A Progress Report from the
Institute of Food Science and Engineering
University of Arkansas Division of Agriculture

from field to table
The Institute of Food Science and Engineering is composed of three interactive technology centers:

**Center for Food Processing and Engineering**  
Dr. Justin R. Morris, Director  
Activated 1995

**Center for Food Safety and Quality**  
Dr. Michael Johnson, Coordinator  
Activated 1997

**Center for Human Nutrition**  
Activated 2000

The Institute of Food Science and Engineering is a unit within the Division of Agriculture (Milo J. Shult, Vice President; Ivory W. Lyles, Associate Vice President; and Gregory J. Weidemann, Associate Vice President), University of Arkansas System. The University of Arkansas Division of Agriculture follows a nondiscriminatory policy in programs and employment.
Contents

Institute Personnel .............................................. 3
Foreword............................................................ 4
Executive Summary ............................................ 5
Introduction ....................................................... 6
Major Program Areas
  Rice Processing Program ................................ 8
  Pickle Science and Technology Program ........ 9
  Vineyard Mechanization and Grape Processing Program .................... 10
  Rheology and Sensory Program ................... 11
  Thermal Processing and Product Development Program .................... 12
  Lipid and Surface Chemistry Program .......... 14
  Functional Foods Program ........................... 15
  Food Microbiology and Safety ..................... 16
  FAO Center of Excellence for Food Quality, Safety and Nutrition ............ 17
Research Publications ...................................... 18
Advisory Board ................................................ 25
Affiliated Scientists ........................................... 26
Organizational Structure .................................. 27
Americans enjoy the most affordable, the highest quality and the safest food supply in the world thanks to the productivity of our farmers and those who process, package and market food products.

Agriculture is big business in Arkansas. One out of every five jobs and 22 percent of the Gross State Product are generated from the total direct, indirect and induced economic impact of agricultural production and processing.

The University of Arkansas System’s Division of Agriculture provides research and extension support for both the production and processing of agricultural products. Our Institute of Food Science and Engineering (IFSE) creates problem-solving partnerships between the University and food companies and industry organizations.

IFSE is a primary partner with the food industry in a number of dynamic research and extension programs and projects. The active participation of the food industry assures that we focus on problems that need solving. These demand-driven research and extension projects and programs are designed by our faculty scientists working with counterparts in the industry. They produce research-based information that processors can use to solve problems, improve efficiency and better serve the consumer.

A significant added benefit of the IFSE is the training provided for University students who are often involved in projects. They receive valuable experience that prepares them for jobs in the food processing industry.

This publication provides a look at some of the positive impacts of the IFSE-sponsored alliances of the food industry with Division of Agriculture research and extension faculty. They are solving problems and creating new opportunities for growth in a vital sector of our state, regional and national economy.
Agricultural production and processing is a vital and growing sector of the Arkansas economy. Food processing ranks number one in total industry output with the total economic impact of the agricultural production and processing sector exceeding $20 billion.

The Institute of Food Science and Engineering was founded on the concept of making the research and extension expertise of the University of Arkansas Division of Agriculture more accessible to the food industry. The Institute has successfully done so by promoting alliances between the food industry and the University. This “demand driven” approach has been described by Dr. Milo Shult, Vice President for Agriculture, as assuring “that University resources are applied to projects with a direct, positive impact on the value-added processing of food products.”

The Center for Food Processing and Engineering has partnered with 103 different companies (representing 30 states and six foreign countries). As of this writing, industry has contributed more than $3.8 million in grant funds, equipment and training.

Many of these projects are multi-year, multiple stage investigations. A very successful example of such an ongoing program is the Rice Processing Program. We are quite proud of the important, innovative research being done in all areas of Food Science. To date, 189 research publications from work by our affiliated scientists funded by the Institute and our industry partners have been published.

In addition to an applied research program assisting commercial food processors with processing and quality programs, pilot plant facilities can be used to mimic retorting operations to produce benchmark results in trial runs of new products or to improve existing products. In addition to the extensive analytical equipment used for evaluation, the Institute offers product development support for a wide range of clients as part of its education and technology transfer activities.

A permanent, professionally trained Descriptive Sensory Panel operates as a self-supporting University Service Center. The panel provides descriptive analysis of food product appearance, aroma, flavor and texture in a state-of-the-art sensory laboratory.

The activities of the Arkansas researchers of the Food Safety Consortium have been integrated into the Center for Food Safety and Quality. Its activities to assist food processors in Arkansas and the region with their food microbiology and safety questions and concerns assumed an international component when the United Nation’s Food and Agricultural Organization designated the Institute as a Center of Excellence for Food Quality, Safety and Nutrition.

The ultimate arbiter of success is the consumer. The Institute of Food Science and Engineering, its programs mentioned above, and its affiliated scientists are employing multidisciplinary efforts and providing cutting edge assistance to the food industry as it attempts to better address the problems of changing consumer wants and needs.

Executive Summary

Justin R. Morris
Director, Institute of Food Science and Engineering
and
Center for Food Processing and Engineering

January 1, 2003
Introduction

The University of Arkansas System seeks to become the premier institution in the southern region for developing and disseminating scientific information associated with, and providing educational programs related to, value-added further processing, storage and marketing of food products. These efforts will assure food safety and improve the sensory and nutritional quality of food to meet the nutritional requirements and food preferences of a changing society.

The Institute of Food Science and Engineering and its three technology centers grew from the commitment of the University of Arkansas Division of Agriculture to finding creative ways to bring its expertise and resources to bear on specific problems and issues that affect productivity and growth in the food processing industry, with the mission of strengthening that critical component of the agricultural sector and the entire economy.

The Institute assists industry by fostering cooperative, multidisciplinary efforts that provide research to solve problems, technology transfer to put new information to work, and education in skills needed by specific industries. Alliances between the Institute and private industry devise solutions to identified problems. This demand-driven approach assures a direct, positive impact on the value-added processing of food products.

Listeria, E. coli and other cultures are used in a food safety research project.
The Center for Food Processing and Engineering’s primary objective is to facilitate research leading to value-added products and improving the efficiency and effectiveness of the processing of agricultural products. Activities of the Center for Food Safety and Quality seek to maintain or improve the safety of foods through production, harvest, processing, distribution and storage. The Center for Human Nutrition’s main thrust is to develop new value-added functional foods with elevated levels of health promoting compounds and ways to motivate people to include generous amounts of these foods in their daily diets.

The Institute of Food Science and Engineering ... has provided funding for 75 identifiable, specific research projects in addition to the general research of its affiliated scientists. In addition to numerous generous donations of equipment, industry provided cash funding that was matched by the Institute.

- Our 103 industry partners are located in 30 states as well as Australia, Canada, Germany, Japan, Sweden and Uruguay.

- Important research programs of the Institute include rice processing, pickled vegetables, vineyard mechanization, viticulture and enology, rheology and sensory, lipid and oil, and carbohydrate chemistry. Applied research projects assist commercial food processors with thermal processing and quality problems. Pilot plant facilities are used to mimic retort operations to produce benchmark results in trial runs of new products or to improve existing products. Product development support for a wide range of clients is only one of IFSE’s education and extension activities. The Institute’s Descriptive Sensory Panel offers complete sensory programs in descriptive, discriminative and affective analysis for the benefit of its scientists and the food industry.
Rice Processing Program

The rice industry is important in Arkansas, where almost half of the U.S. rice crop is grown. The Rice Processing Program was formed to provide multidisciplinary approaches to both basic and applied research addressing current and long-term challenges facing the rice industry. These efforts represent a unique integration of engineering, cereal science, food science and sensory evaluation.

The Rice Processing Program has grown to international prominence with major support from the industry. In return for their financial support, corporate sponsors provide input into research projects and have first, and immediate, access to research results.

The focus of this research is on rice post-harvest issues, including drying/tempering, storage, milling, sensory analysis/quality assessment and cereal chemistry/value-added processing. Projects are designed with a multidisciplinary, systematic perspective to take advantage of the full range of research capabilities and facilities at the University of Arkansas.

**On-Farm Storage of Rice**

On-farm storage of rice is increasing every year. Typically, the rice is stored in large bins, manually aerated with ambient air and treated with fumigant to control insects. However, the guidelines for an aeration schedule are very loose and the use of fumigants is under attack by the EPA.

In IFSE-sponsored research, the temperature in three 30,000 bu bins was quickly reduced and maintained by an automatic aeration controller while three other bins were manually aerated by the farm manager. Rice quality was maintained and insect survival was reduced by the automatic aeration system without the use of fumigation. The automated controller is relatively inexpensive and can be added to any farm's storage facility.

**Controlling Cracking of Milled Rice**

Milled rice kernels have a tendency to crack during the drying process. Broken kernels are worth about half the price of whole kernels. Studies have shown that rapid drying may remove moisture too quickly, leading to kernel cracking. Kernels may also crack after drying if they are cooled too quickly. A hypothesis explaining moisture transfer behavior and fissure formation in rice kernels based on glass transition principles from polymer science was validated in 2001. This hypothesis could have a far-reaching impact on the rice industry. It has been estimated that a 0.5 percent increase in whole kernel rice yield from the current industrial average will provide an additional $7,000,000 per annum to the rice industry.
The Pickle Science and Technology Program is dedicated to increasing product value by improving production and quality of pickled vegetables. The program enjoys significant industry support and includes the annual International Product Evaluation Program. Research, technical service and training are provided to assist suppliers and manufacturers of all types of acidified and fermented vegetables.

Experienced scientists along with state-of-the-art research and processing equipment provide outstanding capabilities to address technical challenges facing the pickle industry. This research program has addressed many texture, flavor and color issues of pickled vegetables.

Use of Heat Tolerant Polyethylene Terephthalate (PET) Containers

PET containers offer lighter weight, non-breakable alternatives to glass for pickle jars. UA researchers have shown that appearance and texture of fresh pack dill spears, bread and butter chips and hamburger dill slices processed in PET are similar to products in glass for up to four months.

However, distinct off-flavors of some pickle products occur in PET, which appear to be caused by oxidation reactions. Studies are being conducted to identify volatiles responsible for the adverse flavors and to prevent oxidation reactions by caps lined with oxygen adsorbent materials.

Improving Quality of Fresh-Pack Pickles

Fresh-pack pickles are a growing market in the pickle industry. During heating of fresh cucumbers, the trapped air in tissues expands and is displaced by brine during cooling. This loss of air affects fresh appearance and subsequent market life of sliced fresh-pack pickles. Studies are being conducted to evaluate the effect of pressure during heating and cooling on retention of entrapped air.

Use of Pickle Industry Byproducts

One way to add value to the pickle industry is by utilizing or recycling byproducts that have previously been regarded as waste. Discarded oversized cucumbers represent about 15 percent of cucumbers produced for pickle manufacturing. Studies are focusing on the development of usable products from these currently unusable cucumbers. Two volatiles that can be extracted from cucumbers have been found to be effective inhibitors of mold, yeast and some pathogenic microorganisms in food. Development of cosmetics and foods using these volatiles will provide a means of utilizing a large amount of cucumber waste.

Disposal of waste brine is expensive and has significant environmental implications. Research has shown that evaporation of water to concentrate brine is the most economically feasible method for reducing the amount of brine. An additional benefit of brine concentration is that concentration from three to 12 percent salt allowed the brine to be reused in fermentation processes. Possible industry use of steam or condensed water from the evaporation process may be another benefit of concentrating brines.

Firmer Pickles

Polygalacturonase is a softening enzyme that builds up in pickle brine, particularly if the brine is reused. Softening caused by this enzyme reduces the value of pickles. A process using Pure-Flo B80, developed by the Pickle Science and Technology Program, is now widely used by the industry to remove softening enzymes from recycled brines. This process has provided major economic benefits through improved brine management and improvements in pickle product texture. Further studies are directed on utilization of activated charcoal for removing polygalacturonase. The charcoal is very promising for removing enzymes as well as pigments and volatile components.

Inhibition of Yeast Growth

Potassium sorbate is commonly used to prevent yeast growth in cucumber pickle fermentation brine and non-pasteurized pickle products. Alternative methods of preventing yeast growth are needed since potassium sorbate is expensive and unstable, and its use may adversely affect product color and taste. Several natural substances have been screened for their ability to inhibit yeast growth and some have been identified as being effective. Caproic acid appears to be a promising alternative to sorbate since it inhibits yeast growth without affecting lactic acid bacteria fermentation.
Extensive studies were designed to examine the effects of viticultural practices such as training systems, pruning severity, shoot positioning, shoot thinning, fruit thinning, canopy management and post harvest handling on yield and final product quality. The results produced a wealth of information for improving viticultural and processing methods that have paved the way for our grape industry to be competitive in a global market.

Establishment of a Total Vineyard Mechanization System

The Vineyard Mechanization and Grape Processing Program was established to support the Arkansas and regional grape industry. Cost and scarcity of hand labor are limiting factors in most vineyards, resulting in a keen interest in mechanization which can keep the juice and wine industry competitive locally, nationally and globally. The Morris-Oldridge Plan (patented to the University of Arkansas on April 23, 2002) encompasses mechanization of all viticultural practices of 12 trellising systems, which represent all major grape-growing systems. The success of the Morris-Oldridge systems approach to vineyard mechanization is due to minimizing labor inputs while maintaining or improving yield and fruit quality. The Morris-Oldridge Plan consists of more than 40 different machines and attachments. The whole system approach has been evaluated in every major wine-growing region of the United States.

Improved Grape Varieties and Product Development for Juice and Wine

New, high quality, disease resistant grape varieties that are adapted for Arkansas are evaluated in cooperation with fruit breeders in the Department of Horticulture at the University of Arkansas. More than 50 wine grape selections have been made and are in various stages of testing. Chardonel, a new New York wine grape variety, was found to be adaptable to Arkansas growing conditions and was made successfully into several different wine styles.

Cynthiana grapes are native to Arkansas and offer good winter hardness, disease resistance and fruit that can produce excellent red wine. Studies in this program have reduced the high acid of Cynthiana grapes through canopy management. Wines with high pH (a frequent problem with this variety) were adjusted using both resin and membrane ion exchange techniques to produce higher quality wines. Separate studies used four yeast strains to determine which improved wine color and mid-palate mouthfeel and reduced perception of acidity. Improving this premium wine should increase profits for the Arkansas wine industry.

Good quality but blemished table grapes are considered a waste product, so studies were designed to develop a grape juice product from these grapes, which could be competitive on the juice market. Studies were also designed to determine the best methods to produce and process Sunbelt into juice. Also, this program has developed for the Arkansas wine industry some of the new wine styles that are in demand by today’s consumers.

Prevention of Fermentation in Juice and Semi-Sweet Wines

Addition of dimethylcarbonate (DMDC) at bottling has been studied to reduce total sulphur dioxide (SO₂). DMDC was effective in combination with low levels of SO₂ for the prevention of fermentation, and it does not have the negative effects of SO₂. A major winery in Arkansas is using these findings and has installed a special DMDC unit, one of six units in the United States.
The Rheology and Sensory Program consists of an interdepartmental research group that evaluates the effects of food processes on quality. The program is organized into three interactive research areas.

- **Sensory Properties Characterization** addresses the development of methods for product evaluation and quality assessment.
- **Consumer and Market Research** focuses on the development of a better understanding of consumer preference and acceptance of food products.
- **Analytical Tools Development** is working toward the development of alternative methods for predicting sensory properties of foods.

### Professional Sensory Panel

A very important component of the Rheology and Sensory Program is its professional sensory panel trained by Sensory Spectrum. The University of Arkansas is the only university in the nation with a professional sensory panel. This group of highly trained individuals is used to qualify and quantify the sensory properties of a wide range of food products. The panel has more than 1,000 hours of experience in analyzing appearance, aroma, flavor and textural attributes of foods and drinks. The high level of training of this panel allows members to act like a calibrated instrument in assessing sensory characteristics of foods. The panel is available for contractual work with industry and for use by University researchers.

### Development of Instrumental Measures for Sensory Characteristics

While panelists provide the best method for determining sensory characteristics, conducting panels is expensive and time-consuming. Development of instrumental methods to evaluate sensory characteristics would provide food companies with alternatives to using sensory panels. This integrated research gives insight into the physiology of perception.

The primary focus of current research is on texture. A number of unique instruments are being evaluated for their ability to duplicate what happens in the mouth when consumers assess a food’s texture. One instrument being evaluated involves replicas of the sensory panelist’s teeth used in combination with a simple press to measure the force needed to crush products.

Another instrument, commonly used in a dentist’s office to evaluate jaw problems, has been modified for use in the rheology lab to measure chewing speeds. The instrument consists of a headset with giant ear pads that are connected to a series of electrodes placed at strategic locations on the face. A magnet is placed under the test subject’s lower front teeth and electromyography measures muscle activity during chewing. It has been demonstrated instrumentally that chewing speeds vary greatly among individuals and that food breaks down differently at different chewing speeds. This type of information is critical in manufacturing processes where texture is an important characteristic of the product.

The Texture Analyzer is used to measure the texture of cooked rice, an important determinant of consumer acceptance.
The Thermal Processing Program assists companies and entrepreneurs in developing new products, improving existing ones and solving problems related to thermal processing of foods. In addition to applied research projects, the Program has a strong industry-sponsored research division.

**Thermal Processing Technology**

The pilot plant facilities allow for inexpensive experimental operations prior to full-scale commercial operation. These state-of-the-art facilities have been used by large-scale processors during product development/improvement operations and by entrepreneurs working to perfect products prior to market introductions. The pilot plant is equipped with an FMC Steritort Model 610-10 Laboratory Pressure Sterilizer with LogTec Automated Control System. The Steritort can simulate the operation of rotary, orbital and hydrostatic retorts. Thermocouple and data logging equipment allow determination of reel speed, steam pressure and microbial lethality in any product. Steam and water-spray sterilization can be studied with the FMC Model 091-A Pilot Sterilizer with LogTec Automated Control System. Using this equipment microbial lethality, rotation speed and steam pressure can be studied for products in metal, glass and flexible containers.

Pilot plant facilities are used to mimic retort operations to produce benchmark results in trial runs of new products or to improve existing products. Advanced analytical equipment is available to measure quality attributes and nutritional content of processed products. Sensory evaluation of processed products can be performed by a trained descriptive analysis panel or by consumer panels.

**Product Development and Assistance for Entrepreneurs**

The Institute offers product development support for a wide range of clients. Experienced scientists and production personnel can develop products and produce small runs of finished product for evaluation. In addition to assisting large, national food processing companies in development and quality improvement of thermally processed products, assistance has also been provided to small commercial kitchens and entrepreneurs wanting to begin a food processing business.

In addition to offering one-on-one assistance upon request, a comprehensive guide, *Starting a Food Processing Business*, is offered for sale. Through this guide, individuals interested in starting a food processing business are provided with information on such topics as regulations, safety, labeling, ingredients and packaging. In addition, information is provided on financial aspects of starting a business and on marketing products. A second publication, *Developing Your Product*, is also offered for sale. The free publication, *Starting a Food Business*, provides an introduction to the above topics and serves as a starting point for establishing a new business. Other publications to assist entrepreneurs include fact sheets on such topics as “Acidified Foods,” “Processing Herbal Foods,” “Handling Fresh Fruits and Vegetables” and others. All of these publications are available to the public through county extension offices.

The Institute publishes a newsletter, designed to provide both established processors and entrepreneurs with information on current issues affecting the food industry and updates on Institute activities. Each issue highlights an Institute Affiliated Scientist and his/her work.

The Institute is involved in a wide range of education and extension activities. These include an annual Better Process Control School, HACCP (Hazard Analysis of Critical Control Point) workshops, safety and sanitation seminars and training sessions for entrepreneurs.

This laboratory scale Steritort may be used to simulate the operations of rotary, orbital and hydrostatic retorts.
Value-Added Products Help Local Farmers

Fruit and vegetable production in Arkansas, Oklahoma and Mississippi is dominated by small family-owned operations. These small farms have relied on direct marketing through farmers’ markets, roadside stands and pick-your-own operations. However, these outlets are inadequate to handle the volume of fresh produce during peak seasons and spoilage losses are significant for many farms.

A new project now underway addresses these problems by helping these farmers gain knowledge about the production, development and marketing of value-added horticultural products. Major research thrusts involve improvements in cultural practices, the formation and evaluation of new products, consumer acceptance trials for these products, development of affordable further processing techniques and analysis of accessible marketing channels. While emphasizing food safety, the program will help open important marketing venues and increase profits for local farmers.

Many Arkansas roadside markets sell both fresh and processed products.

Peaches, blueberries, apples and grapes have been used to develop new value-added products for direct marketing.
The Lipid and Surface Chemistry Program was designed to provide information on theoretical and practical aspects of lipid chemistry, flavor changes during processing and surface interactions. This program is the only one of its kind to provide a platform for academic research and related industrial activities in this field and enjoys support not only from industry but also state and federal funding.

Companies in Arkansas benefit from this program in many ways. The state-of-the-art facilities for the program provide equipment that may be used to obtain detailed surface, structural and chemical information for a product or group of products. Desirable product characteristics can be related to processing techniques to optimize these characteristics. New products can be developed to add value to raw material sources. New methods are being developed and existing technologies are being adapted to address specific lipid-related food quality issues.

Brewing Quality of Milled Rice

Milled rice is used in the brewing industry but has surface lipids from residual bran particles that cause a rancidity quality problem. The rancidity results in off-flavor formation that can adversely impact beer flavor. An oil breakdown product, called free fatty acids, is known to be a reliable indicator of rancidity.

The Lipid and Surface Chemistry Program has recently developed a rapid method that can measure the milled rice surface free fatty acid within a few minutes, using infrared spectroscopy. This technique is faster and less expensive than conventional methods and does not require undesirable solvents that are traditionally used for analysis. Further studies have provided insight into the cause, control and prediction of free fatty acid development on milled rice and practices that may impact free fatty acid formation and brewing quality.

Functional Uses for Rice Hull Ash

Rice hulls comprise 20 percent of harvested rice and were a waste disposal problem until they were combusted in a suspension burning process to produce electric power. Some of the resultant rice hull ash has been used by the steel industry as a refractory and by the cement industry to enhance concrete quality. Researchers in the Lipid and Surface Chemistry Program have been working to gain a better understanding of rice hull ash structure and composition, especially the relationship between silica and carbon components.

Program researchers were instrumental in developing a simple method for alkali extraction of the silica in rice hull ash. The availability of this silica led to the production of a number of silica-based products and plastic films as well as materials for use as insulation, heat resistant surfaces and lightweight ceramics.

Recent studies have shown how the control of rice hull combustion can control ash quality and performance for various uses to allow the production of a variety of products of commercial importance.
The Functional Foods Program is the premier activity of the Center for Human Nutrition. The Program’s mission is to conduct research on existing and novel foods that provide both required nutrients and the biologically important phytonutrients. Research focuses on:

- Identification and evaluation of phytonutrients present in fruits, vegetables, grains and legumes grown in Arkansas and the South;
- Enhancements of phytonutrient content through advanced breeding techniques;
- Development of new value-added functional foods with elevated levels of health promoting compounds;
- Identifying ways to motivate people to include generous amounts of these foods in their daily diets.

Enhancing Functional Properties of Foods

Arkansas produces many foods, such as blueberries, red grapes, watermelons, spinach and rice, that are receiving attention for their functional properties. Recent studies have analyzed the phytonutrient content and antioxidant capacity of these crops. Significant genetic variation in the functional properties were found among breeding lines of each fruit and vegetable tested. Antioxidant capacity was found to correlate with the phenolics responsible for purple-blue color. These findings provide a guide for breeders to improve the antioxidant capacity of small fruits by selecting for darker, more intensely colored fruit.

Studies also are underway to determine the effects of crop maturation and storage conditions on phytonutrient content of blueberries, muscadine grapes and rice. In work to determine the phytonutrient content of foods after processing, it was found that the antioxidant capacity of processed carrot puree increased 34 percent during thermal processing and continued to increase during one week of storage at 40°C. The researchers also found retaining the outer skin on carrots boosted the antioxidant capacity by 10 percent.

Increasing Consumer Consumption of Phytonutrient Rich Foods

In a collaboration between the Departments of Food Science and Horticulture and the School of Human Environmental Sciences, fresh spinach, was substituted for lettuce in fast food entrees, such as hamburgers, sub-sandwiches and tacos. The spinach used was from Arkansas breeding lines high in lutein and antioxidant capacity. Data from consumer taste panels indicated that panelists had no preference for lettuce over spinach so the substitution would be feasible. If this substitution was adopted by fast food chains, the change would both increase the phytonutrient content of the American diet and double the market for fresh spinach.

Another way to increase consumer consumption of phytonutrients is the development of functional foods made with phytonutrient rich cultivars or specific phytonutrients that have been isolated, concentrated and purified. University researchers have developed techniques such as optimal pressurized fluid, supercritical fluid and membrane separation parameters for isolating, concentrating, purifying and stabilizing phytonutrients from rice bran, blueberry, red grape, watermelon and spinach extracts. These researchers work with Pennington Biomedical Research Center and Louisiana State University to study the health benefits of these isolated phytonutrients.
The Center for Food Safety and Quality (CFSQ), conducts research on the safety and quality of food products with a focus on reducing biological hazards. Ways are being sought to maintain or improve the safety of foods through the development of methods for rapid identification, elimination or control of pathogenic microorganisms and their toxins.

The program has components within several departments of the Division of Agriculture, the UA Medical Sciences program and Arkansas Children’s Hospital. Cooperation with the centers of food safety at other universities is fostered by the National Alliance for Food Safety, a partnership of 20 universities and the USDA Agricultural Research Service.

**Electrochemically Activated Water Reduces Pathogens**

Raw food products including poultry, meat, vegetables and fruits may be contaminated with pathogenic bacteria. Pathogen reduction techniques that do not alter the color and texture of the fresh product are desirable. One such technique that has been developed at the University of Arkansas is the use of electrochemically activated water as an antimicrobial spray. Vegetables treated with a 3-minute to 5-minute spray of electrochemically activated water showed a 3 log reduction of *L. monocytogenes*, *E. coli* O157:H7 and *S. typhimurium*. In another use, electrochemically activated water allows recirculation of brine-chiller water at meat processing plants. Cooked poultry and meat products, including hot dogs, sausages and bacon, can be recontaminated or cross-contaminated with *L. monocytogenes* in brine water during chilling. Using a laboratory-scale electrochemical treatment system to treat and recirculate brine chilling water, a 6 log reduction in *L. monocytogenes* was achieved within 30 minutes. This method also has been tested for treatment of poultry chiller water to destroy *S. typhimurium* and *C. jejuni*. Electrochemical water treatments will provide consumers with a safer product and will reduce the costs and environmental problems associated with discharging used brine.

**Effects of Thermal Processing on Food Quality and Safety**

The overall objectives of this research are to determine property changes, evaluate heat and mass transfer mechanisms, establish models for pathogen lethality and product yield and investigate the bacterial safety of thermally processed foods. Studies are being conducted on various meat products to determine the thermal inactivation kinetics for *Salmonella* and *Listeria*. The products are being processed using lab- and pilot-scale oil, steam, hot water and air convection processes.

The pathogen lethality during cooking and the bacterial recovery and growth after cooking also are being studied. It has been found that pathogen lethality is affected by product formulation, product temperature and processing conditions. Studies indicate that storage conditions after processing affect the recovery and growth of bacteria. The results from these studies provide the industry with valuable information to validate thermal processes and improve product quality, yield and safety.

**Edible Protein and Hydrocolloid Films to Protect Against Microorganisms**

Protein films derived from a variety of cereal and oilseed sources are being investigated for their ability to protect against microorganisms. Production methods allow films to be produced with different functional and barrier properties, such as thickness, oxygen permeability and water vapor permeability. Quality attributes such as antioxidants, color, flavor, nutrients, nutraceuticals, drugs and antimicrobials can all be incorporated into these films that prevent spoilage and microbial contamination. Coated edible films while preventing moisture loss and maintaining quality provide a means for immediate or delayed release of functional ingredients. Films can extend the shelf-life of a product, are made from renewable resources and reduce waste from packaging.

Films made from soy and other food proteins have many applications.
The Institute of Food Science and Engineering was established to work primarily with the food industry in Arkansas and the Southern region. However, in today’s economy, every state and region is affected by happenings in the rest of the world. In 1998, the United Nations Food and Agriculture Organization (FAO) established an FAO Center of Excellence for Food Quality, Safety and Nutrition within the Institute.

Training for Safe Food

With the recognition that a major source of produce in the United States is imported from other countries, the Center’s work with FAO focused on training activities related to food safety and quality in growing and handling fresh produce. Activities of the IFSE/FAO Center included coordinating input from technical advisors from the University of Arkansas, U.S. and U.N. agencies and participating countries to the FAO Regional Training Needs Assessment Workshop, held in Guatemala, December 1998, and the FAO Regional Training Course on Improving the Quality and Safety of Fresh Produce from Latin America, held in Costa Rica in May 1999.

Another activity of the IFSE/FAO Center was to facilitate the participation of IFSE affiliated scientists and others as technical advisors for activities related to international food safety. The Center helped identify speakers for short courses held in Panama, Guatemala and Chile, and for international food safety symposium/workshops at the 2000 Institute of Food Technologists (IFT) food safety conference and the 2001 IFT annual meeting.

Safety of Food Imports

Through a grant from the Joint Institute for Food Safety and Applied Nutrition (JIFSAN), the Center provided leadership for the development of Improving the Safety and Quality of Fresh Fruits and Vegetables: A Training Manual for Trainers. This manual is to train trainers to work with those producing fresh produce for international trade. It is predominantly aimed at improving the safety of produce grown in Latin America and imported to the U.S., but it has applicability worldwide. Text of the manual is available electronically in both English and Spanish through the JIFSAN web site, www.jifsan.umd.edu.

Economics of International Food Safety

The IFSE/FAO Center, conducting a project for the USDA Foreign Agricultural Service using an IFSE international consultant and University of Arkansas faculty from the Department of Agricultural Economics and AgriBusiness and the Department of Economics, developed the document “Global Assessment of Food Safety and Quality Constraints to Global Trade in Food.” This assessment was used as the basis for the United States Agency for International Development (USAID) Partnership in Food Industry Development project.

Assisting Juice Processors in Developing Countries

Faculty from the University of Arkansas and the University of Florida collaborated to produce the FAO book, Principles and Practices of Small- and Medium-Scale Fruit Juice Processing. Although developed for FAO, the book provides theoretical and practical information that has application to both domestic and international small- and medium-scale juice processors who generally receive minimal attention in traditional texts.
Publications from Institute Activity

One hundred eighty-nine refereed research publications have been generated from industry-sponsored research projects. These are listed by programmatic area below. Eleven additional Institute publications have been published.

Rice Processing Program


### Rheology and Sensory Program


### Thermal Processing Program


### Vineyard Mechanization and Grape Processing Program


— Functional Foods


**Pickled Vegetables Program**


**Lipid and Surface Chemistry Program**


Food Microbiology and Safety


Other Publications


Institute of Food Science and Engineering
Advisory Board

■ **Steve Brooks** is President and CEO of Razorback Farms, the largest provider of green beans for the food processing industry in the eastern United States. Razorback Farms also produces several other vegetable crops for processing.

Brooks provides insight and direction in the area of post-harvest physiology.

■ **Dr. Donald Freeman** is the Director of the Harry K. Dupree Stuttgart National Aquaculture Research Center in Stuttgart, Arkansas. In addition to his valuable experience managing a multidisciplinary USDA research program cooperating with land grant, sea grant and 1890 institutions, he provides an excellent scientific perspective for the evaluation of all projects.

■ **Dr. Patti Landers**, a food scientist and registered dietitian, is on the faculty of the Department of Nutritional Sciences at the University of Oklahoma Health Sciences Center. She writes “Healthy Appetites,” a newspaper column dealing with nutrition, cooking and consumer advice.

Dr. Landers provides the consumer’s perspective on food processing issues.

■ **Don McCaskill**, Vice President for Research, Riceland Foods, Inc., is responsible for applied research and development of new rice and soybean products for consumer, food service and food ingredient markets. He provides insight into the research and development needs of industry.

■ **Dr. Timothy J. O’Brien** is Director of the Biomedical Biotechnology Center and professor of biochemistry and molecular biology at the University of Arkansas for Medical Sciences. He is a founder of the Arkansas Biotechnology Association.

Dr. O’Brien provides direction for multi-disciplinary research in food biotechnology and agricultural medicine.

■ **Dr. Ellis Brunton** is the Vice President for Science and Regulatory Affairs for Tyson Foods, Inc. Overall responsibilities include quality assurance programs, process improvement training, laboratory services, consumer relations and government regulatory relations. His technical experience in basic and applied research from a corporate perspective serves the IFSE well.

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■ **Frank Sharp** is owner of the Ozark Mountain Family Company. His father, Roy, raised turkeys on a hillside farm and started the Ozark Mountain Smokehouse in 1946. The company now includes a mail order division, a bakery and nine retail stores. Sharp’s entrepreneurial success makes him a valuable resource for efforts to assist new food industry entrepreneurs.
Affiliated Scientists, Institute of Food Science and Engineering

- Nicholas B. Anthony (Poultry Science, PhD, Virginia Tech) conducts research in poultry breeding and selection for traits of economic importance.
- Jason K. Apple (Animal Science, PhD, Kansas State) conducts research that focuses on carcass traits of beef and swine that affect yield, eating quality, safety and value.
- Phillip Breen (Pharmacy, UAMS, PhD, Massachusetts College of Pharmacy) develops strategies to control microbial contamination and spoilage of food.
- Ronald W. Buescher (Food Science, PhD, Purdue) conducts research on vegetables and fruits with emphasis on improving product quality and prolonging product life.
- Julie Carrier (Biological and Agricultural Engineering, PhD, McGill) conducts research in solvent and supercritical phytonutrient extraction.
- M. Don Cave (Anatomy, UAMS, PhD, Illinois Med. School-Chicago) develops molecular probes and fingerprinting methods for pathogens in foods and clinical specimens.
- Caesar Compadre (Pharmacy, UAMS, PhD, Illinois) develops strategies to control microbial contamination and spoilage of food.
- Philip G. Crandall (Food Science, PhD, Purdue) conducts research in plant phytochemicals.
- Donald W. Freeman (USDA, ARS Stuttgart National Aquaculture Center, PhD, Mississippi State) conducts research related to development of new and improved aquaculture production and processing systems.
- Navam S. Hettiarachchy (Food Science, PhD, U. of Hull) conducts value-added basic and applied research in rice and soybean proteins relating to structure-function relationship, processing and product application.
- Luke R. Howard (Food Science, PhD, Arkansas) does research in the functional foods area, currently focusing on the nutraceutical value of Southern fruits and vegetables.
- Michael G. Johnson (Food Science, PhD, California, Davis) conducts research on detection, identification and control of microbes impacting the quality and safety of vegetables, fruits, cereals, meat and poultry products.
- Preston E. La Fenney (Agricultural Economics, PhD, Oklahoma State), Director, Global Marketing Support Services, specializes in marketing, trade and policy analysis and international development.
- Yanbin Li (Biological and Agricultural Engineering, PhD, Pennsylvania State) conducts research related to the safety and quality of processed foods, currently focusing on poultry.
- John A. Marcy (Poultry Science, PhD, Iowa State) provides food safety education for industry, government agencies and consumers.
- Jean-François Meullenet (Food Science, PhD, Georgia) conducts research on sensory profiling, psychophysics and mathematical modeling of food perception.
- Wayne P Miller (Agricultural Economics, PhD, Wisconsin) specializes in rural economic and community development.
- Teddy E. Morelock (Horticulture, PhD, Wisconsin) conducts research on the breeding of vegetables for processing.
- Justin R. Morris (Food Science, PhD, Rutgers) conducts research on harvesting, post-harvest variables and handling of grapes. He develops new processes and products with emphasis on juice and wine.
- Brad Murphy (Horticulture, PhD, Yale) conducts research on enhancing the nutraceutical content of horticultural crops.
- Rong Y. Murphy (Chemical Engineering, PhD, Arkansas) seeks to establish the scientific basis and statistical confidence for controlling pathogen lethality and product quality and yield of thermally processed poultry products.
- Casey Owens (Poultry Science, PhD, Texas A&M) conducts research to evaluate the effects of pre-slaughter environmental conditions and processing techniques on muscle metabolism and meat quality of poultry.
- Andrew Proctor (Food Science, PhD, Arkansas) conducts research on vegetable oil processing, quality and utilization with emphasis on soy and rice oils.
- Steven Seideman (Food Science, PhD, Texas A&M) conducts extension education and technology transfer activities for IFSE.
- Terry J. Siebenmorgen (Food Engineering, PhD, Nebraska) conducts research on drying, processing and quality assessment of rice, rice products and other cereal grains.
- Michael E. Slavik (Poultry Science, PhD, Iowa State) conducts research on bacterial and mycoplasmal diseases of poultry.
- C. Dayton Steelman (Entomology, PhD, Oklahoma State) conducts research in veterinary and medical entomology investigating effects on food safety.
- Keith Striegler (Horticulture, PhD, Michigan State) investigates the impact of cultural practices on the quality of fruit crops.
- Michael R. Thomsen (Agricultural Economics, PhD, Minnesota) addresses firm level and food policy problems related to the marketing of agricultural products within an increasingly industrialized food system.
- Eric J. Wailes (Agricultural Economics, PhD, Michigan State) specializes in rice and soybean marketing, international trade and development policy and economic outlook.
- Ya-Jane Wang (Food Science, PhD, Iowa State) characterizes the structure and properties of carbohydrates and investigates the interactions between carbohydrates and other food constituents.
- Wade Yang (Food Engineering, PhD, University of Saskatchewan) models mathematically the drying process of rice with emphasis on the rice fissuring process.
Organizational Structure of the Institute of Food Science and Engineering

Institute of Food Science and Engineering

University of Arkansas

University of Arkansas Division of Agriculture

Cooperative Extension Service  Agricultural Experiment Station

Industry Partners

USDA Agricultural Research Service

University of Arkansas at Pine Bluff

Center of Excellence for Poultry Science

Food Safety Consortium

National Alliance for Food Safety

University of Arkansas Food Safety Group

University of Arkansas Medical Sciences

University of Arkansas Children's Hospital

Food and Agriculture Organization Center