Literature Review: The potential for composting wool and bracken

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Executive summary:

Both wool and bracken have been considered as candidates for compost material, as both are materials that are considered waste or have limited commercial potential. No literature has been identified here which considers the potential of both materials when composted together, but for each individual material, studies have been conducted that indicate either material has potential in this respect. In the case of wool, the studies considered suggest that it is in fact necessary to mix this material with other more readily decomposable materials, to advance or enhance the decomposition process. Thus, bracken could be useful additive material in this respect, and worthy of further consideration.

What a search of the literature found:

No evidence was identified here for the principle of composting both wool and bracken material simultaneously. Studies were identified for either target material, and the results of those studies are summarised below.

Wool:

Wool is a natural fibre that has been historically used for the production of clothing. However, this material has recently become a popular candidate for use as a compost material due to the increasingly low economic value of this material as a textile fibre (Hustvedt *et al*., 2016). Wool is primarily composed of keratin, which is a natural source of nitrogen (N), potassium (K), phosphorus (P), and sulphur (S), (Zheljazkov, 2005; Hustvedt *et al*., 2016), and when applied directly to soil, decomposes slowly and acts as a slow release fertiliser. Wool is highly effective at retaining moisture, and can hold around 15-20% moisture content (Zheljazkov, 2005), which can improve soil water availability. Wool-based composts can however acidify soil (Zheljazkov *et al*., 2009), which could be beneficial in circumstances of high alkalinity, but for already low pH soil, may prove problematic.

Composting wool alone is potentially challenging for multiple reasons. It has a high chemical oxygen demand (COD) and biological oxygen demand (BOD) during breakdown, and contains large amounts of materials which are potentially unfavourable for decomposition (grease, sand, dirt, and residual livestock production chemicals) (Petek & Logar, 2021). Generally, studies that have considered the potential of wool compost are relatively rare. Trials identified here focus on the addition of materials to the compost mix to increase the potential for breakdown of the wool. Tiwari *et al*., (1989) considered wool composted with cattle slurry and rock phosphate, and concluded that wool mixed with 10% cattle slurry, and 2% rock phosphate performed best in terms of biomass reduction (decomposition) and subsequently as a compost in growth trials with chickpea and wheat crops. Hustvedt *et al*., (2016) trialled mixing sheep wool in different mixtures using woodchips, dried grass clippings, horse stall waste, food waste, and water hyacinth matter in varying proportions as sources of carbon (C) and/or N. This study concluded that 25% (v/v) of waste wool, mixed with 25% (v/v) of horse stall waste and 50% (v/v) of dried grass clippings was the best feedstock composition.

In addition to compost, wool has also been considered as a candidate for either substrate or fertiliser material. Studies which have this offer encouraging results. Crops which have been tested include cucumber (Böhme *et al*., 2005), petunias (Bilderback & Lorscheider, 2000), tomato, lettuce, and poinsettia (Böhme *et al*., 2010). Furthermore, when added directly to soil as an amendment, wool material had a beneficial influence on the growth of basil, thorn apple, peppermint, and garden sage.

Bracken:

Bracken (*Pteridium aquilinum* (L.) Kuhn) is a perennial plant that possesses certain biological characteristics which make it highly competitive, allowing it to expand effectively into new ranges and quickly dominate these new communities. Bracken produces a dense canopy of fronds which can effectively outcompete other plants for available resources such as light and can generate large amounts of litter to suppress colonisation by other species. In addition to this high level of productivity and competition, bracken has an extensive rhizome system within which large stores of carbohydrate and nutrients are contained (Marrs *et al*., 2000; Marrs & Watt 2006). Bracken can also produce potentially toxic compounds for defence against herbivory or disease infection. These substances are also believed to be allelopathic, which means they can be used to interfere or suppress the growth of other plants (Gliessman & Muller 1972; Marrs & Watt 2006). The characteristic of developing large underground stores of carbohydrates and nutrients makes this plant highly tolerant of disturbance and therefore control of this plant very difficult. One key form of control is cutting, which can result in large amounts of residual biomass which is a material ideal for composting.

Pitman (2000) reports that bracken is most effectively cut as it reaches maximum biomass at the end of July or early August. This timing avoids the sporulation period in late August, when airborne spores may pose a health hazard during harvesting activities, but notes the timing of this act is quite variable year to year. The harvested material is naturally N poor, K rich with a pH level < 5.0, at cutting. It can be composted safely and produces an almost chemically inert potting medium, with good water drainage characteristics. During composting, particle size declines but pH naturally rises. Composted bracken has a low buffer capacity, but too high pore space, except in mixes with other material (Pitman & Webber, 2013). Overall, composting of bracken material produces a compost which can be used for mulching, or as a low pH mulch or potting medium, suitable for growing calcifuge plants (Pitman & Webber, 1998).

Bracken does contain a carcinogenic material known as ptaquiloside. This can be broken down during the composting process in around 12 weeks, so long as composting temperatures of 60 ^{o}C are maintained, and the compost is turned regularly. It is noteworthy that bracken spores may release ptaquiloside over a longer period and may require up to 16 weeks composting time before this material is safe to handle (Pitman & Webber, 1998; 2013).

Summary:

No studies have been identified in this review that consider the potential of composting bracken material with sheep wool. Studies have been identified for either material, but none together. Studies that have been undertaken indicate bracken produces a suitable compost material for calcifuge or acid tolerant plant species, and that composting can eliminate unfavourable compounds, such as the carcinogen ptaquiloside. Wool is a good source of nutrients, but is reasonably decomposition resistant and breaks down slowly. To speed up the composting process, the addition of other organic, less decomposition-resistant material has been shown to enhance the composting process, and result in a material suitable as compost or slow release fertiliser.

One factor identified by this review which is potentially worth further consideration is the pH of the resultant compost material. Composting of bracken material typically yields an ericaceous compost, beneficial for acid tolerant plants. The literature suggests that wool too may result in material with a lower pH. When composted together the resulting compost material may offer a low pH growing medium, but further testing would be needed to confirm this.

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