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Overview

Dr. Sajid Alavi, is the supervisor of the Extrusion Program in the Department of Grain Science and Industry. This research program has a strong emphasis on all three major academic activities - service, research and teaching. At the core of the extrusion program is the Extrusion Pilot Lab which is housed in the new Bioprocessing and Industrial Value-Added Program building. The Extrusion Pilot Lab has a variety of production facilities including a pilot scale Wenger TX-52 twin screw extruder, a pilot scale Wenger X-20 single screw extruder, and a Wenger Series 4800 gas-fired dryer. Additionally, the Extrusion Labs in Waters 47 and Waters 02G have a lab scale American Leistritz Micro 18 twin screw extruder, various analytical equipment and bench space for analysis of raw materials and extruded products. Dr. Alavi is involved in extrusion related research projects including - 1) phase transition analysis for understanding structure formation in extruded products, 2) use of non-invasive X-ray Micro Tomography (XMT) for characterizing extrudate micro-structure, 3) structure – texture relationships in expanded food products, 4) developing improved extrusion process control systems, 5) use of sorghum and other novel ingredients for producing new extruded food products, 6) production of specialty aquatic feed, and 7) use of biological ingredients for non-food/ industrial applications. Currently there are two Ph.D. and one Masters level graduate students, and one full-time post-doctoral associate engaged in extrusion related research under Dr. Alavi's supervision. Additionally, there are two graduate students from Physics and Computer Science, and one undergraduate student from Electrical Engineering involved in various extrusion-related research projects. The Extrusion Program also works in collaboration with other on-campus and off-campus researchers, with several other graduate students working on extrusion-related research. In the two and a half years since April 2002 when Dr. Alavi was appointed to the Grain Science and Industry faculty, the Extrusion Program has been successful in securing one major funding of \$250,000 from the USDA-NRI program for a three year period between 2003 and 06. Currently several proposals to different funding agencies including USDA, NASA, and Kansas Wheat Commission are pending or in various stages of approval. At least 8 manuscripts are near completion or submission to major peer-reviewed journals.

Additionally, the Extrusion Program provides services to the industry for pilot and bench-scale trial runs for various products. In FY04, approximately 300 hours of extrusion time was spent on activities related to both industry and research. Out of this,

about 85% time was spent on industry related work, and the rest was spent on academic research (for both on-campus and off-campus researchers) and laboratory classes. In FY05 until December 04, about 300 hours of extrusion time was spent on activities related to both industry and research. Out of this, about 65% time was spent on industry related work, and the rest was spent on academic research and laboratory classes. Some of the companies which utilized the services of the Extrusion Program were Wenger Manufacturing, Phibro, Safeway, Abbott Labs and Kemin Nutrisurance. Products made included pet food, corn puffs, sorghum puffs, soybean puffs, pasta, snack food, breakfast cereal, aquatic feed, corn starch, wheat starch.

Teaching of undergraduate and graduate level extrusion classes is an important aspect of the Extrusion Program. GRSC 720 Extrusion Processing in the Food and Feed Industry is a senior level extrusion class which was offered in Fall 2002 and 2003, and will be next offered in Fall 2005 by Dr. Sajid Alavi with emphasis on introduction to extrusion technology and hands on laboratory exercises. In addition, a graduate level extrusion class GRSC 820 Advanced Extrusion Processing was first taught in Fall 2004 and will be taught next in Fall 2006.

Impact

Agricultural products which utilize extrusion technology constitute approximately a \$40 billion annual market in the U.S. alone. This includes breakfast cereal, snacks, pasta, pet food, aquatic feed, and bio-based industrial materials. The Extrusion Program in the Department of Grain Science and Industry is an invaluable asset to the ongoing quest for enhancing the value of Kansas agricultural commodities like wheat, corn, sorghum and soybean. The program includes ongoing research at both fundamental and applied levels for further developing extrusion technology for food and feed processing, and utilizing commodities like wheat for non-food applications like biodegradable packaging. The Extrusion Program works very closely with regional and national agro-industry and provides services and consultancy to a range of companies like pet food manufacturers (example, Safeway), food processors (example, Kellogg's), new technology companies or organizations (example, Nanoscale and NASA) and equipment manufacturers (example, Lockheed Martin, Agrichem and Wenger Manufacturing). The relationship with Wenger especially is very beneficial to the State of Kansas as a whole, as it serves as both a catalyst and a testing ground for new processing technologies. Apart from research and industrial activities, the teaching aspect of the Extrusion Program ensures that Grain Science and Food Science graduates from the University are well versed with latest processing technologies.

Future Goals and Needs

In the coming years, the Extrusion Program will continue its strong emphasis on the above mentioned thrust areas for research, teaching and extension. In addition, we will increase efforts towards collaboration with other value-added agricultural products, and petfood and animal feed research being conducted at K-State. The Extrusion Center facilities moved to the new Bioprocessing and Industrial Value-Added Program (BIVAP) facility in Spring of 2004. This move has been very helpful in better coordination of value-added research activities with other researchers and has improved access to Kansas entrepreneurs who are interested in employing new cutting edge processing technologies for utilization of agricultural commodities.

Some of the important needs of the Extrusion Program in the near and long-term future include –

- A self-contained laboratory in the BIVAP building exclusively for extrusion-related laboratory equipment, graduate students, and post-doctoral associates.
- Department support for at least one new graduate student every year. This is especially important as the Extrusion Program is relatively nascent (full-time faculty reinstated in April 2002) and requires a few years before it can be self-sustaining for funding through federal and regional grants and industry sources.
- A second full-time post-doctoral associate costing about \$40,000 a year.
- More laboratory/ analytical equipment for extrusion and rheology-related research. This will tentatively cost about \$200,000.
- A second pilot-scale dryer. This will tentatively cost around \$500,000.
- Several more processing equipment including pilot-scale flaking rolls, puffing gun and cooking kettles. These will tentatively cost around \$500,000.

Strategies to Meet Goals and Needs

The Extrusion Program will work aggressively towards fulfilling the above mentioned goals and needs by – 1) strategic partnership with major industry partners like Kelloggs, Wenger, ADM, and Lockheed Martin and 2) extensive solicitation of funding from external agencies such as U.S.D.A., N.S.F. and NASA, and regional commodity organizations with research focus on the areas of new value-added applications of existing ingredients, novel ingredients for processing, space food for lab animals and humans, non-invasive technologies for microstructure characterization and structure-texture relationships, and improvement of extrusion process control.