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INNOVATIONS IN BIOMATERIAL INDUSTRY-PROPOLIS AS AN COMPLEMENTARY ELEMENT

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Abstract: *This work highlights the importance of biomaterials in the fashion industry, outlining the recent progress and innovations in this field. The actuality of the topic is determined by the necessity of the fashion industry to adopt sustainable and ecological materials with the purpose of reducing the negative impact of textiles on the environment. Biomaterials, which are presented in the first stage of research and development, represent biopolymers which offer new perspectives on the production of traditional textiles. The main purpose of the work is to create new recipes for biomaterials with the addition of propolis. The general objective is to obtain a biomaterial with similar aesthetic properties as natural leather, at the same time having therapeutic functions. There are examples presented to illustrate the diversity and potential of biomaterials. The experimental part presents the fabrication process of biomaterials, including their creation and analysis, with the aim of evaluating their proprieties and quality. It is proposed to use propolis for conferring additional properties such as antimicrobial, antioxidant, anti-inflammatory, and air fresheners. The coat made from samples of biomaterials presents an example of a wearable, functional, and sustainable product whose functionality is determined by the proprieties of the propolis powder in the biomaterial's recipe. As further directions of development is mentioned the wearing in real conditions of the prototype made in order to evaluate the antibacterial, odorizing, anti-inflammatory properties.*

Key words: *sustainable, materials, recipe, agar-agar, gelatin.*

1. INTRODUCTION

In the context of promoting a sustainable fashion industry, designers have the role of finding nature-friendly solutions. An example of this is replacing traditional materials with bio-based materials. Bio-based materials are becoming significant for the fashion industry due to the benefits they bring to the environment, as well as the functionalities that can be attributed to them through the use of consumer-friendly components. Currently, biomaterials are presented as prototypes or in their early stages of research and development, having a promising result in the near future. They represent biopolymers, which offer new ways to conceptualize traditional textile production. [1-8]

In this work it is proposed way of obtaining biomaterials for fashion industry, materials that will be the basis for creating models of clothing products that will meet the needs of today's society – functional and sustainable clothing products.

2. EXAMPLES OF BIOMATERIALS IN FASHION INDUSTRY

Biomaterials for the garment industry must possess similar proprieties as the traditional materials: physical properties (width and length, specific mass, thickness), mechanical properties (tensile strength and elongation, wear resistance), hygienic-functional properties (thermal insulation capacity, air permeability, hydrophilia, hygroscopicity, water permeability), visual properties (dimensional stability, wrinkling ability to return, draping, flexibility, transparency) [10, 11].

As mentioned in the studied sources [10, 11], the methods of obtaining biomaterials for fashion industry are the following: manufacturing (bio-plastic, skins, yarns); growth (skins based on mycelium, skins based on microbes, silk from spider threads); extraction (examples: pinatex, bamboo, coconut, banana).

Mostly, existing biomaterials come as a substitute for traditional textiles. A first example of innovative biomaterial is jacquard textile from banana's plant. This can be obtaining from a species of banana cultivated in Filipine. The material is lightweight, highly resistant, air-permeable, has antibacterial properties and is biodegradable. [1]

Carmen Hijosa is the designer that created Pinatex- a trademarked fabric obtained from pineapple leaf waste. [2] Vegea is a product obtained from the recovery of waste from the Italian wine industry and biomass. [3]

Fig. 1: *Pinatex – biomaterials obtained from pineapple leaves' waste [2]*

Fig. 2: *Vegea - vegan alternative from grape for animal leather [3]*

Adriano di Marti's Company, Mexic, after two years of researches, produce Desserto bioleather in 2019. This is obtaining from Nopal cactus, the leaves of which are picked twice a season, without harm to the plant. [4] Engineers from Bolt Treads produce leather from mycelium – fibres derived from mushroom root structures. In 2022, it was created the first luxury bag from mycelium- Mylo bag. [5]

Fig. 3: *Desserto Bioleather [4]*

Fig. 4: *Luxury bag from mushroom leather [5]*

In 2023, Stella McCartney collaborates with startup Radiant Matter and creates biodegradable sequins. [6] Vegan leather is the hallmark of the Hungarian brand Nanushka. Although the brand was founded a decade ago, it has made known by the growing interest in sustainable fashion. [1,8]

Fig. 5: *Delevingne model in Biosequins-covered jumpsuit on the April cover of Vogue [6]*

Fig. 6: *Jacket from vegan leather Nanushka [7]*

Another example in this field are the projects of the participants of the intensive multidisciplinary program Fabricademy. Within the Biofabric Materials course, under the guidance of Cecilia Raspanti [10], they learnt how to create biomaterials. The recipes underlying the study presented in this work, recipes for biofoils, bioplastics and bioskin, are described in the specialised publications studied [11, 12].

Fig. 7: *The final projects from Fabricademy program- concepts based on biomaterials uses [10]*

Based on the studied information, we can say that the field of biomaterials, although it is at its beginnings, it represents the interes of designers who promote nature-friendly fashion.

3. EXPERIMENTAL RESEARCH

3.1. Material and method

The process of obtaining biomaterials can vary depending on the specific type of biomaterial and the biological resource used. However, there are some general steps that most biomaterials go through in their production process: raw material preparation, biomaterials processing, product finishing, testing and evaluation, integration into finished products.

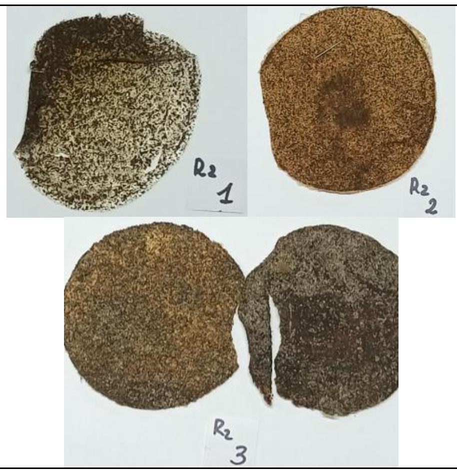
Initial experimental studies included the creation of biofoil and bioplastic samples. In both cases, propolis powder was added.

Studied recipes has 3 main components: bio-polymer – gelatin or agar-agar plasticiser– glicerin; solvent – water.

Propolis powder will be used in the composition of bio materials, in order to confer antimicrobial, antioxidant, anti-inflammatory and odorizing properties, properties that propolis powder possesses.

Following are described the experiments done initially (table 1).

Table 1: *Biomaterials samples with addition of propolis*

Recipe	Biomaterial's samples obtained initially
First recipe - biofoils	
Ingredients: agar-agar, glicerin, gelatin, propolis powder. Raport: 1:5:6,6. Water – 400 ml. The total quantity of propolis represent 10% of the solution quantity after evaporation. We mixed the ingredients in cold water and put them in the pot on low heat. We flutter ocassionaly the mixture and collect the formed foam. The boiling time is about 40- 50 minutes. The biomaterial is poured into a lined form with waterproof material. The optimal drying time of the biomaterial is about seven days, at room temperature, without strong drafts. At the same time, the room should be well-ventilated.	
Second recipe - bioplastic	
Ingredients: agar-agar, glicerin, propolis powder. Raport: 2:1. Water – 400 ml. The total quantity of propolis represent 10% of the solution quantity after evaporation. We mixed the ingredients in cold water and put them in the pot on low heat. We flutter ocassionaly the mixture and collect the formed foam. The boiling time is about 40- 50 minutes. The biomaterial is poured into a lined form with waterproof material. The optimal drying time of the biomaterial is about seven days, at room temperature, without strong drafts. At the same time, the room should be well-ventilated.	

The initial sample obtained were analysed visually and tactilely. Properties similar to those of natural leather were observed in the case of samples obtained based on recipe 1.

Further experiments were carried out to obtain perfect samples of larger sizes which will later be used to make a real product – a coat for people suffering from various diseases that could be improved using propolis.

For some casting surfaces appeared difficulties like: determining the optimal boiling time, the drying period until the extraction of the biomaterial from the form in which it was poured, the correct determination of the amount of ingredients raorted to the casting surface. The optimal final recipe is: ingredients – water 450 ml; raport – 1 (agar-agar): 5 (glicerin): 6,6 (gelatin); boiling time:50 min. The surface were the biomatersial was poured has the following dimensions: 410/300 mm. By experimental method – on a wooden stick the initial level of cold liquid was marked, occasionally the level of it being measured with the same stick. When the liquid dropped more than 50% and corresponded to the boiling time, it was added the propolis powder, which boiled in the composition for up to 5 minutes.

Some samples obtained at this stage where presented in figure 2. The eighth sample from the figure 2 was obtained by applying the final recipe described above.

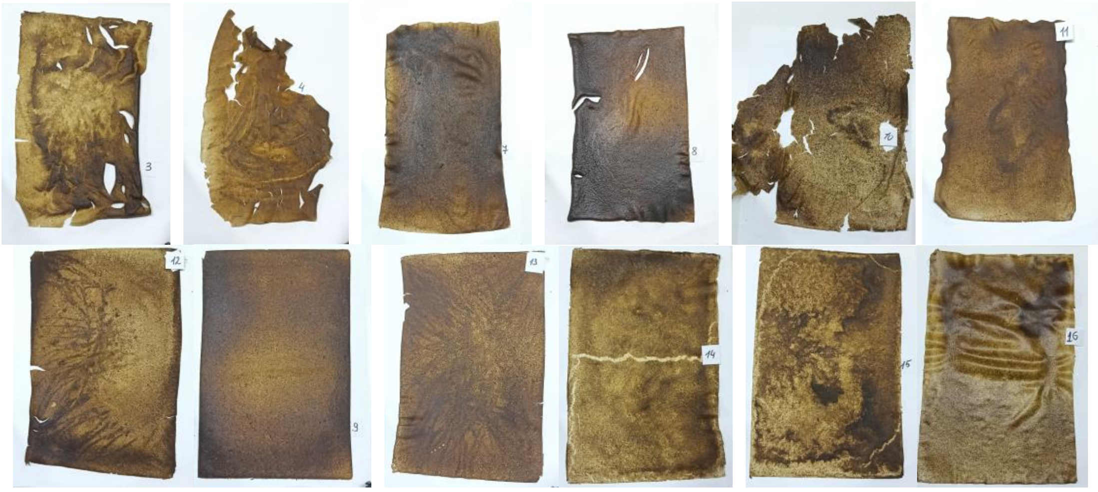


Fig. 2: *Biomaterial samples obtained in the second stage of experimentation.*

3.2. Results and discussion

The experimentation period for obtaining biomaterial samples was quite long as there were many variables that determined the appearance, quality, elasticity, durability of the material. These include: boiling time, boiling temperature, proportions used, casting surface, quality of raw material, temperature of the room where samples were left for drying.

Recommendations: for 200 ml of water take 1.5 gr. of agar-agar, 7.5 ml of glycerin and 15 gr. of gelatin. The amount of ingredients is calculated depending on the area of the form into which the biomaterial is poured. The flame of the stove is set to the minimum. It is worked quickly, because the biomaterial as soon as it begins to become cold, solidifies.

Following the experiments described above, the obtained samples were used to make the prototype of the coat for people with various diseases that can be improved with the help of propolis (figure 3). It is presumed that the antimicrobial and anti-inflammatory properties of propolis powder integrated in the biomaterial samples obtained have been retain. Regarding to the odorizing properties, by interacting with the heat production of the wearer's body, they were intensified when the jacket was wore for a short time.

Fig. 3: *The coat prototype realised by using biomaterial with propolis addition*

4. CONCLUSIONS

It is important to note that manufacturing processes and exact formulas of recipes may been vary depending on the specific goals of the designers. The materials obtained can have varied textures and properties, and their usage can contribute to the development of more sustainable and environmentally friendly options. Recent research and developments in the field of biomaterials point a promising direction for the future of textile industry and other related fields. Although there are still challenges in the production, implementation and experimental research of biomaterials such as that described in this work, there are important contributions in understanding and improve these materials. Recommendations for optimising the production process, such as the biomaterial coat with added propolis presented in this study, represent important steps towards the wide use of biomaterials in various practical applications. As further research directions, it is planned the wearing of the created prototype in real time in order to subjectively and objectively assess of the antibacterial, odorizing, anti-inflammatory and antifungal properties of propolis.

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