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Green Fashion: Milk Fiber as An Alternative to Synthetic Fiber

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Abstract
Green fashion emphasizes sustainable and eco-friendly alternatives to traditional materials. Milk fiber, derived from casein protein in milk, offers a biodegradable and renewable option to synthetic fibers. It combines the softness of natural fibers with moisture-wicking and antibacterial properties, making it suitable for textiles. This innovation reduces environmental impact by utilizing milk waste and limiting reliance on petroleum-based fibers. In this paper, author explained about how milk fiber supports the transition to circular fashion practices.

Keywords: Natural fiber, Casein fiber , sustainable.

1. Introduction

Natural fibres cover both plant and animal origin fibers which possess excellent flexibility, fineness and a high ratio of length to thickness. These fibers are used in apparel and technical textiles in various sectors (Firoz Ahmed, et al., 2021).

Milk fiber is fiber made from the casein protein found in milk. This type of fiber is also called casein fiber (soma parven, 2023). Casein fibers are made using a viscose process, the same process used to produce viscose rayon. It takes 100 pounds of skim milk to make 3 pounds of milk fiber. Milk fiber is a blend of casein protein and the chemical acrylonitrile, which is used to make acrylic (Mazharul Islam Kiron, 2012). Milk fiber contains eighteen amino-acids .The pH of milk fibre is 6.8 which is same as human skin.Milk protein fiber is a blend of nature, science and technology that has benefits of natural as well as synthetic fiber (Neha Chauahn, et al., 2018). It biodegrades and is renewable. The major uses of casein until the 1960s were in technical, non-food applications such as adhesives for wood, paper coating, leather finishing and in synthetic fibers, as well as plastics for buttons, buckles etc (Diamond, 1939).Textile businesses have begun to adopt synthetic material alternatives in the interest of sustainability and eco-friendly manufacturing(AG Hassabo, et al.,2024).

2. Milk Fiber

A new generation of innovative fiber and a kind of synthetic fiber made of milk casein through bio-engineering method with biological health care function, natural and long-lasting antibacterial effect, which has got valid certification for international ecological textile certification of Oeko-Tex Standard 100 Authentication approved it in April 2004. It is most comfortable with excellent water transportation

and air-permeability. It is also more healthy, light, soft and colorful being resistant to fungus, insects and ageing (Neha Chauahn, et al., 2018).

2. 1 Types of milk fiber

There are two types of milk fiber,

2.1.1 Rennet casein

2.1.2 Acid casein

2.1.1 Rennet Casein Fiber

Rennet casein fiber is a type of protein fiber derived from milk casein, a protein found in mammalian milk. It is produced through a process involving the coagulation of milk with rennet, an enzyme extracted from the stomach lining of young animals.

Figure 1 : Rennet casein fibre

2.1.2 Acid Casein Fiber

Acid casein fiber is a protein-based textile material derived from milk casein, produced through an acid coagulation process. This fiber boasts excellent strength, elasticity, and moisture-wicking properties, making it suitable for various textile applications. With its natural origins, biodegradability, and sustainability, acid casein fiber is an attractive alternative to synthetic fibers, offering a unique combination of performance, comfort, and eco-friendliness.

Figure 2 : Acid casein fiber

3. Methods of milk fiber

Milk: The milk is dehydrated and skimmed to remove fat.

Extracting casein: Milk is mixed with acid to extract casein, which is then coagulated into a curd. The

curd is washed, dried, and ground into a powder.
Dissolving casein: The casein powder is dissolved in a caustic soda solution and left to mature.
Spinning: The solution is pumped through a spinneret, which has many small holes, and the resulting fiber is immersed in a coagulating bath. The bath contains sulfuric acid, formaldehyde, glucose, and water.
Hardening: The fiber is chemically treated to harden it, which is usually done with formaldehyde.
Washing and drying: The fiber is washed and dried.
Crimping and cutting: The fiber is mechanically crimped and cut into staple fibers.

3.1 Care of casein fibers

Washing : Garments containing casein fibers should be washed with care and treated very gently. High temperature and strong acid or alkaline conditions must be avoided. Neutral detergents are preferable for washing. Wash by hand or washing machine (in bag and weak force) under 350C. Don't use chlorine bleach (wash with chlorinated washing powder is not recommended)(Neha Chauahn, et al., 2018).
Drying : Garments should be dried as wool, care being taken to avoid high temperatures. Don't wring out or hang dry when the moisture content is over 50% (Neha Chauahn, et al., 2018).
Ironing : The full, soft handle of garments containing casein will be maintained if they are slightly damp or almost dry before being ironed or pressed. Wool settings should be used at ironing in medium temperature (or with steam) (Neha Chauahn, et al., 2018).
Dry cleaning : Casein is not affected by dry cleaning solvents and garments and can be dry cleaned readily as wool (Neha Chauahn, et al., 2018).

3.2 Properties of milk protein fiber

Table 1: Properties of milk protein fiber

PROPERTIES	INDEX
Fiber tenacity (dtex)	0.8-3
Breaking tenacity (dtex)	2.5-3.5
Breaking elongation rate (%)	25-35
Modulus (cN/dtex)	60-80
Standard moisture regain (%)	5.5
Specific resistance	1.5×104
Static friction coefficient	0.187
Dynamic friction coefficient	0.214
Color fastness to washing	4-5grade
Fastness to crocking	4-5 grade
Fastness to perspiration	4-5 grade

Color fastness to light	4 grade
Pilling resistance	3 grade

3.3 Benefits of sustainble textiles in milk fiber

Moisture absorption: Milk fiber absorbs moisture well, keeping skin cool and dry.
Breathability: Milk fiber is breathable.
Sun protection: Milk fiber protects skin from the sun's rays.
Softness: Milk fiber is soft and smooth.
The original production process for milk fiber used formaldehyde, which is toxic, and other chemicals that may be harmful to workers and the environment. A more modern method uses graft copolymerization, which doesn't use formaldehyde, but acrylonitrile, another known toxin and carcinogen.

4. Application of milk fiber

Apparel: Milk fiber is used to make a variety of clothing items, including T-shirts, underwear, sweaters, and sportswear. It can also be blended with other fabrics, such as cotton or silk, to create a smoother texture or reduce costs.
Home textiles: Milk fiber can be used to make home textiles like towels and bed sheets. It can also be blended with cotton or silk to create comfortable and robust home furnishings. .
Medical applications:
Milk fiber can be used in medical applications like wound dressings and surgical gowns. It is hypoallergenic, biodegradable, and can be sterilized easily.
Food packaging:
Milk fiber can be used as a sustainable alternative to petroleum-based packaging materials.
Casein fibers were commercially produced in various countries with trade names such as:
Aralac and Caslen (U.S.A), Lactofil (Holland),Cargan (Belgium),Tiolan (Germany),Silkool (Japan),Fibrolane (Enmarket),Lanital and Merinova in Italy,Wipolan in Poland.

5. Conclusion

In conclusion, milk fiber emerges as a sustainable and innovative alternative to synthetic fibers, it is an eco-friendly textile material known for its exceptional softness, breathability, and moisture-wicking properties. Hypoallergenic and suitable for sensitive skin, it is both biodegradable and compostable. Produced through wet spinning, milk fiber exhibits characteristics similar to wool and silk, making it an excellent choice for clothing, textiles, and even cosmetics. Its applications extend beyond fashion into the biomedical field, showcasing significant potential for advancing sustainable fashion and research. By addressing environmental concerns while delivering comfort and performance, milk fiber emerges as a promising alternative to synthetic fibers. Despite challenges such as higher production costs and limited scalability, this paper explores milk fiber's unique benefits and its transformative role in the textile industry.

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