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Dept. of Grain Science and Industry

Impact Report 2005

Program or Project: Extrusion Program

Issue Statements:

FNHS1 Promote a Safe Food Supply from Production to Consumption
FNHS3 Develop New, Appealing Food Products
AIC3 Enhance the Value of Kansas Agricultural Goods
AIC5 Develop Agricultural Technologies and Information Systems

Faculty Member: Alavi, Sajid

Department or Planning Unit: Grain Science and Industry

Additional Team Leaders: Keith Behnke, Susan Sun, Tom Herald, Scott Bean (USDA)

Summarize Program:

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 in research, teaching and service. The extrusion program is based on pilot-scale processing equipment in the Bioprocessing and Industrial Value-Added Program facility and lab-scale processing equipment in Waters Hall. Pilot scale equipments include single and twin screw extruders, a gas-fired dryer and a batch mixer. Lab-scale equipments include a twin screw extruder that allows time-efficient study of novel ingredients and processes in an economical manner, before scaling up for pilot runs. The extrusion program also has access to various analytical equipments including differential scanning calorimeter, phase transition analyzer, texture analyzer, controlled humidity chamber and supercritical fat extractor, and adequate bench space for analysis of raw materials and extruded products.

Dr. Alavi is currently involved in several 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) use of sorghum for producing new extruded food products, and 5) starch-clay nano-composites for improved barrier and mechanical properties. Currently there are two Ph.D. students, one M.S. student, and two full-time post-doctoral scientists engaged in the above mentioned research under Dr. Alavi's supervision. Additionally, there is one co-supervised graduate student from Computing and Information Sciences, who is working on development of image analysis software. Dr. Alavi is also involved in collaborative

work with other researchers. These include several on-campus faculty members from Grain Science, Animal Science, Human Nutrition, Computing and Information Sciences, and off-campus researchers from USDA, Iowa State University, California State University, Cornell University and Auburn University.

In the three 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 grant of \$250,000 from the USDA-NRI program (2003-06), and smaller grants from other sources including \$29,000 from the Kansas Wheat Commission (2005-06). Currently several extra-mural proposals to different funding sources, including the USDA, are pending. Three peer-reviewed manuscripts have been published from work originating at Kansas State University, and at least 10 other manuscripts are near completion or under consideration by peer-reviewed journals.

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 with emphasis on introduction to extrusion technology and hands on laboratory exercises. This class was offered by Dr. Sajid Alavi in Fall 2002 and 2003, and will be next offered in Fall 2006. 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 2007.

The Extrusion Program provides services to the industry for pilot and bench-scale trial runs for various products. In 2005, a total of 1092 hours were devoted to performing extrusion runs for industry, research and teaching purposes. 85% of the total time was devoted to service for industry while the remaining time was spent on research and teaching activities. The number of hours of extrusion time was a substantial increase from that in 2004 (440 hours) and 2003 (250). Companies and organizations utilizing the extrusion lab facilities included Wenger, American Institute of Baking (AIB), Cargill, Industrial Microwave Systems, AFB, Kemin Nutrisurance, Heartland Ingredients, Lockheed Martin and National Aeronautical & Space Administration (NASA), and Agrichem (a Minnesota-based online sensor manufacturer). Projects involve a diverse range of products and applications including pet food, experimental animal food, corn puffs, sorghum puffs, pasta, snack food, breakfast cereal, aquatic feed, pregelatinized wheat starch, and various industrial products.

Summarize 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 agricultural commodities for value-added applications like biodegradable packaging

and encapsulation. 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, AFB, Doannes Petcare), ingredient companies (example, Cargill), government organizations (example, NASA) and equipment manufacturers (example, Agrichem, Industrial Microwave Systems, 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. The research, teaching and industrial activities of the extrusion program are well-aligned with the mission of the Bioprocessing and Industrial Value-Added Program (BIVAP) and lead to a very unique integration of various disciplines across the University, including Agronomy, Grain Science and Industry, Food Science Institute, Electrical Engineering, Biological and Agricultural Engineering, Computing and Information Sciences, and Business Administration.

Summarize Next Steps:

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 continue efforts towards collaboration with other K-State researchers in the areas of food biosecurity, value-added agricultural products, petfood and animal feed research.

Important needs of the Extrusion Program in the near and long-term future

- Continued departmental support for at least one new graduate student every year. This is especially important as the Extrusion Program is relatively new and requires a few years before it can be self-sustaining for funding through federal and regional grants and industry sources.
- Continued funding support for at least one 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.
- 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 Wenger and Frito-Lay and 2) extensive solicitation of funding from external agencies such as U.S.D.A., N.S.F., and regional commodity organizations with research focus on the areas of new value-added applications of existing ingredients, novel ingredients for processing, non-invasive technologies for microstructure characterization and structure-texture relationships, and improvement of extrusion process control.

Percent of Faculty Time Invested: 100

Number of Volunteers Involved: None

Total Volunteer Hours: none