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BIO-SEQUINS FROM BIOMATERIALS – A SUSTAINABLE ALTERNATIVE TO MICROPLASTIC POLLUTION IN FASHION

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The research explores the role of biomaterials derived from natural resources, highlighting their advantages such as biodegradability, reduced carbon emissions, and user safety, as well as their limitations, including durability and cost-related challenges. The experimental section of the study focuses on producing bio-based sequins from natural ingredients through a controlled process of heating, casting, and drying. The results show that the aesthetic and functional properties of the biomaterial depend on the proportions of the components and technological parameters used. It is therefore possible to obtain bio-sequins with a uniform surface, moderate flexibility, and sufficient strength for decorative applications.

Key words: *microplastics, biomaterials, bio-sequins, sustainability, fashion design.*

INTRODUCTION

Microplastic pollution is one of the most serious environmental challenges of the 21st century, closely tied to the production and consumption of plastic materials across various industries, including the textile sector. The textile industry is considered one of the most polluting worldwide, significantly contributing to the release of synthetic microfibers and plastic particles that result from the breakdown of materials and decorative accessories [1].

A relevant example is the widespread use of sequins in fashion design. Most of them are made from polyvinyl chloride, which places them in the category of microplastics. These particles, smaller than 5 mm, can persist in the environment for long periods, contaminating soil, water, and food chains. Studies suggest that by 2050, around 22 million tons of microfibers could end up in the marine environment, with serious consequences for ecosystems and human health [2].

In response, recent research has focused on finding more sustainable alternatives, such as biodegradable biomaterials that can help reduce environmental impact. These include bioplastics, plant-based leather, and bio-based sequins made from natural ingredients - promising solutions for a more responsible and circular fashion industry [3].

PURPOSE

The aim of this paper is to highlight the negative impact of microplastics originating from decorative accessories used in the fashion industry - particularly synthetic sequins - and to examine the potential of biodegradable biomaterials as sustainable alternatives. It also investigates the feasibility of producing bio-sequins from natural ingredients within the framework of responsible fashion design.

RESULTS AND DISCUSSION

A. Biomaterials as Sustainable Alternatives

Biomaterials are an innovative category of materials derived from natural resources, characterized by their biodegradability and reduced environmental impact. Relevant examples include plant-based leather made from pineapple fibres (Piñatex), cactus leather, and materials created from food waste such as banana and apple peels [2-4].

In the field of textile decoration, a notable innovation is the bio-sequins developed by Radiant Matter. These are made from cellulose and structurally coloured, meaning they achieve their visual effect without the use of toxic pigments. They have also been featured in the collections of designer Stella McCartney, who is widely recognized for her commitment to sustainable fashion [2,4].

The advantages of biomaterials include biodegradability, reduced carbon emissions, improved health safety, and the ability to replicate the appearance of conventional materials [4].

However, their use also presents challenges related to strength, durability, and production costs, highlighting the need for ongoing investment in research and development.

B. Experimental Research on Bio-Sequins

As part of the study, several biomaterial formulations based on agar-agar, gelatine, glycerine, and water were tested with the aim of producing biodegradable sequins suitable for use in fashion design. The experiments showed that the final properties of the material depend directly on its composition and the processing technique. Increasing the amount of gelatine resulted in a stiffer biomaterial, while glycerine enhanced flexibility and prevented brittleness after drying. The use of silicone molds allowed for smooth, uniform surfaces, and the thickness of the cast layer influenced both drying time and the risk of biological degradation.

The bio-sequins were produced through an experimental method involving the preparation of a biodegradable biomaterial by boiling, followed by shaping and controlled drying. In the first stage, the main ingredients—water, gelatine, glycerine, and food-grade colorants—were prepared. Water acted as the dispersion medium, gelatin provided structure and strength, and glycerine ensured elasticity.

The ingredients were placed in a metal container, mixed continuously for homogenization, and heated over low heat until reaching the boiling point. The mixture was maintained at this temperature for approximately 5–6 minutes to allow complete dissolution of the components and the formation of a uniform, viscous mass. The hot biomaterial was then poured into special molds, using syringes or graduated spoons to control uniformity and layer thickness.

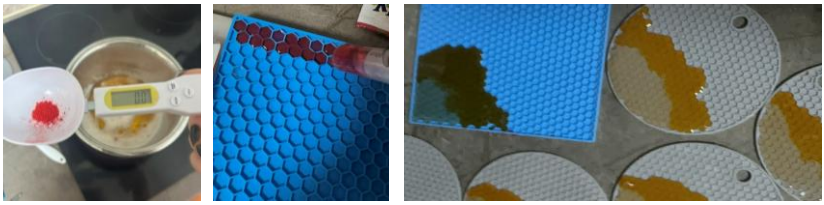

Fig. 1. The bio-sequin production process [5]

After casting, the material was left to dry at room temperature, under normal humidity conditions, for 3–5 days. It was observed that thinner layers dried more evenly and reduced the risk of mold formation compared to thicker ones.

Once completely dried, the bio-sequins were removed from the molds and evaluated. The resulting products displayed smooth, glossy surfaces, adequate rigidity, moderate flexibility, and could be easily perforated, making them suitable for integration into decorative textile items. By adjusting the proportions of the ingredients and optimizing the casting and drying stages, the optimal formula—based on water, gelatin, glycerin, and food-grade colorants—was established, enabling the production of bio-sequins with appropriate aesthetic and functional properties.

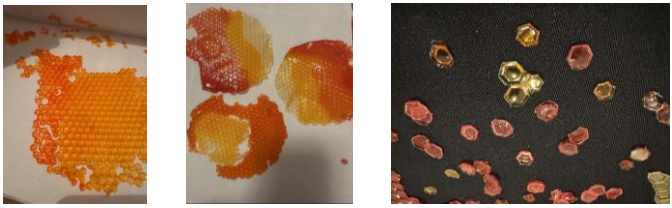

Fig. 2. The bio-sequins obtained in the study [5]

The research findings confirm the potential of biomaterials to replace plastic decorative accessories and highlight their contribution to reducing microplastics generated by the fashion industry. The next step involves integrating these bio-sequins into actual garments and testing their performance under real-life conditions of use.

CONCLUSIONS

Microplastics generated by the textile industry, including those originating from sequins, represent a major concern for both the environment and human health due to their persistence and ability to accumulate in ecosystems and organisms. Biodegradable biomaterials offer a viable and sustainable alternative, providing innovative solutions to reduce the negative impact of synthetic materials. Experimental results on the production of bio-sequins demonstrate that they can meet the aesthetic and functional requirements of the fashion industry.

However, widespread adoption of these solutions depends on: the development of production technologies; cost reduction; consumer education;

implementation of effective regulations. Looking ahead, integrating biomaterials into fashion design represents an important step toward a sustainable, responsible, and circular fashion industry. Additionally, further research is needed to optimize the mechanical and visual properties of bio-sequins for large-scale industrial applications. Collaboration between designers, manufacturers, and policymakers will be essential to promote sustainable practices across the fashion sector. Ultimately, consumer awareness and demand for eco-friendly products will play a key role in driving the transition toward a microplastic-free, environmentally responsible fashion industry.

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БІО-ПАЙЄТКИ З НАТУРАЛЬНИХ БІОМАТЕРІАЛІВ – СТАЛА АЛЬТЕРНАТИВА ЗАБРУДНЕННЮ МІКРОПЛАСТИКОМ В ІНДУСТРІЇ МОДИ

Дослідження вивчає роль біоматеріалів, отриманих із природних ресурсів, підкреслюючи їхні переваги, такі як біорозкладність, зменшення викидів вуглецю та безпека для користувачів, а також їхні обмеження, включаючи міцність і витрати на виробництво. Експериментальна частина дослідження зосереджена на виробництві біопайєток із натуральних інгредієнтів за контрольованим процесом нагрівання, формування та сушіння. Результати показують, що естетичні та функціональні властивості біоматеріалу залежать від пропорцій компонентів і використаних технологічних параметрів. Таким чином, можливо отримати біопайєтки з рівною поверхнею, помірною гнучкістю та достатньою міцністю для декоративного застосування.

Ключові слова: *мікропластик, біоматеріали, біопаєтки, сталий розвиток, дизайн одягу.*