101 West Peabody
Urbana, IL 61801
Phone: 217/244-4232
FAX: 217/244-8594

C-FAR Research Reporting

Project Number	00E-010-1	**Prior Number**	
Status	In Progress		
Project Title	Influence Of Corn Hybrid On Dry Milling And Extrusion Product Performa		
Research Program	External Competitive Grants Program		
Principal Investigator	Kent D. Rausch		
Department/College	Agricultural Engineering / ACES		
Institution	University of Illinois at Urbana-Champaign		
Co-Investigator(s) (name, department/ college and institution)	S. R. Eckhoff, Agricultural Engineering, ACES, UIUC J. F. Faller, Food Science and Human Nutrition, ACES, UIUC M. E. Tumbleson, Veterinary Biosciences, Veterinary Medicine, UIUC		
Total C-FAR Funding	$80,000		
Type of Research	Multidisciplinary		
Funding Period	Jul 01, 1999	--	Jun 30, 2003
C-FAR Research Focus Area	Expanding Agricultural Markets		
Research Category	Corn		

Purpose and Goals

Understanding the magnitude of variability caused by commercial hybrids encountered by processors would allow processors, millers, and producers to increase quality and value. This project aimed to measure the variability present in extruded corn snacks caused by corn hybrid characteristics.

Outcomes and Impact

Corn meal is a low valued coproduct from the dry milling process. Variation in corn meal characteristics often does not reveal itself until the meal is being processed. Understanding variation caused by corn hybrid will show the value that corn producers can provide by marketing corn hybrids with similar characteristics for extrusion processing. This project has found that extruded snack characteristics are influenced by the source of corn. Textural attributes were significantly different for selected hybrids. Four commercial hybrids grown on research plots were dry milled in batches of 50 kg and blocked according to hybrid. Batches of whole corn were tempered and degerminated to obtain "throughs" and "tails" and were separately roller milled, aspirated and sieved to obtain through meal and tail meal. Tail meal was blended with through meal to obtain a standardized fat content (<1%) in sufficient quantity for pilot scale extrusion. Batches (~8 kg) were extruded using a co-rotating twin screw extruder. Extrusion parameters included a screw length:diameter ratio of 87.7, screw speed of 250 rpm, feed rate of 30 lb/hr and 22% moisture content. Samples of puffed corn products and data on extruded performances were collected. Dry milling yields were measured, samples of meal were tested for fat content, particle size, rapid viscoanalysis (RVA) characteristics and color. Similar parameters

	were also tested in the extruded puffed corn products as well as textural attributes of the puff. In addition, data on extrusion performance were collected. Hybrid was found to influence parameters such as dry milling performance and yields, particle size distribution of corn meal, and RVA characteristics. Functional differences as measured by RVA profiles were detected between through and tail meal fractions.
Beneficiaries	End users of corn dry milling products, dry millers seeking added value in corn meal production and corn producers.
Outreach	Several meetings have been held with corn producer groups, scientific communities and corn dry millers to discuss results and impacts of the project. Posters, presentations and papers have been distributed. Development of formal journal articles and one page handouts for general use have been developed.
Leveraged Funding	none
Related Websites	none
Initial Entry Date	November 8, 2001
Information Updated	October 31, 2002

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1701 West Peabody
Urbana, IL 61801
Phone: 217/244-4232
FAX: 217/244-8594

research

C-FAR Research Reporting

Project Number	01E-035-1	**Prior Number**	01E-035-1
Status	Completed		
Project Title	Scale-up of a High Productivity Continuous Reactor for Butanol Productic		
Research Program	External Competitive Grants Program		
Principal Investigator	Nasibuddin Qureshi		
Department/College	National Center for Agricultural Utilization Research		
Institution	USDA		
Co-Investigator(s) (name, department/ college and institution)	Hans P. Blaschek University of Illinois Dept. Food Sci. & Human Nutritior 1207 W Gregory Drive, Urbana, IL 61801		
Total C-FAR Funding	$40,000		
Type of Research	Multidisciplinary		
Funding Period	Jul 01, 2000	--	Jul 01, 2002
C-FAR Research Focus Area	Expanding Agricultural Markets		
Research Category	Corn		

Purpose and Goals

The purpose of this project was to scale-up a continuous bioreactor for butanol production. Butanol is an excellet fuel that has more energy content (per lb or per gal)than ethanol. It can be produced from corn. The development of continuous bioreactor would allow economic production of butanol. In order to economize butanol production we also attempted nutrient limitation. The microbial culture that was used to produce butanol from corn was Clostridium beijerinckii BA101 developed at the University of Illinois.

Outcomes and Impact

The bioreactor was successfully scaled up. In comparison to a laboratory bioreactor (25 days continuous operation) the scaled up reactor was operated for 96 days. This would allow economic production of butanol. Nutrient limitation was not successful. It was concluded that a new culture (spo-) be developed before further studies are attempted.

Beneficiaries

Corn growers, corn processors and general public would benefit from this project.The results of the project have been provided to the Illinois Corn Marketing Board.

Outreach

We have provided results to the Illinois Corn Marketing Board. Furthermore attempts are being made to scale up butanol production from corn. However, the information obtained in these studies is not used for the scale up.

Leveraged Funding

Part of the studies were funded by the Illinois Corn Marketing Board.

Related Websites	None
Initial Entry Date	
Information Updated	November 10, 2003

1101 West Peabody
Urbana, IL 61801
Phone: 217/244-4232
FAX: 217/244-8594

research

C-FAR Research Reporting

Project Number	02E-073-1	**Prior Number**	
Status	In Progress		
Project Title	Enhancing Value of Corn by Fermentation to Butanol and Removal by Extraction		
Research Program	External Competitive Grants Program		
Principal Investigator	Nasib Qureshi		
Department/College	National Center for Agricultural Utilization Research		
Institution	University of Illinois at Urbana-Champaign		
Co-Investigator(s) (name, department/ college and institution)	Professor Hans P. Blaschek, Dept of Food Science & Human Nutrition, ACES University of Illinois, Urbana-Champaign		
Total C-FAR Funding	$115,000		
Type of Research	Single Discipline		
Funding Period	Jul 01, 2001	--	Jun 30, 2003
C-FAR Research Focus Area	Expanding Agricultural Markets		
Research Category	Corn		

Purpose and Goals

The objective of the project was to produce butanol from corn and recover from the fermentation broth by extraction. Butanol is toxic to the cells of Clostridium beijerinckii that produce it. The maximum concentration that can be achieved in the fermentation broth is less than 25-33 g/L (total acetone butanol ethanol or ABE). Recovery of butanol (or ABE) from fermentation broth by traditional distillation is energy intensive. Recovery of butanol by extraction has been reported to be a cost effective technique. Hence, the goals of the project were: i) evaluation of the effect of extraction solvent (oleyl alcohol) on growth of C. beijerinckii and butanol production; ii) production of butanol and separation by extraction; iii)scale up of butanol production from corn to 2L batch bioreactor; and iv) production of butanol from corn in fed-batch bioreactor. C. beijerinckii BA101 is a hyper butanol producing strain which has an industrial potential.

Outcomes and Impact

Oleyl alcohol was used to study its affect on cell growth of Clostridium beijerinckii BA101 and butanol production. It was observed that oleyl alcohol does not inhibit cell growth of this culture. It has also been confirmed that oleyl alcohol does not extract glucose or nutrients from the fermentation medium. Further, studies were performed on production and removal of butanol by extraction in 100 mL reactors. Results suggested that ABE production was increased by 32% and glucose utilization was increased by 14%. It was also possible to reuse treated oleyl alcohol. The recovered oleyl alcohol resulted in higher ABE production and glucose consumption. However, problems such

	as formation of emulsion which caused oleyl alcohol separation problem were experienced. Further studies on scale up to 2 L batch reactor are being planned. Initial studies on fed-batch fermentation and recovery have been unsuccessful. However, further attempts with modified reactor designs are being planned.
Beneficiaries	It is anticipated that successful completion of the project will benefit Illinois corn growers. Butanol is a superior fuel to ethanol. Currently we are working on commercialization of butanol production from corn.
Outreach	The results of this investigation will be presented in national conferences and published in scientific journals. Additionally, the results will also be sent to Mr. Phil Shane of Illinois Corn Marketing Board.
Leveraged Funding	None
Related Websites	None
Initial Entry Date	
Information Updated	November 1, 2004

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FAX: 217/244-8594

research

C-FAR Research Reporting

Project Number	02E-070-1 **Prior Number**
Status	In Progress
Project Title	Coproduct Characterization from Dry Grind Ethanol Processing for Enhai Value
Research Program	External Competitive Grants Program
Principal Investigator	Kent Rausch
Department/College	Agricultural and Biological Engineering
Institution	University of Illinois at Urbana-Champaign
Co-Investigator(s) (name, department/ college and institution)	Vijay Singh, Agricultural and Biological Engineering, ACES, UIUC; David Johnston, Eastern Regional Research Center, ARS, USDA, Wyndmoor, Ronald Belyea, Animal Sciences, University of Missouri, Columbia; Thon Clevenger, Civil Engineering, College of Engineering, University of Missc Columbia; M. E. Tumbleson, Agricultural and Biological Engineering and Veterinary Biosciences, Colleges of ACES and Veterinary Medicine, UIU
Total C-FAR Funding	$48,745
Type of Research	Multidisciplinary,inter-institutional
Funding Period	Jul 01, 2001 -- Jun 30, 2003
C-FAR Research Focus Area	Expanding Agricultural Markets
Research Category	Corn
Purpose and Goals	The production of ethanol from corn is rapidly growing. Currently, there is capacity to produce 2.9 billion gallons of ethanol per year; it is predicted that the demand for ethanol will reach 5.0 billion gallons per year by 2005. There are two processes used to produce ethanol from corn: wet milling and dry grind (DG). Wet milling has higher capital investment than DG processing; the increase in ethanol capacity will be created from new or expanded DG processing facilities. However, the DG processor can market only two coproducts: carbon dioxide and distillers dried grains with solubles (DDGS). Both of these coproducts do not increase value relative to the cost of corn. Carbon dioxide has market value at less than one cent per pound and DDGS is valued at approximately 3 to 4 cents per pound. Approximately one third of the material entering a dry grind plant is converted into DDGS. If production of ethanol is doubled, supply of DDGS will increase proportionately. While state of the art facilities are highly sophisticated in the production of fuel grade ethanol, little has been published regarding nutrients in the production of DDGS. Our objective was to determine nutrient content of process streams in DG plants to identify opportunities for increasing coproduct value.
Outcomes and Impact	The dry grind corn (DG) process involves processing components of the entire kernel through fermentation. The DG process

produces ethanol, carbon dioxide and DDGS. The kernel components that do not ferment are concentrated into the DDGS coproduct. While most components are beneficial for animal nutrition, there can be a concern if these components are not available to animals or are fed in excess. The end result is phosphorus excreted as animal wastes. Phosphorus has become a nutrient of environmental concern because it can be transferred from land surfaces into streams and lakes. The phosphorus content of DDGS is typically three times (approximately 0.8% dry basis) the concentration in corn (0.3%). It is anticipated that animal producers will be valuing coproducts such as DDGS based on phosphorus content, since regulations for land application of animal wastes are expected to tighten. A large supply and high phosphorus content could reduce further the value of DDGS and hamper the economic sustainability of the dry grind corn processing industry. Our project involved the participation of two universities, a USDA research laboratory and nine dry grind corn processing facilities. Through characterization of the process streams at 11 locations in each of the DG plants, we found that thin stillage and syrup streams were twice as high in phosphorus concentrations than in DDGS. This provides an opportunity to lower phosphorus concentration in DDGS, by eliminating or reducing phosphorus in the thin stillage or syrup streams before they are processed into DDGS. Future work should focus on these two streams to lower phosphorus, which would improve DDGS value and reduce potential environmental impact.

Beneficiaries

DG facilities are located in rural communities and where corn is in plentiful supply. By identifying opportunities for DG processors, the long term economic sustainability of the DG industry is improved, generating income for these communities. Creating opportunities for coproducts having higher value potentially improves the profitability of DG process facilities. This should lead to improved demand for corn, since many DG facilities are farmer owned operations. Additionally, research based on these results could result in animal food ingredients that have lower environmental impact.

Outreach

During and following the project, we have met with people at the participating DG plants. Most of these plants are farmer owned. By meeting with people at the plants and through several mailings to plant managers, workers at the plants and corn growers in their area became aware of the project and its objectives. We met with each plant to explain the project, train personnel as needed on sample collection techniques, assist collection of samples and provide updates as data was analyzed. We have presented research findings at Fuel Ethanol Workshops in 2002 and 2003, each of which hosted approximately 1,000 attendees from the fuel ethanol industry. We have met with corn producers in several states to discuss the project.

Leveraged Funding

none

Related Websites

Initial Entry Date

Information Updated

October 30, 2003