Objectives: We aim to develop processes to convert peanut shell into value-added bioplastics and chemicals, and thus generate expanded nonfood markets for peanuts while reducing dependence on petroleum-based plastics. Bio-based materials from peanuts will be high-value, sustainable, and safe for people and the environment.

What is done: Lignocellulosic fibers and particles from plant biomass represent important feedstocks for plastic reinforcements. The primary benefits of lignocellulosic polymer reinforcements include their low cost, stiffness, low density, and reduced abrasiveness compared to traditional mineral and glass fiber reinforcements. Ground peanut shells (GPSs) represent a promising low cost lignocellulosic-based reinforcement for plastics. The general composition of GPSs has been reported to be 45% cellulose, 36% lignin, 6% hemicellulose, 5% protein, 4% ash, and 0.1% fat.

Similar to other lignocellulosic fibers and particles derived from plant biomass, technical challenges associated with these materials include poor compatibility with non-polar polymer matrices, such as polyolefins (POs), and the presence of thermally unstable components that undergo substantial thermal degradation during plastic process, such as extrusion and injection molding. The thermally unstable components include waxes/oils and hemicellulose. For the project, PO-based plastics reinforced with unmodified and modified GPSs are being investigated. The variables being investigated include the nature of GPS modification and the use of maleated PO (mPO) coupling agents. The GPS modification methods include solvent extraction, NaOH treatment, and NaOH treatment followed by treatment with $NaClO_2$/acetic acid solution. The function of the mPO is to enhance the strength of the plastic by enabling compatibility between the PO matrix and GPS reinforcement via reaction of the anhydride groups of the mPO and cellulose hydroxyl groups present at the surface of GPS particles. Synergy between GPS pretreatment and the use of the mPO is expected since removal of lignin, proteins, waxes/oils, and hemicellulose enriches the content of cellulose in the particles and increases accessibility of cellulose hydroxy groups for reaction with the mPO.

At present, methods for GPS modification and quantifying changes in chemical composition have been developed. In addition, a method for compression molding GPS-reinforced PO plastics into sheets in order to produce specimens for determining mechanical, viscoelastic, thermal, and rheological properties has been put in place. All PO-GPS plastic compositions will be produced and fully tested and characterized once appropriate melt mixing rotors that have been ordered are received. Using statistical design software, those compositional factors that influence plastic performance will be identified along with any higher order interactions between compositional variables. A model derived from statistical analysis will provide predicative capability for optimizing PO-GPS-based plastic formulations that possess a specific desirable set of properties.

Impact: This research is important for peanut growers because it aims to increase demand for peanuts by discovering novel nonfood applications. New value-added products can expand their market opportunities beyond traditional food uses and increase domestic demand in case there is a decline in peanut exports due to factors such as trade agreements, price, quality, overseas regulatory requirements, and competition.