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BIOMATERIALS FOR THE FASHION INDUSTRY

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Abstract: *The textile industry is estimated to be the second most polluting industry in the world. Carbon emissions exceed the amount of simultaneous emissions from the aviation and shipping industries, which are also responsible for 20% of the total amount of polluted water. Biomaterials are a sustainable alternative to traditional materials used in the fashion industry. The actuality of the theme is determined by the increased interest of researchers in the field of the fashion industry to find a sustainable alternative for traditional textiles. The aim of the paper is to find sustainable alternatives in the textile industry. The paper includes not only theoretical studies on the current state of availability and areas of usage of biomaterials in the fashion industry but also practical applications for obtaining biomaterials and studying their characteristics. For this purpose, I created 3 samples of biomaterial according to the same recipe, following the same process. The samples had been researched in different environmental conditions. Environmental conditions were simulated under laboratory conditions. For the manufactured biomaterial sample were detetermined characteristics such as thickness, mass and surface. The obtained results are summarized in the form of graphs. The obtained data allow to evaluate the samples of the tested biomaterial and determine the conditions, areas of use. Further research directions will include the determination of mechanical, hygienic-functional, and appearance properties for manufactured biomaterial samples.*

Key words: *bioplastic, characteristics, assessment, environmental conditions, manufacture.*

1. INTRODUCTION

The textile industry is estimated to be the second most polluting industry in the world, responsible for 10% of global carbon emissions. Chemical paints and substances used in the textile finishing process pollute 20% of all waste water globally [1,2]. Global textile fiber production has doubled over the past 20 years, reaching an all-time high of 111 million tons in 2019, and growth forecasts remain for 2030 [1]. The recycling rate of textile waste is very low, with only 13% of it being recycled [1].

The impact of the textile industry on environmental pollution is one of the problems that requires finding sustainable alternatives in the field of fashion. A circular economy is a solution that reduces environmental impact. Biomaterials are a future trend in fashion and sustainability, but also contributing to a circular economy. Although, biomaterials are implemented in the fashion industry, they are not fully studied. In the fashion industry, biomaterials can be obtained in different ways: by contain "biomass", from biological ingredients, made by using biological processes, biodegradable, or all of the above. For their wider use in fashion, theoretical and experimental research is needed to establish the theoretical and practical aspects necessary for finding sustainable solutions to traditional textiles.

2. EXAMPLES OF BIOMATERIALS FOR THE FASHION INDUSTRY

Due to the growing concern about sustainability and the negative impact of the textile industry on the environment, in recent years, interest in biomaterials has increased significantly. Evidence of the concerns about the use of biomaterials in the field of fashion are the works of fashion designers who work with biomaterials, or create new biomaterials (table 1) [3].

Table 1: Biomaterials for fashion

Name	Creator	Brief description
Sequins made from algae	Carolyn Raff	Biodegradable sequins created from bioplastic made from algae.
Increased crystals from sweat	Alice Potts	Athletic clothing covered with crystals grown from sweat
Glass-like dress	Scarlett Yang	Glass-like dress, grows over time and can decompose in water in 24 hours. Made from algae extract and silk cocoon protein.
BioMarble	Hannah Elisabeth Jones	Made from paper's wasting, it has a unique texture and surface pattern.
Fabric from bacteria	Jen Keane	He created a process of "microbial weaving" by manipulating bacteria found in kombucha, also known as K. Rhaeticus. This synthetic fibre is stronger than steel and more durable than Kevlar.

Biomaterials are a promising research topic, being also actively used by commercial companies (table 2) [4,5].

Table 2: Biomaterial manufacturing companies

Biomaterial name	Manufacturing company	Brief description
Sorona Fiber	DuPont	Made of 37% plant materials.
Piñatex	Piñatex	Obtained from the fibres of pineapple leaves. It is characterized by strength and durability. It is used for making some products of clothing, bags, shoes and accessories.
Mycelium	MycoWorks	Bioleather made from mushrooms grown in the laboratory and then processed to obtain a flexible and durable textile material. It is used for making some products of clothing, bags, shoes and accessories.
Desserto	Desserto	Bioleather made from cactus-natural material that has properties similar to those of animal skin. It is used for making bags, belts, shoes and clothing.
Zoa	Modern Meadow	Made from the collagen of animal cells. It is used to create a variety of leather products, from clothing to leather goods.
Spider Silk	Bolt Threads	Obtained by cultivating a species of spider in the laboratory and extracting the silk thread. A strong and flexible material, used in high-quality clothing and fashion accessories.
MycoFlex	Ecovative	This is a flexible, durable material, mainly used to create shoes and fashion accessories.

3. EXPERIMENTAL PART

3.1. Material and method

The study includes the manufacture of bioplastic samples with the following composition: agar-agar, glycerine, and water. The process and recipe are described in table 3.

Table 3: Bioplastic with agar-agar

Recipe	Process
• 2 gr agar-agar; • 1.25 ml glycerine; • 200 ml of water; • 1 gr denim yarn.	• Heat the water to a temperature of 60 degrees; • Add the plasticizer- glycerine; • Add agar-agar; • Stir until smooth and cook until a thick liquid is obtained; • Pour on the chosen surface and leave it to dry in a dry room.

For the manufactured samples, the following characteristics were determined: thickness, surface area, weight (table 4).

Table 4: The characteristics of manufactured bioplastic

Characteristics	Appearance		
	sample 1	sample 2	sample 3
			
thickness, mm	0,3	0,3	0,3
surface area, mm^2	132,7	132,7	132,7
weight, gr	5	5	5

3.2. Results and discussion

For studying how the characteristics of the manufactured biomaterial change in different environmental conditions, I did some researches. The environments were: high humidity (sample 1), temperature < 0^0C (sample 2), and high temperature (sample 3). Environmental conditions were simulated under laboratory conditions. Observations were recorded for different time periods: 3 hours, 8 hours, and 24 hours (table 4).

Table 4: Results

Environmental conditions	Characteristics	Results		
		3 hours	8 hours	24 hours
High humidity – 80…90%	thickness, mm	0,3	0,3	0,2
	surface area, mm^2	132,7	130,6	124,6
	weight, gr	5	4	2
Temperature < 0^0C	thickness, mm	0,3	0,3	0,3
	surface area, mm^2	132,7	132,7	132,7
	weight, gr	5	5	5
High temperature – 34…37^0C	thickness, mm	0,3	0,3	0,3
	surface area, mm^2	132,7	132,7	132,7
	weight, gr	5	5	5

Based on the recorded results, I made some graphs that represent the changes of the sample biomaterials in different environments and their changes over a period of time (fig. 1).

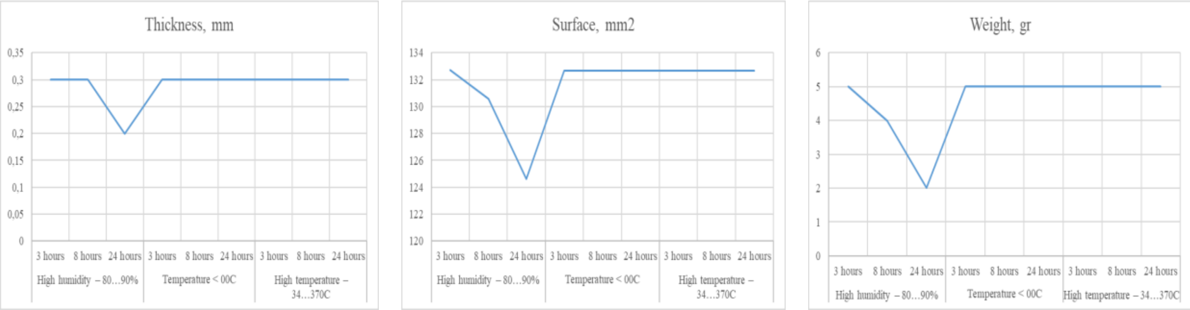

Fig. 1: The changes of the biomaterials characteristics in different environmental conditions

The obtained data allow for determining the resistance of the tested biomaterial in various environmental conditions and, subsequently, establishing concrete areas of use.

5. CONCLUSIONS

The samples of the manufactured biomaterial were tested in 3 different environments: increased humidity, temperatures below 0^0C and high temperatures:

- in the environment of increased humidity (80 ... 90%), the sample changed its characteristics of thickness, surface, and mass, being obvious a degradation of it;
- in environments below 0^0C and high temperatures (34...37^0C), the characteristics of the tested samples did not change.

The recorded data allow to determine the conditions and areas of use, as well as estimating the conditions of their biodegradation in a short period of time.

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