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| Project Number:  | 1730-352-0502 |
| Project Title:  | Soy Protein Products From Aqueous Extraction Process: Method Optimization, Quality Evaluation and Growth Performance in Trout Feeding Studies – Phase I |
| Organization:  | U.S. Department of Agriculture, Agricultural Research Service |
| Principal Investigator Name: | Keshun Liu |
| Project Status - What key activities were undertaken and what were the key accomplishments during the life of this project? Please use this field to clearly and concisely report on project progress. The information included should reflect quantifiable results (expand upon the KPIs) that can be used to evaluate and measure project success. Technical reports, no longer than 4 pages, may be included in this section.  |
| The key objective of this research project was to develop and optimize an aqueous extraction process that uses water instead of hexane as a solvent. The process separates oil and protein from soybeans simultaneously and produces a new soy protein product, which has a protein content between defatted meal and a protein concentrate, but has significantly reduced concentrations of both heat liable and heat stable anti-nutritional factors as compared to hexane defatted soymeal. As a whole, the proposed research was a 2-year project, with Phase 1 for the first year and Phase 2 study for a following year. The Phase 1 research was funded by USB via SAA, and is what this final report concerned about. It consisted of several sub-objectives: 1) method development of soybean alternative processing in a lab scale, 2) chemical evaluation of a new soy protein produced by the lab scale, 3) production of the new soy protein product by a pilot plant, 4) chemical evaluation of the new protein product produced by the pilot processing, and 5) digestibility testing of the pilot plant produced protein product through rainbow trout feeding trials. Phase 2 Research is a follow-up study, to be done in the second year through a subsequent proposal submission. It will focus on comparison of the new product to defatted soybean meal and fishmeal through trout feeding study, with respect to growth performance and pathophysiological changes such as distal intestinal enteritis in rainbow trout. This follow-up study has not been funded by USB through SAA yet.For Phase 1 research, the one-year term contract agreement between SAA/USB and USDA started on October 1, 2016 and ended on Sept 30, 2017. However, it took almost half year for the two parties to complete negotiation of the agreement. So the contract was finally signed by both parties in late February, causing about 6 months delay of the project. This was unexpected. Furthermore, since the contract agreement could not be extended, the Phase 1 study had to be abruptly terminated. As a result, only the first two sub-objectives of the Phase 1 research were achieved. The rest three sub-objectives of Phase 1 research (the second half year of Year 1) were unfinished. In other words, for the proposed 2-year research, we only had about 6 months (1/4 of the total time needed) to work on it, and used only a fraction of the USB fund allocated. With regard to the first sub-objective of the Phase 1 research: method development of soybean alternative processing in a lab scale, the following is what we accomplished. We first obtained soybeans samples from two sources, and then set out to conduct an experiment with an objective to investigate the effect of pretreatments on aqueous extraction of protein and oil from soybeans. The pretreatments included heating, extruding, and pressing. Aqueous extraction was carried out in a laboratory setting. We investigated at their effects on 1) oil extraction into the supernatant, 2) oil retention in the remaining residue, 3) protein extraction into the supernatant, 4) protein retention in the remaining residue, and 5) the presence/mass of any oil fraction that is floating as a top layer. We found that all the pretreatments had significant effects on these parameters. With an optimized processing condition, a new soy protein product with a protein content around 65% and fat content around 4 could be produced. This product was obtained without use of any organic solvents (hexane and/or ethanol). With regard to the second sub-objective of the Phase 1 research: chemical evaluation of a new soy protein produced by the lab scale, the following is what we accomplished. By a lab scale, we obtained several porotype soy protein products under optimal conditions. In order to determine their suitability as trout feed, we analyzed these samples for contents of key nutrients (protein, oil, ash and total carbohydrates). We also focused on assay for levels of some anti-nutritional factors such as trypsin inhibitors, phytate and oligosaccharides in these samples. Results show that our aqueous extraction method could reduce the content of oligosaccharides by 80% and phytate by 60% of the amounts present in the original raw soy material. As for trypsin inhibitor activity, the aqueous process itself caused significant reduction, but further reduction could be achieved only by a heat treatment, which can be applied easily after the protein product is made. Based on chemical analysis of nutrients as well as anti-nutritional factors, we concluded that the newly made soybean protein products are suitable for fish feed. Since we only worked on the proposed Phase 1 study for about half year due to delay in reaching a contract agreement and failure to get extension for the project, the rest three sub-objectives of Phase 1 study were unachieved. This was unfortunate, because, due to early termination, we have not had a chance to scale up the new method in a pilot plant, make into trout feed, and conduct nutrient digestibility study by feeding trout.  |
| Did this project meet the intended Key Performance Indicators (KPIs)? List each KPI and describe progress made (or not made) toward addressing it, including metrics where appropriate.  |
| For the proposed 2-year research, there were five intended KPIs. Yet, because we only had 6 months (¼ of total time required) to work on it, and used only a fraction of fund allocated, we were able to address the first KPI only, leaving the rest 4 KPIs unaddressed.1. This project will deliver alternative soybean processing that will make U.S. soy products more suitable as feedstuffs for domestically produced fish, as well as fish grown abroad, since the aqueously defatted soymeal will be more nutritionally similar to fishmeal. The project will improve U.S. soy protein as a better alternative protein source in fish and shrimp feeds and result in higher inclusion levels. Progress was made toward addressing this first KPI. See the report and summary in the Project Status above.2. Animal nutritionists (including fish nutritionists) will examine the new soymeal using different fish or animal models and comparing it to traditional soymeal as a better fishmeal replacement.3. Feed manufacturers will evaluate how this new protein ingredient can be formulated into the feed they are producing. Food processors (particularly the organic sector) will be interested in the new oil made by the process and begin to incorporate the oil into their products.4. The project will increase demand for U.S. soy products in aquaculture feeds for the global aquaculture industry. The aqueously defatted soymeal is particularly suitable for farmed species. The enabling technology, if transferred to international aquaculture production, will lead to higher and better soymeal use in aquafeeds. 5. Finally, American soybean producers will find their soybeans more value-added and higher market-demanding as more and more soybeans are processed into the new protein product for use in aquafeed. |
| Expected Outputs/Deliverables - List each deliverable identified in the project, indicate whether it was supplied and if not supplied, please provide an explanation as to why. |
| Due to incompletion of the proposed Phase 1 study, the deliverable was not supplied.  |
| Describe any unforeseen events or circumstances that may have affected project timeline, costs, or deliverables (if applicable.) |
| Negotiation of the contract agreement and final signature by the two parties took unexpected longer time. We thought that the time lost due to agreement negotiation by the two parties could be compensated by allowing project extension. Unfortunately, for some reasons that are hard to understand from researchers’ perspective, no extension of the funded project was allowed. A large portion of the allocated fund for the project had to be returned, as a result, we had to terminate the unfinished project.  |
| What, if any, follow-up steps are required to capture benefits for all US soybean farmers?Describe in a few sentences how the results of this project will be or should be used. |
| In order to capture benefits for all U.S. soybean farmers, the following follow-up steps are required: 1) Pilot scaling up of the new method developed in the USDA lab, 2) Chemical analysis and quality evaluation of the new soybean protein product that is produced by pilot plant processing, 3) Formulate and make new feed with the new protein product, and feed trout for nutria digestibility study, and 4 ) Conduct a larger trout feeding study for growth performance, monitor pathophysiological changes such as distal intestinal enteritis in rainbow trout, and compare with defatted soymeal and fishmeal. A new funding is required for carrying out these follow-up steps. |
| **List any relevant performance metrics not captured in KPI’s.** |
| None |