2\kappa + (-\kappa + \lambda(b+\lambda))\mu}$,

$$\theta^T = \frac{\gamma\kappa(a+c-\phi)}{\gamma^2\kappa + (-\kappa + \lambda(b+\lambda))\mu},$$

$$d^T = \frac{a(\gamma^2\kappa + (-\kappa + \lambda^2)\mu) + b\lambda\mu(-c+\phi)}{\gamma^2\kappa + (-\kappa + \lambda(b+\lambda))\mu},.$$

$$\Pi^T = \frac{\kappa\mu\left(a(\gamma^2\kappa + (-2\kappa + \lambda^2)\mu) - (\gamma^2\kappa + \lambda(2b+\lambda)\mu)(c-\phi)\right)(a+c-\phi)}{2(\gamma^2\kappa + (-\kappa + \lambda(b+\lambda))\mu)^2}$$

Decentralized Decision-making Model (C Model)

Under decentralized decision-making conditions, raw material suppliers and enterprises make decisions based on the principle of maximizing revenue. According to formula (1), second derivative of Π_F about m is $\partial \Pi_F{}^2/\partial^2 m = -\kappa < 0$. According to its first derivative $\partial \Pi_F/\partial m = -m\kappa + (-c+w)\lambda = 0$, it is given as $m = \frac{(w-c)\lambda}{\kappa}$; substituting it into formula (2), the second-order conditions of Π_E about w and θ are $\frac{\partial \Pi_E{}^2}{\partial^2 w} = -\frac{2\lambda^2}{\kappa} < 0$, $\frac{\partial \Pi_E{}^2}{\partial^2 \theta} = -\mu < 0$

$$\frac{\partial \Pi_E{}^2}{\partial^2 w}\frac{\partial \Pi_E{}^2}{\partial^2 \theta} - \frac{\partial \Pi_E{}^2}{\partial\theta\partial w} = -\gamma^2 + \frac{2\lambda^2\mu}{\kappa}$$

Therefore, at $2\lambda^2\mu - \gamma^2\kappa > 0$, there exist optimal values w and θ, to obtain the maximum of Π_E. According to the first-order condition: $\frac{\partial \Pi_E}{\partial \theta} = p\gamma - w\gamma - \theta\mu = 0$, $\frac{\partial \Pi_E}{\partial w} = \frac{-\gamma\theta\kappa + c\lambda^2 - 2w\lambda^2 + p(\kappa + \lambda^2) - \kappa\phi}{\kappa} = 0$.

Then,

$$w = \frac{-c\lambda^2\mu + p(\gamma^2\kappa - (\kappa + \lambda^2)\mu) + \kappa\mu\phi}{\gamma^2\kappa - 2\lambda^2\mu},$$

$$\theta = \frac{\gamma(c\lambda^2 + p(\kappa - \lambda^2) - \kappa\phi)}{\gamma^2\kappa - 2\lambda^2\mu}$$

. According to $a - bm = \phi + \lambda m + \gamma\theta - p$,

$$p^C = \frac{a\kappa(-\gamma^2\kappa + 2\lambda^2\mu) + \lambda(-bc\gamma^2\kappa + bc\lambda^2\mu + c\lambda^3\mu + b\kappa\mu\phi - \kappa\lambda\mu\phi)}{\lambda(\lambda(-\kappa+\lambda^2)\mu + b(-\gamma^2\kappa + (\kappa+\lambda^2)\mu))}$$, and

$$w^C = \frac{a\kappa(-\gamma^2\kappa + (\kappa+\lambda^2)\mu) + \lambda\left(bc(-\gamma^2\kappa + (\kappa+\lambda^2)\mu) + \lambda\mu(c\lambda^2 - \kappa\phi)\right)}{\lambda(\lambda(-\kappa+\lambda^2)\mu + b(-\gamma^2\kappa + (\kappa+\lambda^2)\mu))},$$

$$\theta^C = \frac{\gamma\kappa\left(a(\lambda^2-\kappa) + b\lambda(\phi-c)\right)}{\lambda(\lambda(-\kappa+\lambda^2)\mu + b(-\gamma^2\kappa + (\kappa+\lambda^2)\mu))}, \quad m^C = \frac{a(\gamma^2\kappa - (\kappa+\lambda^2)\mu) + \lambda^2\mu(\phi-c)}{\lambda(\kappa-\lambda^2)\mu + b(\gamma^2\kappa - (\kappa+\lambda^2)\mu)},$$

$$d^C = \frac{\lambda\mu(a(\kappa-\lambda^2) - b\lambda(\phi-c))}{\lambda(\kappa-\lambda^2)\mu + b(\gamma^2\kappa - (\kappa+\lambda^2)\mu)}, \quad \Pi_E = -\frac{\kappa\mu(\gamma^2\kappa - 2\lambda^2\mu)(a(\kappa-\lambda^2) - b\lambda(\phi-c))^2}{2\lambda^2(\lambda(-\kappa+\lambda^2)\mu + b(-\gamma^2\kappa + (\kappa+\lambda^2)\mu))^2},$$

$$\Pi_F = -\frac{\kappa\left(a(\gamma^2\kappa + (-3\kappa+\lambda^2)\mu) + \lambda(2b+\lambda)\mu(\phi-c)\right)\left(a(\gamma^2\kappa - (\kappa+\lambda^2)\mu) + \lambda^2\mu(\phi-c)\right)}{2(\lambda(\kappa-\lambda^2)\mu + b(\gamma^2\kappa - (\kappa+\lambda^2)\mu))^2},$$

$\Pi^C = \Pi_E + \Pi_F$.

MODEL ANALYSIS AND SIMULATION

Conclusion 1: When the raw materials quality of the two decision models is the same, the degree of carbon emission reduction is also the same, that is,

$m^T = \mathbf{m}^C \Leftrightarrow \mathbf{d}^T = \mathbf{d}^C$, but $\Pi^C > \Pi^T$.

To testify: at $m^T = \mathbf{m}^C$,

$$\frac{\lambda(a+c-\phi)}{(-1+\gamma)\kappa + \lambda(b+\lambda)} = \frac{a(\kappa - \gamma\kappa + \lambda^2) + \lambda^2(c-\phi)}{-\kappa\lambda + \lambda^3 + b(\kappa - \gamma\kappa + \lambda^2)},$$

and then $a = \dfrac{\lambda(\gamma^2\lambda + b(\gamma^2 - \mu))\mu(\phi - c)}{-\gamma^4\kappa + 2\gamma^2\kappa\mu + (-\kappa+\lambda^2)\mu^2}$.

Substituting a into $\mathbf{d}^T$ and $\mathbf{d}^C$, $\mathbf{d}^T - \mathbf{d}^C = \mathbf{0}$. Also

$$\Delta\Pi = \Pi^T - \Pi^C = -\frac{\gamma^2\kappa\mu^2(\kappa\mu + 2\gamma^2(\lambda^2-\kappa))(c-\phi)^2}{2(\gamma^4\kappa - 2\gamma^2\kappa\mu + (\kappa-\lambda^2)\mu^2)^2},$$

according to the hypothesis, $\Pi^C > \Pi^T$. The details are shown in Fig. 1 below.

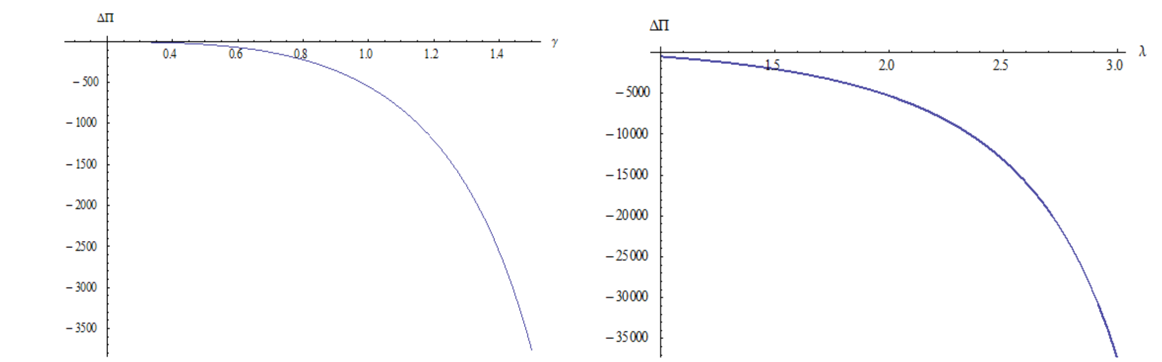

Figure 1. Change trend of $\Delta\Pi$ with γ, λ

It can be seen from Fig. 1 that $\Delta\Pi$ is always less than 0, and with the increase of γ and λ values, the total profit at the time of decentralized decision making is larger than that of the centralized decision.

Conclusion 1 indicates that the market demand is consistent when the quality requirements of the raw materials are the same in the two decision-making models. At this time, the enterprise should prefer to operate separately from the raw material suppliers and make independent accounting of profits, especially in case of greater impact of quality on demand.

Conclusion 2: When the carbon emission reduction degree of enterprises under the two decision-making models is consistent, that is, $\theta^T = \theta^C$, then, $m^T > \mathbf{m}^C$, $d^T < \mathbf{d}^C$, $\Pi^T < \Pi^C$

To testify, at $\theta^T = \theta^C$,

$$a = \frac{\lambda^2(b^2 - \kappa + 2b\lambda + \lambda^2)\mu(\phi - c)}{\kappa(\gamma^2(\kappa - \lambda(b+\lambda)) + (-\kappa + \lambda(2b+\lambda))\mu)}$$

Due to $\gamma^2(-\kappa+\lambda(b+\lambda))+(\kappa-\lambda(2b+\lambda))\mu > (\lambda^2+2b\lambda-\kappa)(\gamma^2-\mu) > 0$, then

$$\Delta m = m^T - m^C = \frac{\lambda\mu(\phi - c)}{\gamma^2(-\kappa+\lambda(b+\lambda))+(\kappa-\lambda(2b+\lambda))\mu} > 0,$$

$$\Delta\Pi = \Pi^T - \Pi^C = -\frac{\lambda\left(2\lambda b^2(\lambda^2-\kappa)+\lambda(\kappa^2+2\lambda^2(\lambda^2-2\kappa))+2b\left(\kappa^2+2\lambda^2\left(\lambda^2-\frac{3\kappa}{2}\right)\right)\right)\mu^2(c-\phi)^2}{2\kappa\left(\gamma^2(\kappa-\lambda(b+\lambda))+(-\kappa+\lambda(2b+\lambda))\mu\right)^2} < 0,$$

$$\Delta d = d^T - d^C = \frac{-b\lambda\mu(\phi - c)}{\gamma^2(-\kappa+\lambda(b+\lambda))+(\kappa-\lambda(2b+\lambda))\mu} < 0$$

, thus, $m^T > m^C$, $d^T < d^C$, $\Pi^T < \Pi^C$. The details are shown in Fig. 2 and 3 below.

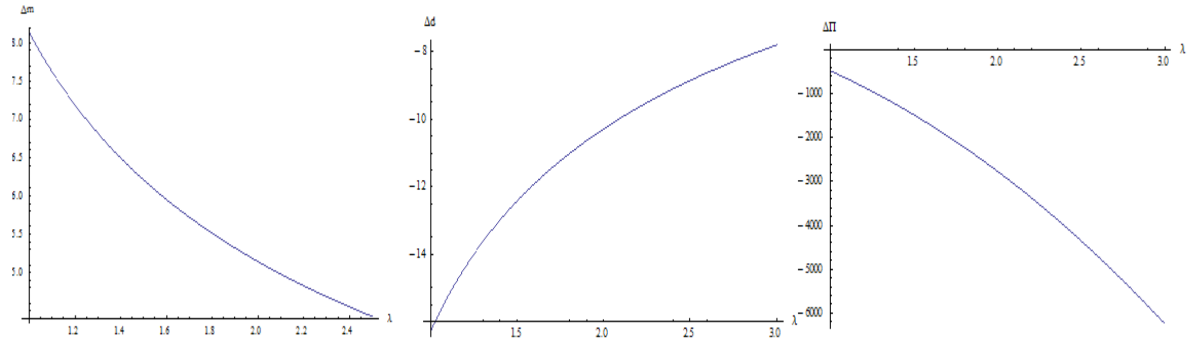

Figure 2. Change trend of $\Delta m, \Delta d, \Delta\Pi$ with λ

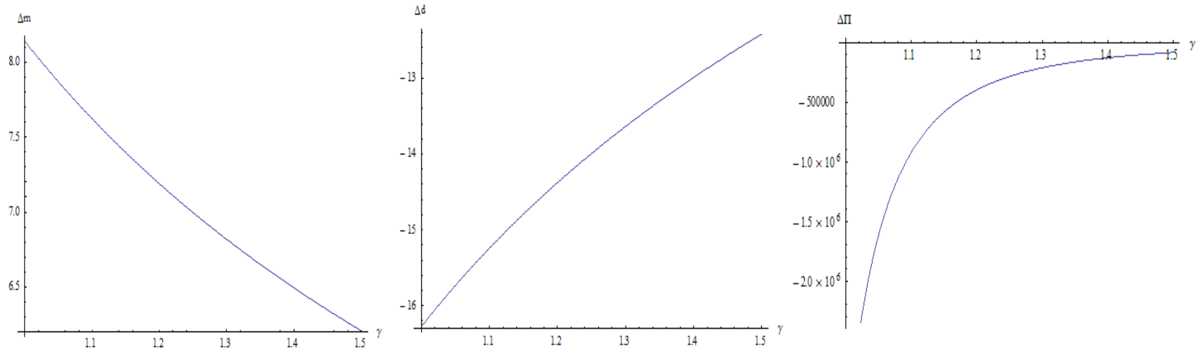

Figure 3. Change trend of $\Delta m, \Delta d, \Delta\Pi$ with γ

It can be seen from Fig. 2 and 3 that $\Delta m > 0$, $\Delta d < 0$, $\Delta\Pi < 0$, and the raw material quality difference Δm decreases with the increase of λ and γ, and the market demand increases with the increase of λ, γ. The demand difference Δd decreases with the increase of λ, γ, but the profit difference increases with the increase of λ and decreases with the increase of γ.

Conclusion 2 shows that in the case of consistent carbon dioxide emission requirements under the two decision-making models, the quality of raw materials provided by raw material suppliers is higher in the centralized decision-making, but the demand and total profit are lower than those of the decentralized decision-making. Compared with enterprises, this conclusion indicates that when product carbon emissions are consistent, especially when raw material quality has a large impact on demand, the decentralized decision-making is still superior to centralized decision-making.

CONCLUSIONS

In this paper, for the footwear supply chain consisting of one enterprise and one raw material supplier, considering the raw material supplier's production capacity limitation, the quantity and quality of raw material production was balanced under the limited production capacity of suppliers; the game theory was used to establish one centralized decision-making model and one decentralized decision-making model. Then, the optimal decision was studied when the quality of raw materials is consistent and the degree of carbon emission reduction is the same under the two decision-making models, and the sensitivity analysis was also carried out through simulation. The supply chain coordination mechanism model was established in this paper when considering the consistency between the raw material supply and product demand; whereas, the inconsistency will cause the corresponding market shortage or losses. How does this factor affect the supply chain decision-making? This shall be discussed in the subsequent studies.

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TESTING A NEW PRODUCT BASED ON ESSENTIAL OIL WITH ANTIFUNGAL PROPERTIES FOR TREATMENT OF NATURAL LEATHER

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TESTING A NEW PRODUCT BASED ON ESSENTIAL OIL WITH ANTIFUNGAL PROPERTIES FOR TREATMENT OF NATURAL LEATHER

ABSTRACT. Tanned, crust or finished leather may be damaged by different types of molds, which irreversibly degrade natural leather (during processing or storage). This paper presents the resistance to *Aspergillus niger* strain of leather samples treated with the developed cinnamon essential oil-based product. Testing of antifungal product based on cinnamon oil was carried out monitoring the manner in which mold growth is influenced by the treatment applied to the sample through the resistance to mold in simulated contamination conditions. This product improves leather and leather product resistance to fungi, while ensuring a higher quality of natural leathers.

KEY WORDS: cinnamon essential oil, natural leather, *Aspergillus niger*

TESTAREA UNUI NOU PRODUS PE BAZĂ DE ULEI ESENȚIAL CU PROPRIETĂȚI ANTIFUNGICE PENTRU TRATAREA PIEILOR NATURALE

REZUMAT. Atât pieile tăbăcite, cât și cele crust sau finisate pot fi deteriorate de diferite tipuri de mucegaiuri, care degradează în mod ireversibil pielea naturală (în timpul prelucrării sau depozitării). Această lucrare prezintă rezistența la tulpina de *Aspergillus niger* a probelor de piele tratate cu produsul dezvoltat pe bază de ulei esențial de scorțișoară. Testarea produsului antifungic pe bază de ulei esențial de scorțișoară s-a realizat prin monitorizarea modului în care creșterea mucegaiului este influențată de tratamentul aplicat pe probă prin rezistența la mucegai în condiții de contaminare simulată. Acest produs îmbunătățește rezistența pielii și a produselor din piele la fungi, asigurând o calitate mai înaltă a pieilor naturale.

CUVINTE CHEIE: ulei esențial de scorțișoară, piei naturale, *Aspergillus niger*

ESSAI D'UN NOUVEAU PRODUIT À BASE D'HUILES ESSENTIELLES AUX PROPRIÉTÉS ANTIFONGIQUES POUR LE TRAITEMENT DU CUIR NATUREL

RÉSUMÉ. Les cuirs tannés, en croûte ou finis peuvent être endommagés par différents types de moisissures, qui dégradent de manière irréversible le cuir naturel (pendant le traitement ou le stockage). Cet article présente la résistance à la souche d'*Aspergillus niger* d'échantillons de cuir traités avec le produit développé à partir d'huile essentielle de cannelle. Le test du produit antifongique à base d'huile essentielle de cannelle a été réalisé en contrôlant l'influence de la croissance de moisissures sur le traitement appliqué à l'échantillon par la résistance à la moisissure dans des conditions de contamination simulées. Ce produit améliore la résistance du cuir et des produits en cuir aux moisissures, assurant une meilleure qualité du cuir naturel.

MOTS CLÉS : huile essentielle de cannelle, cuir naturel, *Aspergillus niger*

INTRODUCTION

Tanned, crust or finished leather may be damaged by different types of mold from the *Aspergillus niger*, *Aspergillus flavus*, *Trichoderma viride*, *Penicillium glaucom*, *Penicillium cyclopium* and *Paecilomyces variotii* species, which, by means of the enzymes they produce (colagenases, lipases and proteases), irreversibly degrade natural leather (during processing or storage). Biocides used in the leather industry are toxic to humans and the environment, some of which are prohibited by the directives in force (pentachlorophenol, polyhalogenated phenolic compounds) [1]. Recent research aims to fully or partially replace potentially toxic biocides with environmentally friendly materials. In the past years, natural antimicrobial agents, such as essential oils, have been identified and used in the treatment of natural leather. The literature indicates the use of oregano, aloe vera, eucalyptus, lavender, coriander or cedar essential oils to treat tanned leather in wet finishing operations, in the composition of the fatliquoring mixture or for surface treatment [2-8]. Essential oils are highly concentrated in biologically active compounds with different properties: antiseptic, antibacterial, immunostimulatory etc. [9, 10]. These can be used to protect against damage caused by fungi and bacteria. The composition of cinnamon essential oil, analysed by gas chromatography coupled with mass spectrometry – GC-MS, indicates the presence of the following compounds: Eugenol – 85.07%, Caryophillene – 5.28%, Linalool – 1.85%, alpha-Pinene – 1.31%, Phellandrene – 1.59%, Benzyl Benzoate – 1.48% etc. [11, 12]. The effectiveness of biocides is established using biological methods of assessing mold and bacteria attack on leather. Assessment is performed using standardized, leather-specific methods [13].

EXPERIMENTAL

Materials

• Product (marked P-SC) with antifungal properties (made from cinnamon essential oil, ethanol, non-ionogenic emulsifier, polyethylene glycol 400 and deionized water): dry substance – 18-22%, pH (10% solution) – 5-5.5, density – 0.920-0.950 g/cm^3 (INCDTP – Division Leather and Footwear Research Institute Bucharest, Romania).

• Ethanol (Chemical Company, Germany), density – 0.789 g/cm^3 at 20°C, boiling point – 78°C, melting point – 114°C, water solubility – in any proportion.

• The crust bovine leathers natural grain assortments, mineral tanned and wet finished by retanning, fatliquoring and dyeing (1.2-1.4 mm thick, dyed brown) (INCDTP – Division Leather and Footwear Research Institute Bucharest, Romania).

METHODS

• Bioassay was used to determine leather resistance to bacteria and fungi. Method for resistance to fungi is provided in STAS 12697/A91:2008 “Leather. Mold attack test”. It examines how the growth of mold is influenced by existing treatment on the leather sample treated with biocides through mold resistance under simulated contamination.

Aspergillus niger spores were inoculated in 3 points (right, center and left of the sample) according to the procedure of ASTM D 4576-86, “Standard test method for mold growth resistance of blue stock (leather)”. The duration of incubation is 28 days, fungal observations being made at intervals of 7, 14, 21 and 28 days. The development of *Aspergillus niger* strain on leather samples analyzed was expressed according to standard notation by ranking from 0 to 5 (0 – absence of stems and a strong fungitoxic effect, 5 – an almost non-existent effect, i.e. the mold covers the entire surface of the specimen).

• Optical microscopy images were captured using a Leica stereomicroscope S8AP0 model with optic fiber cold light source, L2, with three levels of intensity, and magnification 40X.

• Chemical characteristics of the uncoated leathers were determined according to the following standards: moisture (%) – SR EN ISO 4684:2006; extractable content (%) – SR EN ISO 4648:2008; chromium oxide content (%) – SR EN ISO 5398:2008.

• Chemical characteristics of antifungal product based on cinnamon were determined according to the following standards: moisture (%) – SR EN ISO 4684:2006; pH 10% solution (units) – SR EN ISO 4698:2006; density (g/cm^3) – SR EN ISO 5397:1996. Testing of antifungal product based on cinnamon (P-SC) was carried out monitoring the manner in which mold growth is influenced by the treatment applied to the sample through the resistance to mold in simulated contamination conditions.

Technological variants for treating the crust bovine leathers natural grain assortments are shown in Table 1.

Table 1: Technological variants for treating the crust bovine leather, natural grain assortments

Sample	Composition of antifungal product	Treated leather assortments
P- SC 1	500 g/L product P-SC 50 g/L ethanol 450 g/L water	Crust brown bovine leather
P-SC 2	400 g/L product P-SC 40 g/L ethanol 560 g/L water	Crust brown bovine leather
P-SC 3	300 g/L product P-SC 30 g/L ethanol 670 g/L water	Crust brown bovine leather
P-SC 4	200 g/L product P-SC 20 g/L ethanol 780 g/L water	Crust brown bovine leather
M	0	Crust brown bovine leather

The product with antifungal properties can be applied on crust bovine leather (processed by the neutralization-retention-dyeing-fatliquoring operations), by surface finishing, as a final operation (after the mechanical processing operations - drying, polishing, setting out - using an amount of 20-50% essential oil-based product and 10% ethanol diluted in water 1:1. The moistening solution is evenly spread on the leather surface, using a plush textile material. This operation is repeated twice. Treatment with this product can be repeated at certain time intervals, and the process of application on the leather surface is easy to perform (in the case of leather stored for a longer period of time).

RESULTS AND DISCUSSIONS

Physical-Chemical Characteristics of Antifungal Product Based on Cinnamon Essential Oil

The prepared product, P-SC consists of yellowish white fluids, homogenous, with 18-22% dry substance, pH – 5.0-5.5, density – 0.920-0.950 g/cm^3.

Characterization by Chemical Analyses

Chemical characteristics of the uncoated hides used to obtain natural grain box bovine leather (crust) were determined in accordance with standard STAS 1619:1994 (Table 2).

Table 2: Chemical characteristics of natural grain box bovine leather (crust)

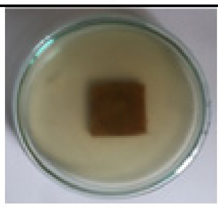
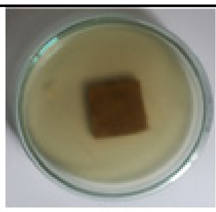
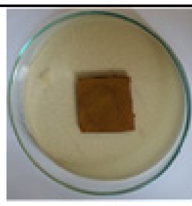
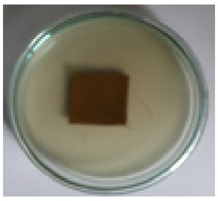
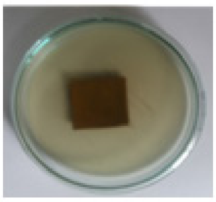
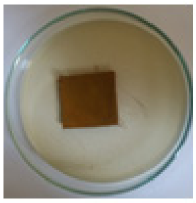
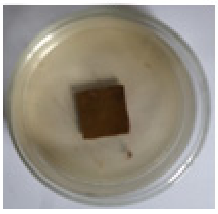
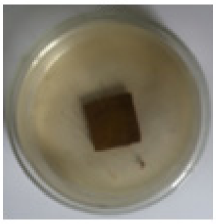
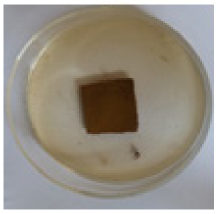
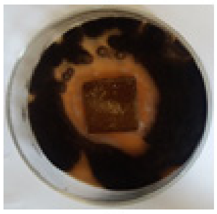
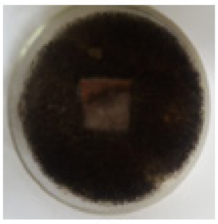
Sample/Characteristic	P-SC 1	P-SC 2	P-SC 3	P-SC 4	M	ST 1619:1994
Moisture, %	14.28	14.45	14.72	14.15	14.82	14-15
Extractable content, %	7.22	7.14	7.86	7.05	7.67	Max.8
Chromium oxide content, %	5.23	5.54	5.78	5.98	5.84	Min.3.5

Chemical characteristics of the natural grain box bovine leather (crust) are within the limits specified in standard.

Biological Characterization of Obtained Leather Assortments

The samples treated with different amounts of antifungal product based on cinnamon oil, P-SC, on the unfinished surface, were inoculated with biological material – *Aspergillus niger* spores. The goal was to monitor the influence of the treatment applied to the sample on mold growth through the mold resistance under simulated contamination, according to STAS 12697/A 91:2008. Development of the *Aspergillus niger* strain on leather samples over time, i.e. macroscopic images of the samples treated with antifungal product are shown in Table 3. The numbers under the images are the marks given according to the standard.

Table 3: Macroscopic images of samples treated with P- SC product after 7, 14 and 28 days

Sample/day	7	14	28
P-SC 1	 0	 0	 0
P-SC 2	 0	 0	 0
P-SC 3	 0	 0	 0
P-SC 4	 0	 0	 0
M	 5	 5	 5

The most resistant to mold are leather samples (P-SC 1, P-SC 2, P-SC 3) treated with antifungal product (30-50% P-SC). The samples do not develop fungi for 28 days (mark 0). The sample P-SC 4 treated with antifungal product (20% P-SC) does not develop fungi for 28 days (mark 0), but mold develops around the leather sample treated with 20% P-SC.

The sample M (not treated with P-SC) develops mold in the first 7 days (mark 5).

CONCLUSIONS

- Essential oil isolated from cinnamon (*Cinnamomum verum*) containing: eugenol – 78.03%, aceteugenol – 10.93%, caryophylene – 9.46%.
- The samples treated with antifungal product (20-50% P-SC) do not develop fungi for 28 days (mark 0).
- The prepared antifungal and antibacterial product made from cinnamon essential oil, ethanol, non-ionogenic emulsifier, polyethylene glycol 400 and deionized water improves the resistance of bovine crust leathers to biological factors (fungi).
- The product P-SC can be used (in proportion of de 20-30%) in surface treatment of crust leathers (by dabbing with a textile cloth).

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EUROPEAN RESEARCH AREA

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 newsletters are available in seven languages at https://www.euroleather.com/index.php/newsletter. The first five newsletters were also published in the first and second 2019 issues of *Leather and Footwear Journal*. The June and September newsletters are given below.

NEWS 6/2019 - June 2019

Sustainability: water consumption and water cleaning

Nowadays the word sustainability is widely used and applicable in all business sectors; in the tanning industry as well. However, sustainability work has been a reality for a long time within the European tanning sector because with the industrial transformation of hides and skins into leather European tanners have long understood that its environmental impact had to be controlled and reduced.

Tanneries are founded close to rivers and lakes because of the need for water in the production processes. Water is the most essential chemical in the tanning process, both regarding volumes and contents. Depending on geographical location of a tannery incoming water contains different substances (humus, minerals, etc.) in different levels, which have considerable effect on the final leather performance.

In addition to water, the tanning process also includes chemicals, meaning effective waste water treatment processes have become an absolute necessity for European tanneries. In the Italian Leather Sustainability Report of 2018, which covers about 60% of Europe's leather industry, you can read that the use of water in leather manufacture has been reduced by 18.4% since 2003. Furthermore, concentration of the most relevant pollutants in effluent discharges have also been reduced to nearly 0 (97.4% reduction of COD and 99.5% reduction of Chromium III).

Follow the link below for an example of low environmental impact after waste water treatment in a Swedish tannery.

Video by ELMO Sweden AB

In previous Newsletters, we have already seen that tanning is intrinsically a sustainable activity, as it takes care of a by-product from the milk and meat industries and refines it into a long-lasting material. It contributes to the circular economy. Almost all of the input material, the hides or skins, can be valorized/transformed into usable products. Not all as leather, of course, but the residues of leather production can also become gelatin or collagen, soap, glue, organic fertilisers, soil improvers, leatherboard and other products or materials useful in other industries.

The sector has experienced great environmental improvements but above all, European tanners have been able to transform sustainability into a competitive advantage.

Compared with other materials for shoes, furniture, bags, clothing, automotive interiors, leather stands out for its longevity and increase in beauty over time. Buying leather means investing in sustainability!

edited bv in collaboration with

COTANCE Svenska Garveriidkareföreningen

NEWS 7/2019 - September 2019

PEFCR: an official tool to demonstrate the environmental performance of leather

In the past, there were no simple tools for tanneries to promote the environmental performance of their processes and products. They had to choose from a confusing range of methods and standards in order to certify their products and communicate their green credentials. Sometimes it was necessary to use more than one, depending on where the leather was marketed.

This resulted in costs for companies and confusion both for clients and operators along the supply and value chain. Luckily, there is good news! In 2013, the European Commission launched the initiative "A Single Market for Green Products", intended to develop a harmonised set of rules recognised at European level, the Product Environmental Footprint (PEF).

The leather industry applied and was selected to join the pilot phase of the initiative and to develop sectorial-specific Product Environmental Footprint Category Rules (PEFCR). The aim was to define the criteria to evaluate the environmental impact attributable to the production of leather. When the pilot phase ended in May 2018, COTANCE's efforts were crowned with the approval and publication of the PEFCR for leather, drafted with its members and many other stakeholders from the leather supply chain.

With the final release of the official PEF compliant datasets in July 2019, the tool is finally ready for use!

The outcome of a PEF study will be a quantification of fifteen environmental impact categories. According to our research work, the most relevant impact categories for the leather industry are:

- Acidification
- Climate change
- Terrestrial eutrophication
- Particulate matter
- Use of fossil resources

Upstream livestock breeding contributes a lot to this state of play. A Leather PEF assessment requires an analysis of the whole supply chain, starting from the cradle, i.e. animal breeding. In multi-functional processes like meat production, the impact must be allocated to the various goods generated, based on economic, physical or biophysical criteria. During the Single Market for Green Products initiative, the tanning sector supported a zero allocation for raw hides and skins, as they are by-products, i.e. waste recovered from another production process. The EU Commission, however, determined that any product with an economic value cannot be treated as "waste", rejecting temporarily the zero-allocation proposal and obliging the industry taking over a portion of the environmental impact of the upstream phases. Although very small in percentage terms, this has significant weight for certain impact categories.

The leather industry at global level calls for zero allocation, and COTANCE will defend this during the next phase of the initiative. In the incoming months, some horizontal topics, including allocation, will be discussed further. The current PEFCR will be rolled out on the market together with new ones that will be developed for other products. After this so called "Transition phase", the European Commission will implement the PEF in EU policy to enhance the circulation of green products in the market.

With the PEFCR, the European leather industry is moving forward, taking responsibility for being transparent!

For further information about the initiative, visit the website https://ec.europa.eu/environment/eussd/smgp/

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NATIONAL AND INTERNATIONAL EVENTS

THE 32nd ADVANCED MATERIALS WORLD CONGRESS
2-5 FEBRUARY 2020, SYDNEY, AUSTRALIA

The Advanced Materials World Congress (AMC) is the premier and most well-established international conference for the advanced materials community organized by the International Association of Advanced Materials (IAAM, a not-for-profit organization). AMC has attracted 5000+ well-known speakers from industry, academia and government organizations in its previous assemblies. The 32nd assembly takes place on 2-5 February 2020, in Sydney, Australia. The congress is scheduled in the Conference Centre on board, Voyager of The Seas, Royal Caribbean Cruise, Sydney, Australia.

Abstracts should be submitted until **20th September 2019** through online submission system.

Important Dates

Abstracts Submission Deadline: 20 September 2019
Acceptance of Abstracts: 25 September 2019
Early-Bird Registration Deadline: 30 September 2019
Full Article Submission Deadline: 15 January 2020

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

INTERNATIONAL WARSAW INVENTION SHOW
14-16 OCTOBER 2019, WARSAW, POLAND

International Warsaw Invention Show **(**IWIS) is the largest in Poland and one of the biggest in Europe international event related to innovation and inventiveness. Last editions, the IWIS was attended by the representatives from lots of Asian, African, American and European countries such as: Saudi Arabia, Croatia, Egypt, Iran, Canada, Malaysia, Korea and United Kingdom. Last year polish and international inventors presented more than 400 inventions. These solutions provide an overview of technical developments, some of them are used in practice. Each year, the International Warsaw Invention Show is accompanied by lectures and seminars on intellectual property rights and granting of patents.

The elementary aims of the International Warsaw Invention Show 2019 are:

- demonstrating the scientific achievements of Polish scientists and inventors on the background of global solutions
- enabling inventors to establish contacts with potential investors
- familiarizing the public opinion with the achievements of Polish inventors
- creating a positive image of Polish science
- promoting innovative thinking among the youth

Deadline for submissions: 30.09.2019.

More information: https://iwis.polskiewynalazki.pl/#/en/

THE 3rd INTERNATIONAL AGRICULTURE AND NATURAL SCIENCES CONGRESS
17-20 OCTOBER 2019, ANTALYA, TURKEY

The III. Eurasian Agriculture and Natural Sciences Congress is a congress which we would like all participants of agriculture and natural science to come together. The Eurasian Agriculture and Natural Science Congress will be a medium for exchanging information on the latest developments and applications to be addressed in all aspects of agriculture and technology in agriculture in the world, and discussions of new technologies in this area. Food, Agriculture, Environment and Life Sciences will be the main topics in the congress at which we would like all participants related to the issue from production to consumption.

Topics include:

- Seed and seed technology.
- Irrigation, drainage and land reclamation, water management, water quality and salinity, land consolidation, hydrology, climate change, agricultural shelters.
- Food chemistry, microbiology and biotechnology, nutrition science, fermentation technology, milk meat, fruit and vegetable products technology, cereal and other field crop products technology, and so on.
- Renewable energy and their resources, bioenergetics and biofuels, energy agriculture and technologies, alternative energy sources, biological diversity.
- Soil physics, soil chemistry, soil biology, soil fertility, soil quality, fertilizer and fertilization, plant nutrition, soil and water pollution and soil conservation.
- Plant diseases and pests, plant and disease management, weeds and management, pesticides, integrated disease and pest management, stored product pest, pathogen and plant relationships, biological and biotechnical control.
- Organic production, good agricultural practices, sustainable and efficient agriculture.
- Agricultural biotechnology, molecular biology and genetics, bacteriology, genetic engineering, bioinformatics, enzymology.
- Animal husbandry and breeding, feed and animal feeding, biometry and genetics, animal health and livestock technology.

More information: http://www.agrieurasia.com/EN/

NANOTEXNOLOGY INTERNATIONAL CONFERENCES & EXHIBITION ON NANOTECHNOLOGIES - ORGANIC ELECTRONICS & NANOMEDICINE
4-11 JULY 2020, THESSALONIKI, GREECE

NANOTEXNOLOGY explores the opportunities in the emerging fields of Nanotechnologies, Organic & Printed Electronics and Nanomedicine. NANOTEXNOLOGY brings together over 2,000 researchers, scientists, engineers, business, technical and policy professionals to promote research and industrial collaborations, identify priorities and strengthen the innovation ecosystem.

NANOTEXNOLOGY is the largest technology, networking and matchmaking annual event in Europe and it includes the premier and Internationally established events:

- International Conference on Nanosciences & Nanotechnologies (NN20) | 7 - 10 July
- International Symposium on Flexible Organic Electronics (ISFOE20) | 6 - 9 July
- International Conference on 3D Printing, 3D Bioprinting, Digital & Additive Manufacturing (I3D20) | 8 - 9 July
- International Summer Schools "Nanosciences & Nanotechnologies, Organic Electronics & Nanomedicine" (ISSON20) | 4 - 11 July
- NANOTEXNOLOGY EXPO 2020 | 6 - 10 July

- Business Forum | 7 - 9 July
- Matchmaking Event | 8 July

Abstracts can be submitted by April 8th 2020!

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

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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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