2022 USAFRI Research Project Objectives

Alfalfa Value-Added Characteristics: Screening Cultivars for Beneficial Biochemical Compounds
USDA-ARS - Heuschele

Project Award: $93,215

Justification:

- Growing alfalfa within a crop rotation has positive environmental impacts such as stabilizing soils, decreasing nutrient inputs, and reducing nitrogen spring runoff in northern climates. All of these traits benefit other crops in the rotation. Unfortunately, alfalfa and alfalfa forage mixtures has declined by 7 percent from last year at approximately 49.2 tons in the US, while silage corn production was estimated at 130 million tons (Crop Production summary 2021) replacing alfalfa in diary forage rations. There are multiple reasons for this switch to corn silage and supplements; the major disadvantage of alfalfa is low biomass yields when compared to corn silage and the need for multiple harvests which increases labor and farm costs. Alfalfa producers need to break into new markets to expand business profits even as they still contribute to the environmental health of their farms and communities.

  Immature alfalfa is high in protein (Lamb et al. 2007), but the protein is rapidly fermented in the rumen to ammonia and not used efficiently (Broderick and Satter, 1998). Although, high quality alfalfa is palatable and often maximizes intake and production of dairy cows. Alfalfa is lower fiber and high in protein compared to other forages, which makes it an excellent complement for grains and other forages in dairy rations. The full benefit of alfalfa has not been realized due to the poor understanding of beneficial secondary compounds present that are utilized by the animal in low dosages. Additionally, alfalfa proteins and secondary compounds could be utilized for other uses. Investigations into extracting protein from the leaves for use in other agricultural markets is currently being investigated (Samac et al, 2019) as well as the optimizing protein extraction (Hadidi et al 2019; Hadidi et al 2020). However there has been little investigation into value added compounds alfalfa contains that would be beneficial to animal health and importantly, compete with soybean meal protein. Both alfalfa and soybean are complete proteins for human health by meeting the FOA requirements for essential amino acid profile (Table 1). For cattle, alfalfa meets 2 more essential amnio acid requirements compared to soy and a contains higher concentrations of most other amino acids (Table 1). Alfalfa also has been shown to provide 10% of the human daily requirement for Vitamin C, Vitamin A and Vitamin B1 (Escudero & Landabure, 1943), and meet cattle daily requirements for these vitamins (Hauge et al 1944), unlike soybean meal. Values of 10% or greater of daily requirements have the potential to be used as fortifiers in foods without additional processing. These biochemical traits also make alfalfa a quality source of protein for livestock stock additives compared to soybean meal (Table 1). These benefits of alfalfa have been documented to impact milk and meat quality (MacKintosh et al 2017). However, it is unknown what levels these vitamins are present in modern cultivars. We propose to screen modern cultivars for nutritional components that might have potential additive market value.

  Alfalfa unfortunately also contains chemicals that make it unpalatable to certain animals at high levels. These compounds include isoflavones, phytoestrogen and saponins. Reducing these chemicals through breeding of new varieties would improve palatability and livestock quality. However, these compounds also have potentials for new markets for alfalfa. Saponins in alfalfa have been documented to reduce cholesterol (Asgary et al, 2008) and blood glucose levels (Salih & Azeez, 2019; Amaie et al. 2015). Modern cultivars that contain high levels of these compounds could be used to create pharmaceuticals, while cultivars with low levels could continue to be used as high-quality livestock forage. Quantification of the variability of these compounds can be found in alfalfa cultivars would lead to new breeding targets for

both the food and feed markets. With further investigation into alfalfa nutritive quality, could result in alfalfa being an environmentally friendly source of plant-based protein with high vitamin content for human consumption and increase the need for alfalfa acreage.

Objectives:

- The objectives of this project are to 1) Measure protein profiles from three commercial alfalfa cultivars and two soybean cultivars to compare value-added characteristics that would affect future market potential (i.e., vitamins, phytoestrogen, and saponins); and 2) Screen 50 lines (cultivars or accessions) for two value-added traits identified in objective 1 important to either current animal or future human market potential.