Dryer Balls As A Sustainable Product Option For Coarse Wool

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Background. As one of the first domesticated animals, sheep have been providing humanity with fiber for clothing since 10,000 BCE (International Wool Textile Organization, 2020). For centuries, wool fiber was used for making blankets, apparel and interior textiles (Broda et al., 2023). More than 1,000 sheep breeds now exist, including Merino and Rambouillet fine wool varieties used primarily for apparel (IWTO, 2020). Losing market share after the introduction of synthetic fibers, wool now accounts for 1.1% of the global fiber market (IWTO, 2020).

Wool fibers are protein fibers which belong to a group of α-keratin fibers (Varghese & Mittal, 2017). Keratin protein is the component of wool fiber, which has polypeptide chain with amino acid side chains arranged in a helical chain structure through strong hydrogen bonding (El Mogahzy, 2009). The surface of wool fibers is covered with scales, which create a differential friction effect (DFE) when fibers rub against one another (Kuffner & Popescu, 2012). When agitated or placed in water, the DFE causes fibers to move together and become entangled.

In wool fiber cultivation, wool waste remains an issue for modern farmers. An average sheep can produce up to 20% of wool unsuitable for conventional textile applications, so much so that this wool is often referred to as ‘waste wool’ (Utah Farm Bureau, 2017). The belly and hind-side fibers are commonly categorized as "short wool," with a staple length of less than 3 inches and fibers which have course grade (IWTO, 2020). These fibers are frequently thinner and have less waviness compared to longer wools, rendering them inappropriate for conventional yarn production. (Scobie et al., 2015). Coarse grade wool generated by sheep farming and the textile industry is frequently discarded in landfills or unlawfully disposed of (Broda et al., 2023).

Waste wool can be transformed into valuable goods using biotechnological methods such as microbial or enzymatic pretreatment and composting. These methods have the potential to minimize the ecological footprint and generate valuable commodities such as fertilizers, biogas substrates, peptides, amino acids, and keratinolytic enzymes (Starkova et al., 2022).

Dryer sheets are a product employed to enhance the softness of clothes, minimize static electricity, and impart a pleasant fragrance to clean clothes. Commonly, they are composed of a non-woven fabric, like polyester or cellulose, which is treated with a range of chemicals that provide softening and aroma properties (Nayak & Ratnapandian, 2018). Dryer Balls offer a reusable option to dryer sheets with the benefit of making commercial dryers more efficient.

Product Development Process. The product development process used to guide this project was adapted from May-Plumlee & Little (1999) and Davis & Sanders (2014). *Market Definition and Research.* Wool production represents about 1% of the global supply of textile fibers (Doyle et al., 2021). Demand for and production of wool continues to decline (Doyle et al., 2021). Wool is a luxury fiber, costing 4 to 7 times as much to produce as manmade and other types of natural fibers (Doyle et al., 2021). Due to this elevated cost, wool consumption tends to be related to a consumer's ability to pay rather than willingness (Doyle et al., 2021). *Merchandising.* A junior level Visual Merchandising and Promotion course at a large Western University helped to oversee and merchandising and promotion for this pilot run of dryer balls. These products were

sold on Etsy.com for prices ranging from $29.99 to $14.99 for a set of 4 dryer balls. Each variety was marked down weekly with additional advertising until inventory ran out or the course project concluded. *Design and Development.* The coarse wool fibers were provided by the University of Wyoming Sheep Unit. This wool was then cleaned and scoured by a local fiber processing business. The wet felting process was attempted in 3 different ways, using ½ to 1 ounce of wool roving. First, a ball of roving was hand spun, put in a nylon net, washed in a commercial washing machine's warm cycle with 5-10 g AATCC detergent for two cycles and tumbled dry for 1 cycle. Second, a ball of roving was hand spun and wet felted before being washed and dried in the manner described above. Third, the dryer balls were wet felted in three stages. This method produced the most cohesive and uniform final products and was used for the prototypes. We produced four varieties: 1) white color variety 2) single colored dryer ball variety, 3) multicolored variety, 4) sheep icon variety.

Prototypes.

For the white color variety, no additional design aspects were incorporated. For the single and multicolored varieties 1000 ml water was mixed with 15-20 g of green and blue fiber reactive dyes heated at 120 degrees Celsius for 30-60 minutes after the addition of the wool. For the sheep icon variety, heat transfer paper was used with an inkjet printer to produce the images. Then, the icons were ironed onto the dryer ball surface for 3 minutes at 90 degrees Celsius. To ensure there would be no color transfer from the sheep icon or dyed fiber varieties, dryer balls were soaked with water and went through the commercial laundering process.

Development Considerations. The pilot products were offered for sale on Etsy.com by a junior level merchandising course at large Western University. Demand was highest for the multi-color variety as this variety was the first to sell out of inventory during the markdown calendar, followed by the sheep icon variety and the single color variety. Only the natural variety had inventory remaining at the end of the sales period. Small scale wool fiber dyeing without industrial dyeing equipment presented some challenges. Dye color was not uniform throughout the length of the roving, in addition to some sections of the roving beginning to felt in the dye bath. Heat transfers to the round wool surface also proved difficult as consistent pressure on the round surface was challenging to achieve. The biggest barrier to expansion for this product is the manual labor needed in manufacturing. Each ball took 45 minutes to craft, meaning at $7.25 federal, hourly, minimum wage levels, labor alone costs $5.44 per dryer ball.

Conclusion. The study demonstrated the potential of recycling waste wool into lucrative items, particularly dryer balls. The study employed wool processing, wet felting, and creative design methods to produce four distinct dryer balls, which were subsequently marketed on Etsy.com. The multicolor variety was the first to be sold out, followed by the sheep symbol and single-color varieties. The challenges encompassed the dyeing process and heat transfer involved in creating design features, as well as the labor-intensive nature of the production process.

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