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| Project Title | **Novel new functional edible protein films from soybean using innovative 3D printing technology** |
| PI’s Name | Navam Hettiarachchy | E-mail | nhettiar@uark.edu |
| PI’s Title | University Professor | Institution: | Food Science, University of Arkansas, Fayetteville |
| Mailing Address | 2650 Young Ave. |
| City/State/Zip  | Fayetteville, AR 72704 |
| Phone number | [(479) 575-4605](https://www.google.com/search?q=food+science+university+of+arkansas&rlz=1C1GCEA_enUS947US947&oq=food+science+university+of+arkansas&aqs=chrome..69i57j46i175i199j0i22i30l3.5760j1j7&sourceid=chrome&ie=UTF-8) |
| Additional PIsFor this project | Drs. Leandro Angel Mozzoni; Pengyin ChenCollaborator Dr. Ali Ubeyitogullari |
| Research Locations (and states involved) | Crop Soil and Environmental Sciences, University of Arkansas, Fayetteville, Arkansas, Soybean Breeding and Genetics, University of Missouri, Portageville, Missouri, Department of Food Science (Collaborator) , University of Arkansas, Fayetteville, Arkansas |
| **Timeline:****Current Year - FY22** | **Multi-Year Project Information** (if applicable) |
| Year 1 Research in progress | Year 2 Requesting | Year 3 |
| Start Date | **2021** | **2021** | **2022** |  |
| End Date | **2023** | **2022** | **2023** |  |
| Total Funds Requested | **$53,073** | **$ 22,440** | **$ 30,633** | $ |
| **Program Area (e.g., breeding, mngt.): Other – New uses** |
| Objectives | 1. Prepare soy protein isolate and hydrolysates from soybean seeds grown in Mid-South (lines R16-5065 from Arkansas and S17-17168 from Missouri). 2. Optimize conditions and prepare homogeneous film solutions with soy protein isolate, glycerol, malic acid and phenolic extract from rice bran (antioxidant), and investigate flow properties. 3. Optimize conditions and extrude soy protein film using 3D printing technology, investigate the physical properties of the extruded films for color, tensile strength, and antioxidant activity of the extruded film.  |
| Justification | Plastic packing materials are non-biodegradable, a threat, and cause environmental pollution. The global plastic packaging market size is projected to reach USD 320.94 billion and potentially causing environmental pollution level higher. Soy protein, a by-product of the oil processing industry has the potential as a resource in the development of edible films as packaging material.  Innovative new uses are in demand for soybeans to compete with other legumes like pea to boost its price in the market. This proposal will lead to development of novel and unique one of a kind edible film formulation using 3D printing technology. The PI’s lab invented an edible film that incorporated organic acids in the edible film by spreading technology that was effective against a wide spectrum of pathogens and was used to coat raw whole fresh-cut fruits and vegetables and also in preserving and packaging of meat, poultry, and seafood. We will use this experience in using all-natural materials including malic acid as a plasticizer and polyphenolic extract from rice bran as antioxidants to produce the edible film with soybean protein with quality using a 3D printer. The edible film with high protein will not only serve as an environmentally friendly packaging material for food products but also as a functional film for encapsulating dietary supplements. Furthermore, the future drug delivery system trend is also focusing on the use of edible films to deliver unpalatable compounds. Soy protein-based edible bioactive film has a high potential to manufacture food packaging. To keep up with the trend food manufacturers are interested to adopt 3D printing |
| Justification | technology, which is robust, automated, convenient, and reduces ingredient waste. The future in manufacturing edible films focusing on 3D printing is a technology that is in demand by the business world. We are proposing to use this promising technology for the *first time* to produce protein-based edible films to preserve and packaging of perishable food products from soybeans. The business world is looking forward to this technology. This is the first time that soybeans grown in Mid-South will be processed for edible film production using 3D printing with sound science. We are making successful research progress from funds received for the first year of this project |
| Exp Setup | 1) Arkansas-grown (R16-5065) and Missouri -grown soybean line (S17-17168) were ground and passed through a 60-mesh sieve into flour and the flour was defatted using hexane (1:3 flour-to-hexane ratio, 3 times), protein isolate and the hydrolysates will be prepared. The protein content will be determined using a reference Kjeldahl method which is routinely used in PI’s laboratory. 2) Response surface methodology will be used to optimize concentrations of soy protein isolate/hydrolysate (30-70%), glycerol (0.50-2% w/v of the protein), malic acid (1-3% w/w), and phenolic extract (2-5% w/v) to prepare the edible film, viscosity of the solution will be measured. 3) Nozzle height (2, 3, 4, 5 mm) and nozzle diameter (15, 20, 30, 40 mm2) in the 3D printer will be optimized, edible film will be extruded, dried in a smart oven, color of the film will be measured (s (L\*, a\*, b\*) using Chroma meter. Tensile strength and antioxidant activity will be evaluated using the texture analyzer (TA/XT2i) and DPPH (2, 2-Diphenyl-1-picryle-hydrazyl) assay method respectively.  |
| Summary  | This study will investigate utilizing soy protein in the production of edible packaging material with antioxidants using a novel 3D printing technology. Soy proteins and hydrolysates will be prepared from high protein soybean lines grown in Arkansas, and in Missouri (one line from each state) by an alkaline extraction and enzyme procedures. Conditions will be optimized to prepare film solutions with soy protein isolate (and or hydrolysate as needed) with glycerol and malic acid as plasticizers to facilitate the extrudability in a 3D printer,Flow properties of the film solutions will be evaluated by a viscometer. The 3D printed edible films will be evaluated for color, antioxidant activity and tensile strength. This newly produced environment-friendly soy protein-based edible film can serve as an alternate packaging to synthetic plastics and reduce the environmental landfill problem, has the potential of sharing the market with the plastic packaging industry and benefit the growers fetching a higher price for value addition. |
| Key Metrics | Edible film with soybean protein with quality using a 3D printer will be produced using all-natural materials including malic acid as a plasticizer and polyphenolic extract from rice bran as antioxidants. Research is in progress to complete objective one and a part of objective 2The edible film serves as an environmentally friendly packaging material for food products and as a functional film for encapsulating dietary supplements. This formulation and novel technology will produce edible films instantly, precisely, and cost-effectively in minimizing food waste, and encourage entrepreneurship. |
| Expected Deliverables | 1-2 journal publications and 1-2 poster presentations. A potential entrepreneur is interested in using the edible film for packaging.  |
| Benefit to midsouth farmers | The finding of this research will have a positive economic benefit to Arkansas, Missouri and other Mid-South soybean growers. The results of this research will also position the soybean growers to capitalize on the soybean market and expand to using other potential high protein soybean lines grown in mid-south for market expansion profiting the growers with high value. |
| Progress Made | The soybeans have been acquired. Prepared soy protein isolate and hydrolysates from soybean seeds grown in Mid-South, evaluated for protein and moisture content. Optimization of parameters for 3D printing are under progress. |
| Signature of Principle Investigator | Date: |
|  | July 14, 2021 |