Development of a Hemp/Wool Nonwoven Menstrual Product

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Abstract

The development of a nonwoven menstrual product made from wool and hemp blends was studied and strategized in this paper. This work aims to develop a zero-waste compostable nonwoven menstrual sanitary napkin with a compostable backing by utilizing natural properties of the fibers. In addition to creating a sustainable alternative in today's market the product also aims to tackle an alarming global environmental issue. Due to COVID-19 protocols, access to laboratory and studios were restricted, and therefore the development process has been slightly delayed.

Introduction

Background

According to National Geographic, it takes over 500 years for menstrual pads and tampons to break down in our landfills (1). Stanford Magazine states that over the course of roughly thirty-eight years of menstruation, 8,000 to 17,000 period products can be discarded in a lifetime (2). In the United States alone, approximately 12 billion pads and 7 billion tampons are discarded each year (2). In today's market, menstrual products are typically made from cotton fibers or a combination of cotton and rayon, also known as wood pulp. It has been shown that cotton and rayon blended pads backed with plastic adhesives have harmful effects on the environment throughout the product's entire lifecycle. Surveys have shown that menstruators are interested in sustainable products with the same functionality, but without radical changes in the design (3).

Purpose

The objectives of this study are to:
(a) design a menstrual pad solely from natural fibers
(b) replace the super absorbent polymer
(c) replace the plastic and latex adhesives
(d) provide a closed-loop product.

Materials and Methods

History

A menstrual pad is composed of a skin-friendly top sheet, followed by an acquisition distribution layer (ADL), a superabsorbent polymer (SAP) core and, lastly, a moisture proof back sheet. The ADL prompts the easy passage of liquids into the absorbent core (4). See Figure 1 for a visual representation of a menstrual pad.

Fig. 1. Anatomy of a menstrual pad.

Materials

Advantages of using a woolen material as the top sheet is to utilize the property of hygroscopicity of wool fiber. The fibers can absorb up to 30% of its own weight in moisture without feeling damp to the touch (5). Wool is naturally biodegradable and consists of the same proteins as the protective outer layers of our skin. Also, wool works alongside with our body's temperature due to its crimped texture (5). The tiny air pockets allow space for our skin to breathe. An additional natural benefit of wool is its anti-microbial properties which is a crucial factor for menstrual products (5).

The following ADL layer will be a wool and Hemp bast fibers (*H*bf) blend. *H*bf's hollow core is very breathable with excellent drying properties. Due to its hydrophilic nature, *H*bf can quickly absorb moisture and can absorb up to 20% of its own weight without feeling wet to the touch (6). Data reported in the Green Market Report shows a single hemp plant yields 220% more fiber than a cotton plant (7). In addition, it takes less resources, less time and less agricultural space to produce hemp (7).

SAP layer is typically made from sodium polyacrylate granules and absorbs up to thirty times of liquid its own weight (8). Studies have shown SAP material is not biodegradable and is linked to skin irritation, and toxic shock syndrome (8). Harmful bleaching agents are used on plasticizers of polymers and chlorine compounds (8). A potential alternative is making the absorbent core of hemp fluff pulp with a wicking finish such as miDori® bioWick, a plant seed oil-based wicking finish (9). This result will still be a cellulosic fiber without sacrificing sustainability or the wearer's health. By replacing the SAP layer with a wicking finish, the function of locking and blocking moisture from leakage will be achieved.

Next, is the up flow and leak-proof barrier. Hemp fiber is put through a fiber purification process using diluted sodium hydroxide to clean the fibers impurities (10). This results in removing the lignin without lowering the fiber's tensile strength. When separating the crystalline from amorphous regions it results in nanocrystals, a natural polymer to produce thermoplastics (11). By optimizing the extraction of cellulose nanocrystals, it creates a circular production. Recent

studies are researching the potential of sugar and glucose molecules derived from the hemp plant (12). This method of extracting crystalline regions and then combining them with the hemp derived sugar molecules may have the potential replace latex adhesives. By replacing the latex adhesives, the menstrual pad will then be 100% compostable.

Methods

Before the wool and hemp fibers are carded, they will be cut into 3 mm – 5 mm long lengths. By cutting the materials into short lengths, my prediction is it will help the menstrual pad breakdown quicker at the end of its lifecycle. In the following step, as previously mentioned, hemp will be purified with diluted sodium hydroxide to separate the crystalline and amorphous regions. Then, the wool top sheet and blended materials will undergo a carding process. This method will lay the fibers parallel and for a soft hand-feel rope called a sliver. The hemp fluff pulp will undergo an airlaid process like the Campen Machinery (13). All layers will be bounded by a hemp sugar heat finish to avoid adding any harmful chemicals or resins. See Figure 2 to visualize how the hemp fluff pulp will layered in between the ADL and moisture proof backing layers.

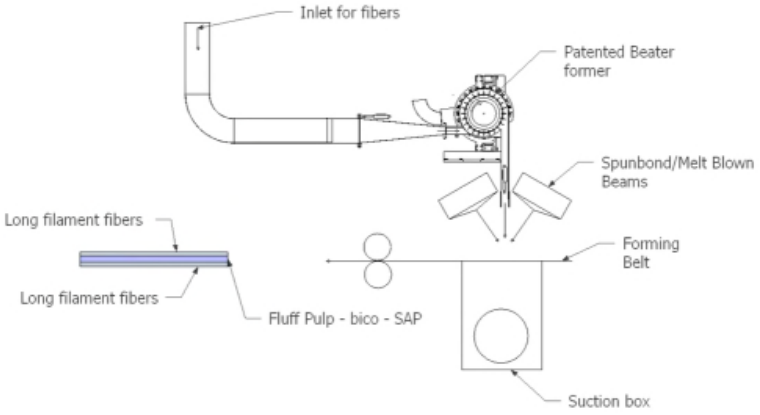

Fig. 2. Airlaid Campen Machinery with patent technology to create nonwoven materials.

After the ADL, hemp fluff pulp, and moisture backing has been combined, there is the option of adding the wool top sheet that is not depicted in the image (13).

Conclusion & Implications

Hemp is an excellent choice to consider for a menstrual product due to its antibacterial properties, high tensile strength, mildew resistance and biodegradable attributes (14). Wool compliments the hemp fiber due to its hygroscopic nature, and antibacterial properties. In

comparison to cotton, hemp fiber does not require herbicides, pesticides, or irrigation during the farming process (3). In addition, hemp's fiber purification process requires a less harsh chlorine bleaching process, due to the low lignin content (15). This study proposes the objective of developing a sustainable nonwoven wool and hemp blended menstrual product by altering its surface properties through mechanical and chemical production.

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