BBOP barley bioproducts opportunities project

update

APRIL 2008

Project finds barley has considerable potential in biorefining

"We wanted to look at if and how barley could be used in biofuels as well as other biorefined products."

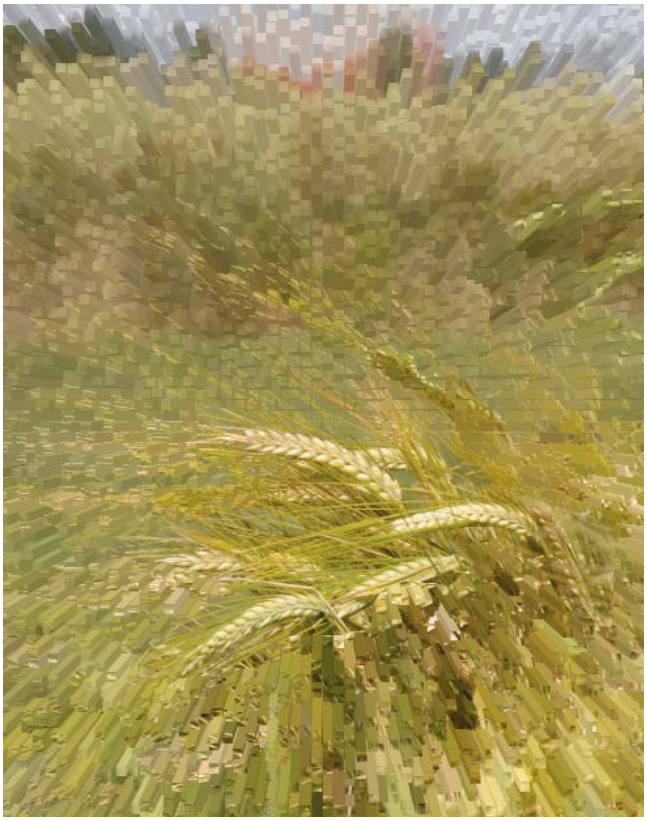
From the beginning, the Barley Bioproducts Opportunities Project (BBOP) was an important first step to discover the potential of barley and how it could be used in the emerging field of biorefining. In a matter of a few months, a world-class team of researchers and analysts has found barley's potential is considerable. It could be used in everything from functional foods to health and wellness applications to industrial applications such as ethanol for fuelling vehicles and distillers grains for livestock feed.

"We wanted to provide reliable, evidence-based technical information on how barley compares to benchmark grains like wheat and corn in traditional industrial markets," project manager Carman Read says. "Our view was that for barley to be competitive in traditional industrial markets we needed to leverage its functional and physiological attributes and identify specific ways we could capture more value out of barley from a broader range of market segments."

While previous research had revealed various high value compounds in barley, baseline information was lacking, especially analysis on fermentation and distillers grains from barley and it was not clear what impacts the biorefining processes may have on certain high value compounds of interest.

While BBOP was influenced by the swell of corn-based ethanol plants in the United States, it goes well beyond "biofuel North."

"From the beginning we took a broader approach," Mike Leslie, chief executive officer of the Alberta Barley Commission, a joint sponsor of BBOP, says. "We wanted to look at if and how barley could be used in biofuels as well as other biorefined products like distillers grains for livestock feed and fractions for functional food and nutraceuticals.



A UNIQUE GRAIN

"We've always recognized barley is a unique grain and we wanted to find unique opportunities for our producers. And, of course, we wanted to maintain our existing customer base and continue to provide significant feedstock to our established feed, food and malt customers."

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Alberta Barley Commission · WBGA · Agriculture & Food Council The Catalyst · Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada · Canada

Project finds barley has considerable potential in biorefining

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The three-phase project began in May 2007 with two key components: technical research and a business feasibility evaluation. On the technical side, BBOP focused on:

- Identifying unique higher-value compounds in barley and assessing processing strategies to preserve and concentrate them
- Dehulling barley or utilizing hulless barley in the production process
- Analyzing the ethanol yield potential of select benchmark barley cultivars including Viterra's Xena, CDC Bold and CDC Fibar barley
- Comparing the ethanol yields of these barley cultivars to corn (Pioneer Hi-bred) and wheat (Canadian Prairie Spring)
- Identifying new processing strategies focusing on higher levels of starch conversion in the barley cultivars
- Identifying strategies to deal with beta glucan in the barley cultivars
- Identifying and leveraging any unique nutritional aspects of barley distillers grains.

Additional key findings

- Researchers found modifying the cold hydrolysis system of converting barley starch to fermentable sugars, generically known as the Stargen method, yielded higher results
- Analysis of the dried distillers grains plus solubles (distillers grains) found barley was highest in in-vitro digestibility and had lower residual starch content than corn. By comparison, corn was highest in crude fat and lowest in crude protein and in vitro digestibility, and wheat was highest in crude protein
- Potential co-products of barley biorefining include protein, fibre, fatty acids and tocols.
- The Stargen method of fermentation, which uses a new line of enzymes, reduces the heat needed for processing (potentially lowering operating costs and increasing profits)
- This method also exposes distillers grains to less heat, which may result in undenatured proteins (undenatured distillers grains proteins are worth two to three times more than denatured proteins).

Mike Leslie

On the business side, BBOP is evaluating a number of different business models for western Canada. These include a pure ethanol and co-product approach to a highly sophisticated barley fractionation and/or processing facility with strategic partnerships that optimize barley's unique compounds and/or fractions in higher value markets. (The business findings will be announced later in May 2008.)

"What's set our project apart from so many other biofuel projects is announced later in our approach to co-production," Olds barley farmer Jeff Nielsen, president of the WBGA, says. "Oil companies don't just base their revenue on what they can sell gasoline for at the pumps. They look at the revenue they can secure from dozens of petroleum-based products. We adopted the same kind of thinking with BBOP."

Jeff Nielson

THE STARCH STORY

In the past, some people labelled barley as a poor crop platform for industrial-scale bioproduction, especially ethanol production. The reason: its starch content is lower than wheat and corn, the most widely used grains in North American ethanol production.

Starch is the building block of ethanol production: the starch in whole grains is converted to simple sugars and fermented into ethanol by yeast.

Conventional thinking holds that the more starch a grain contains, the higher its ethanol yield. While it was well know that barley's starch content is generally lower than corn and wheat, what wasn't known was how barley's starch to ethanol conversion compared to crops such as corn and wheat.

Using and modifying some innovative process technology and strategies to optimize starch conversion, researchers found barley's starch-to-ethanol conversion was comparable to corn's and wheat's ratios (see table on next page).

"In general, the efficiency of conversion of barley starch to ethanol is similar to the corn and wheat we tested," project researcher Dr. David Bressler says.

STARCH CONTENTS – BEFORE AND AFTER FORMENTATION

Grain/variety	Starch content before fermentation	Ethanol yield using Stargen method (cold hydrolysis) fermentation	Ethanol yield using conventional jet-cooking fermentation
Pioneer Hi-bred corn	62.09%	14.51%	13.76%
CPS wheat	56.19%	13.30%	11.80%
Dehulled Xena barley	58.04%	12.92%	12.23%
Dehulled Bold barley	58.86%	14.28%	12.30%
Fibar barley	49.0%	12.47%	11.36%

BBOP also addressed two other major concerns about barley, mainly that the viscosity of barley grain mash (a result of its beta glucan content) slows down processing, and that hulled barley is extremely abrasive to biorefining equipment.

A COMPETITIVE CROP PLATFORM

BBOP's technical findings indicate that as a competitive crop platform (or feedstock) in biorefining, barley has several abilities and advantages. Researchers Bressler and Dr. Ruurd Zijlstra, both with the University of Alberta's Faculty of Agriculture, Forestry and Home Economics, found:

1. New modified low temperature processing methods of the barley varieties tested resulted in starch to ethanol conversion ratios similar to corn and wheat
2. The analysis of the distillers grains demonstrates that fermentation of the barley varieties tested yielded less residual starch than the corn tested
3. The distillers grains produced from barley varieties tested have a high in-vitro digestibility and a high crude protein content
4. Low-temperature processing methods preserved (and in some cases concentrated) high-value components such as phenolics, unsaturated fatty acids, tocopherols, trienols and sterols.

"We believed solid research using the latest technical advances was needed to identify barley's value as a crop platform," Doug McBain, a past president of the WBGA, says. "Biorefining is a rapidly changing industry and we wanted to see if new technology was creating new avenues for barley."

"As consumers become more sophisticated about their relationship between food and health, they're increasingly looking for functional foods and healthy bioactives," says Read.

Barley delivers. On the functional food side, the beta glucan in the grain is a soluble fibre that reduces serum cholesterol and resulting health issues like heart disease. Barley's bioactive components include phytosterols – the most important ones being campestrol, sitosterol and stigmasterol – that can block cholesterol absorption sites in the human intestine.

Read says that while BBOP has answered many questions, many more remain. He hopes the report will generate more interest and investment in barley biorefining research and facilities.

Variety debate not part of study

The real question in our research was: Could the starch in barley be converted to ethanol as efficiently as starch in other grains?

What's the best variety of barley to grow for biorefining?

It's a question members of the Barley Bioproducts Opportunities Project (BBOP) team are often asked to debate. But it's not a question they ever set out to answer.

"Canada has more than 200 registered varieties of barley," BBOP project manager Carman Read says. "We simply didn't have the time or resources to test all of them."

Instead, the project team worked with producers, scientists and grain companies to select three varieties (Bold, Xena and Fibar) for the study. Bold and Xena, both 2-row hulled varieties, were selected as they are considered high yielding and agronomically accepted across most of Alberta. The study team chose Fibar, a 2-row spring feed barley, at the request of the project partners as they wanted to include a hulless variety and a variety with unique attributes such as high beta glucan content.

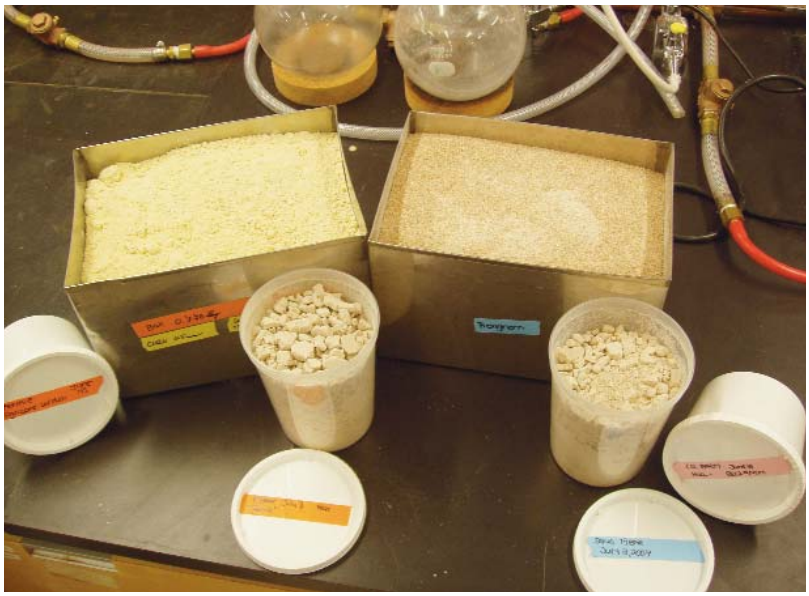

Photo credit University of Alberta

On average, barley typically has a starch content of about 60%. That content, barley plant breeder Dr. Patrica Juskiw of the Alberta Crop Development Centre in Lacombe, says can vary about 3% to 5% due to genetics and to environmental conditions.

"While it's important to consider the starch content of barley before fermentation, the real question in our research was: Could the starch in barley be converted to ethanol as efficiently as starch in other grains like wheat and barley?" Read says.

"We knew that starch content varied by barley variety and the barley's overall starch content is generally lower than crops like wheat or corn. We also knew that barley was considered to be a more difficult crop platform for full starch conversion for a variety of reasons. Based on that, we wanted to study barley's starch conversion to ethanol and compare that to other crops."

To address questions around the efficiency of barley starch conversion, the research team looked at three separate fermentation approaches.

Under the direction of Dr. David Bressler of the University of Alberta's Faculty of Agriculture, Forestry and Home Economics, the research team used "leading-edge" enzyme technologies in tandem with optimal conversion processes developed and proven on cereal grains similar to those grown in western Canada (rather than for corn). Plus, the researchers evaluated a series of other processes to optimize conversion.

Read says the fermentation research resulted in a number of exciting findings, including:

1. Modified low-temperature (Stargen) methods resulted in barley starch-to-ethanol conversion ratios similar to the Hi-bred corn and higher than the CPS wheat tested (see table on previous page).
2. The average residual starch in the distillers grains from the barley varieties tested was equal to or better than the CPS wheat and Hi-bred corn tested
3. Low-temperature fermentation methods preserved high-value components including but not limited to: phenolics, unsaturated fatty acids, tocopherols, trienols and sterols.

Read says the question on which barley variety is best for biorefining depends to a large degree on the driver(s) of a producer's or an organization's business model.

"If the business focus is primarily ethanol production, a high starch content will be a priority," Read says. "If the focus is on the co-production of higher-value components as well as ethanol production, then those needs will have to be considered in variety selection and/or the development of new barley varieties."

Finding value in fractions

We need to find incremental values from barley and extracting different compounds from it is one approach

There's more to the Barley Bioproducts Opportunities Project (BBOP) than ethanol production.

From inception, BBOP's mandate included determination of whether the perceived high-value compounds in barley would be preserved through fermentation.

"We need to find incremental value from barley and extracting different components from it is one approach," Doug McBain says. A Cremona, Alberta grain farmer and a past president of the Western Barley Growers Association (WBGA), McBain says the WBGA believes barley can be a crop platform of choice for specific applications across feed, food and industrial markets. "Our view is optimization strategies such as fractionation will help agricultural producers and operators of biorefineries develop revenue streams."

Doug McBain

The project is examining a variety of business models, including barley-based ethanol production facilities modified to extract a number of barley components (or fractions as they are often known) with health benefits. These compounds potentially include phenolics, phytosterols, fatty acids, tocopherals and tocotrienols (see sidebar). More commonly known components such as fibre, beta glucan and protein could also be extracted.

The project sponsors – the WBGA and the Alberta Barley Commission – believe many of these fractions could be used in product applications in the food, pharmaceutical, nutraceutical and cosmetic markets. Doing so would add value to barley production and processing.

A key finding in BBOP's technical research was that by using a low-temperature, high-gravity fermentation process and by not subjecting distillers grains to high-temperature drying, many of the perceived high-value compounds as well as the nutritional qualities of the grains tested remained intact. Overall, low-temperature methods preserved potential high-value compounds like phenolics, unsaturated fatty acids, tocopherols, trienols, and sterols. Additionally, many higher value compounds, such as tocopherols and fatty acids were concentrated during the fermentation process.

"We don't think anyone has identified this before," says Dr. David Bressler, an assistant professor with the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta who led BBOP's fermentation and fraction research. "This opens whole new opportunities for extraction . . . the whole food industry is looking at new sources of fatty acid oil."

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Tochopherols are Vitamin E antioxidant compounds and play an important role in animal and human health. Alberta Agriculture and Rural Development says "because it is fat-soluble, vitamin E is particularly important in protecting cell membranes from damage. Vitamin E maintains the structure and function of all muscles (skeletal, heart, smooth muscle), and is essential for the immune system."

Best known for their ability to lower cholesterol, **phytosterols** are also antioxidants, anti-inflammatories and anti-carcinogens.

Numerous studies have found **phenolic compounds** reduce the risk of chronic diseases related to oxidative stress; oxidative stress contributes a surprisingly wide range of diseases, including: Parkinson disease, multiple sclerosis, dementia, diabetes, several types of cancer and liver diseases, asthma, cystic fibroses, chronic obstructive pulmonary disease (COPD), cardiovascular and digestive disease, kidney failure and even common colds.

The naturally occurring **fatty acids** in barley (and other whole grains) are a building block of fat (triglyceride) and come in three forms: saturated, polyunsaturated and monounsaturated, with the latter considered the healthiest because it doesn't increase cholesterol. The palmitic, oleic and linoleic acids in whole grains are associated with lowering total cholesterol and low density lipoprotein (LDL) or "bad" cholesterol.

Acknowledging our partners

Our partners have helped us focus our research and understand our potential

More than funders, partners in the Barley Bioproducts Opportunities Project (BBOP) come from many industry sectors and so bring a variety of interests and viewpoints to the table.

The Government of Canada's Biofuels Opportunities for Producers Initiative (BOPI) provided $262,500 of funding for BBOP through the Agriculture and Food Council that administers Agriculture and Agri-Food Canada's Advancing Canadian Agriculture and Agri-Food Program. BOPI is a part of the Canadian Agri-Food Council's Advancing Canadian Agriculture and Agri-Food Canada (ACAAF) program to position Canada's agriculture and agri-food sector at the leading edge of industry to capture new opportunities by developing better products, processes and technology.

The Alberta Barley Commission and Western Barley Growers Association jointly managed BBOP. As well, the Commission provided $30,000 of in-kind support for BBOP activities. The WBGA also provided in-kind support as well as project administration.

One of the world's leading agri-businesses, **Syngenta** is committed to sustainable agriculture through innovative research and technology. Syngenta employs 21,000 people in 90 countries around the world and is renowned for its work in crop protection, and ranks third in the high-value commercial seeds market. Syngenta supported BBOP with a contribution of $45,000.

Edmonton-based Ceapro Inc. committed $10,000 to BBOP. Ceapro is an innovative formulator and advanced processor of active ingredients, botanical extracts, and therapeutic products. In turn, the company creates ingredients and formulations for effective shampoos, cleansers, moisturizers, and cosmetics that are licensed and marketed worldwide.

A family-owned business with offices around the world, the **Wilbur-Ellis Company** markets and distributes agriculture commodities and is known for its ability to find the best markets for new and existing products. In Canada, the company's feed division includes the sale of distillers grains from ethanol and alcohol producers. Through its Lethbridge office, Wilbur-Ellis Co. Canada contributed $2,000 to BBOP.

Parkland Agri Services operates from nine locations in central Alberta, offering independent agricultural service and inputs to producers. The company focuses on delivering quality products and services, cutting-edge technology and knowledgeable, skilled staff to help its customers succeed. Parkland Agri Services gave $1,000 to BBOP.

Finding value in fractions

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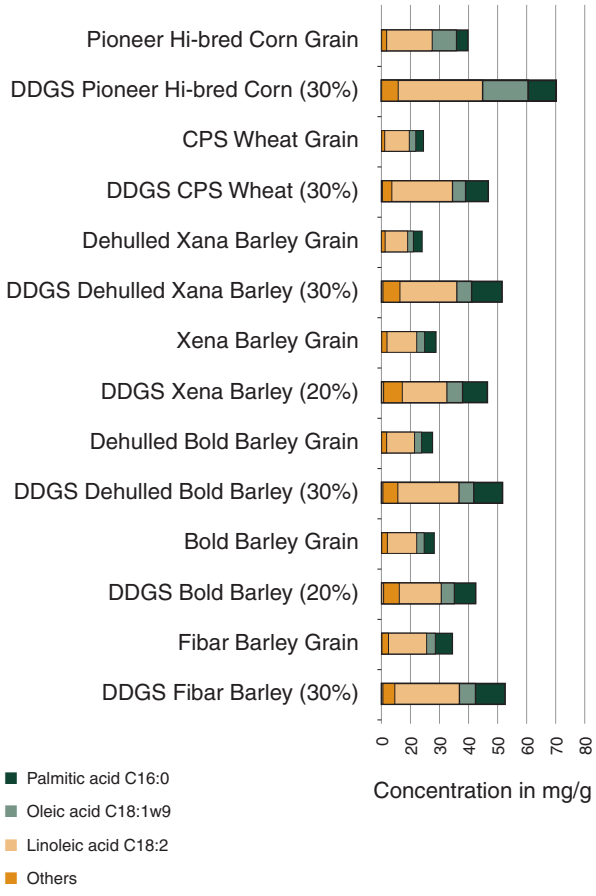
FATTY ACID CONTENT IN GRAINS AND DISTILLERS GRAINS (DDGS)



Distillers grains

"We focused on determining the energy in distillers grains because energy is the most important cost component for feed formulation for livestock."

Distillers dried grains and solubles (distillers grains) is one of the major co-products of biofuel processing. For example, a tonne of barley converted to ethanol produces about 300 to 350 kilograms of distillers grains.

Part of the Barley Bioproducts Opportunities Project (BBOP) mandate was to develop a better understanding of the nutritional content and digestibility of barley-based distillers grains – and how they compare to distillers grains derived from corn and wheat.

Project researchers did this by analyzing samples of all distillers grains for initial feed values such as in-vitro digestibility, crude protein content and crude fibre content.

"We focused on determining the energy in distillers grains because energy is the most important cost component for feed formulation for livestock," says researcher Ruurd Zijlstra. An associate professor of ingredient evaluation and feed processing with the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta, Zijlstra led BBOP's analysis of distillers grains.

Following fermentation, distillers grains were evaporated and then freeze-dried. This two-step process helped keep the distillers grains' unique and nutritional properties intact, Zijlstra says. "The reason we freeze-dried the distillers grains is because you want to look at a best-case scenario, whereas regular drying using heat may damage unique nutritional characteristics."

He adds: "The research results were encouraging. They showed that distillers grains from barley are comparable to many of the key nutritional attributes of distillers grains from wheat and corn."

As was expected, there were some differences (see chart on page 9).

BBOP's research team concluded that using barley as a feedstock for biorefining can provide significant new value-added opportunities while continuing to provide significant feedstock to established feed markets.

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The processing methods

Researchers with the Barley Bioproducts Opportunities Project (BBOP) analysed the fermentation of five different grains (Fibar barley, Xena barley, Bold barley, Pioneer Hi-bred corn and CPS wheat) using three different processes: traditional jet cooking, cold hydrolysis and modified cold hydrolysis.

Jet cooking is a widely used industrial fermentation process that directly injects high-pressure, high-temperature (90° C to 120° C) steam into a grain mash that is treated with conventional enzymes. In this process, the feedstock grain is liquefied and enzymes are added to hydrolyse starches into fermentable sugars that can be utilized by yeast.

Because "cooking" is required, this type of fermentation requires a high amount of energy to produce ethanol. The more energy a fermentation method uses, the less profit it can generate. As well, jet cooking can denature many proteins and nutrients, affecting the quality of distillers grains.

Cold hydrolysis, or the Stargen method of fermentation, is typically carried out at 48° C and uses the latest generation of an industrial enzyme mixture known as Stargen001. This enzyme releases glucose at a slower rate than conventional enzymes, allowing the yeast to more effectively convert sugars to ethanol while also limiting growth of other micro-organisms. This method also better preserves grain nutrients and enzyme life.

As part of its optimization mandate, BBOP's fermentation research team modified the cold starch hydrolysis process in order to improve starch hydrolysis from the barley grains. The modified cold process was carried out at 55° C.

What researchers found:

- Cold hydrolysis (Stargen) fermentation (at very high gravity and 30% solids) produced slightly higher ethanol yields than traditional jet cooking
- Modified low temperature methods resulted in starch conversion to ethanol from barley varieties similar to corn (starch to ethanol ratio)
- Low-temperature methods resulted in preservation of high-value components including but not limited to: phenolics, unsaturated fatty acids, tocopherols, trienols, and sterols.

Distillers Grains

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Other key findings were:

- Distillers grains from the three varieties of barley were highest in in-vitro energy digestibility; the varieties also had a high crude protein content
- Distillers grains from barley had a nutritional profile similar to canola meal
- Distillers grains samples of all grains (Hi-bred corn, CPS wheat, Xena barley, Bold barley and Fibar barley) were low in remaining starch, especially following jet cooking, indicating that starch to ethanol conversion (hydrolysis) was effective
- Distillers grains from corn were highest in crude fat, but lowest in crude protein and in vitro energy digestibility. Zijlstra says based on practical experience, the in-vitro energy digestibility must be confirmed in an animal model.
- Distillers grains from CPS wheat were highest in crude protein content.

DISTILLERS GRAINS ANALYSIS – FEED IMPORTANCE (All data based on dry matter)

Type of fermentation	Solids %	Ash (%)	Moisture (%)	Crude Protein (%)	Crude Fibre (%)	Crude Fat (%)	Total Starch in Grain (%)	Average Residual Starch (%)	In-vitro DM Digestibility (%)	In-vitro Energy Digestibility (%)	Gross Energy (kcal/kg DM)
Pioneer Hi-bred Corn											
Stargen-based	20	5.32	9.35	34.83	3.98	13.38	62.09	1.57	55.74	53.89	5747.35
Stargen-based	30	4.85	7.21	30.78	4.08	15.54	62.09	4.49	56.4	54.80	5752.00
Jet cooking	30	5.58	8.88	31.98	4.62	12.46	62.09	1.42	53.71	49.06	5554.50
CPS Wheat											
Stargen-based	20	4.94	8.75	45.96	4.92	6.36	56.19	1.06	71.48	70.01	5330.40
Stargen-based	30	5.78	6.14	43.08	5.09	4.92	56.19	1.00	70.86	68.49	5232.20
Jet cooking	30	4.83	4.16	43.73	4.17	5.24	56.19	0.64	70.25	67.67	5234.30
Bold Barley without hull											
Stargen-based	20	6.21	7.65	40.36	2.70	8.14	55.86	0.96	74.02	71.26	5312.80
Stargen-based	30	5.19	7.63	40.12	2.86	6.92	55.86	0.90	73.21	70.40	5411.05
Jet cooking	30	5.24	4.85	37.23	3.33	5.57	55.86	0.78	71.75	67.68	5247.90
Bold Barley with hull											
Stargen-based	20	5.71	7.91	35.26	8.20	7.19		1.14	60.56	60.47	5361.00
Xena Barley without hull											
Stargen-based	20	5.17	8.83	43.30	1.98	7.14	58.04	1.16	77.82	74.59	5370.00
Stargen-based	30	4.98	4.38	40.73	2.31	7.93	58.04	1.67	75.66	73.17	5383.05
Jet cooking	30	6.49	4.46	39.28	2.70	4.88	58.04	0.83	75.45	71.10	5154.00
Xena Barley with hull											
Stargen-based	20	5.97	5.53	37.18	7.13	7.45		1.47	60.71	60.60	5328.75
Fibar Barley											
Stargen-based	20	5.10	5.73	39.87	1.62	8.56	49.00	0.82	74.26	71.02	5512.40
Stargen-based	30	5.13	5.15	38.69	1.83	5.55	49.00	0.37	75.96	70.48	5373.65
Jet cooking	30	4.71	3.15	36.6	2.54	5.81	49	0.41	73.29	69.15	5124.40

Barley for food, feed and fuel

We want to complement existing uses not compete with them

Whether fact, opinion or agenda-setting, the rhetoric around food versus fuel is increasing – and is hotly contested in some circles these days. The main debate, of course, revolves around the question: should crops be grown for fuel instead of food?

"We've certainly heard arguments and concerns from both sides and hope the debate will stimulate higher demand for barley," says Carman Read, project manager of the Barley Bioproducts Opportunities Project (BBOP). "What many people don't understand is that barley grain is not widely used directly in foods. In fact, in Canada less than one half of one percent of the barley produced goes directly to food applications, according to Agriculture and Agri-Food Canada."

Mike Leslie, CEO of the Alberta Barley Commission, also points out that BBOP is all about finding ways to simultaneously use barley for food, feed and fuel.

"Our research has focused on removing a number of valuable fractions (or compounds) from barley that could be used in food as well as in nutraceuticals and livestock supplements while also producing biofuels and distillers grains for livestock feed," Leslie says. "We want to complement existing uses not compete with them."

"Domestically, almost 100% of the demand for barley comes from the livestock feeding and the malting industries," Jeff Nielsen, president of the Western Barley Growers Association (WBGA), says. "Roughly 20% of our total production goes to export markets and literally all of that is also for feed and malt."

A concern for barley producers is that as grain prices rise, many traditional barley users look for alternatives. For example, in recent months many Canadian livestock feeders have started shipping their animals south of the border for finishing on cheaper feeds such as corn and distillers grains.

"With the demand for domestic feed barley wavering, we would gladly welcome more direct food or other uses for our grain," Doug Robertson, chairman of the Alberta Barley Commission, says. "We must look at new markets and their opportunities. We believe that using barley in biorefining is one of those opportunities. BBOP is exploring the potential and feasibility of developing new value-added products from barley as well as more distillers grains and other potential nutrient streams for the livestock sector.

"Our view is that barley biorefining is synergistic to our current major customers' needs and will help barley producers remain viable and competitive," Robertson says.

Biofuels is one aspect of biorefining that is dramatically increasing in Canada and elsewhere around the world. In Canada, Prime Minister Stephen Harper and his government clearly see biofuels will lead to new market opportunities for farmers, while helping to reduce greenhouse gas emissions, and creating new jobs in rural areas.

Speaking on behalf of the government in December 2007, Gerry Ritz, the minister of Agriculture and Agri-Food Canada and the minister for the Canadian Wheat Board, said, "[Our] biofuels production incentive is a perfect example of our government's practical, balanced approach to tackling climate change."

Ritz made his remarks while announcing the federal government would make $1.5 billion in biofuel production incentives available through its ecoENERGY for Biofuels initiative. This is in addition to the $20-million Biofuels Opportunities for Producers Initiative (BOPI) – which provided $262,500 in funding to BBOP – to assist farmers and rural communities in seizing new market opportunities in the agricultural sector.

The Province of Alberta also has a vision for developing biofuels. Its Bioenergy Plan helps support the integration of biofuels, biodiesel and biomass generated power with traditional energy sources. The plan was announced in 2006 and calls for the government to invest $239 million over five years to help build a viable market for bioenergy in the province and encourage further private investment.

"We're encouraged by the federal government's and the provincial government's commitment to get solidly behind finding new opportunities for producers and our value chain members," Doug McBain, past president of the WBGA, says.

At the same time, Read says agricultural producers need to be sensitive to their customers and to consumers.

"In western Canada, the existing production of barley is based on long-established infrastructure. That business is and will continue to be important to barley producers. That said, we believe barley can be one of the crop platforms 'of choice' and can provide new solutions or specific applications in food, health and wellness, feed and industrial market segments, contributing to the basic needs of society."

Read adds: "These are exciting times and exciting changes are occurring in the world of commodity production and marketing. Change doesn't happen without good debate and examination, however, more than ever we're convinced our strategy can withstand scrutiny and that we are going in the right direction."

Technical team brings diverse expertise to BBOP

CARMAN READ

A retired executive with Monsanto Canada Inc., Carman Read is the project manager of the Barley Bioproducts Opportunities Project (BBOP). Carman is currently president of C & N Partners, and works with a number of agricultural agencies, associations and businesses, consulting on business development and management as well as integrated product and market strategy. His recent assignments include managing the Western Barley Growers Association's agricultural commodity clearinghouse project and assessing and developing an implementation strategy for bioproducts in Alberta for the provincial government.

Carmen Read

"BBOP is an exciting project and we have definitely achieved what we set out to do, and that was to provide good technical information on how barley compares to benchmark grains such as corn and wheat," Read says. "We've generated new knowledge and hopefully our findings can stimulate more research and interest in biorefining in Alberta."

DR. DAVID BRESSLER

Dr. David Bressler had ulterior motives to leading BBOP's fermentation research.

"I did this project to look at what other components we can pull out of barley and what we can use them for," Bressler says. An assistant professor with the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta, Bressler fully expects to spend the next 20 years of his career finding – and developing - components contained in barley kernels. "Really, at the end of the day you have to find a way to add value."

Dr. David Bressler

Bressler's research at the U of A focuses on industrial applications of chemical, thermal and biological systems for the conversion of conventional agricultural products to platform chemicals, fuels and value-added commodities. He is particularly interested in developing new and better ways of converting these products. Several of his projects, including BBOP, have been multi-disciplinary and in conjunction with the Bio-Industrial Technologies Division of Alberta Agriculture and Rural Development.

As well, Bressler is currently chair of the Management Committee of Agri-Food Discovery Place, the U of A's pilot-scale processing facility.

DR. RUURD ZIJLSTRA

Dr. Ruurd Zijlstra headed BBOP's research related to the nutritional content and digestibility of distillers grain. An associate professor of ingredient evaluation and feed processing with the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta, his research focuses on evaluating the nutritional content of feed and improving feed processing to ensure livestock producers get consistent, high-quality performance from one of their most important inputs. Zijlstra is known throughout Alberta's barley sector for his analysis of feed quality and characteristics in a variety of animals and how those characteristics vary among livestock.

He is also co-principal investigator with Dr. Jim Helm of the Alberta Field Crop Development Centre for a five-year research project establishing benchmark near infra-red reflectance spectroscopy (NIRS) calibrations for major western Canadian livestock feed. This project is giving Alberta's crop and livestock producers a better understanding of how grain varieties, including barley, and processing affect the nutritional value, digestibility and competitiveness of livestock feed.

"With the current price of feed grains . . . it makes a lot of sense for hog and cattle producers to include distillers grains in their feed," Zijlstra says. "Generally distillers grains doesn't requiring additional processing [after the fermentation process is completed] and livestock feeders can use significant quantities of it in their rations."

Dr. Ruurd Zijlstra

CONTRIBUTING RESEARCHERS

Dr. Jonathan Curtis is an associate professor of Agricultural, Food and Nutritional Science at the University of Alberta. His work focuses on analytical lipid chemistry, mainly the development of novel analytical methods to solve emerging problems in lipid chemistry, food science, sensory science, nutraceuticals or natural products. Curtis coordinated the project's chemical analysis and interpretation.

Amera Gibreel and Jim Sanderstock are staff scientists with the Bio-Industrial Technologies Division (BTD) of Alberta Agriculture and Rural Development. Sandercock is also a PhD student with the University of Alberta's Faculty of Science (Department of Biological Science. The two operated and monitored BBOP's fermentation equipment.

Jingui Lan is a support staff member with the University of Alberta's Agricultural, Food and Nutritional Science and conducted BBOP's chemical analysis.

A process engineer, Kristina Djokic is also a staff scientist with the Bio-Industrial Technologies Division (BTD) of Alberta Agriculture and Rural Development. She helped coordinate fabrication of the project's jet-cooking equipment.

SUPPORTING SCIENTISTS AND TECHNICIANS

Senior agricultural and food engineer Hang Qi is a staff scientist with the Bio-Industrial Technologies Division (BTD) of Alberta Agriculture and Rural Development.

Jennifer Moyes is a support technician with BTD.

Undergraduate Larissa Newell worked as BBOP's lab technician throughout the summer of 2007.

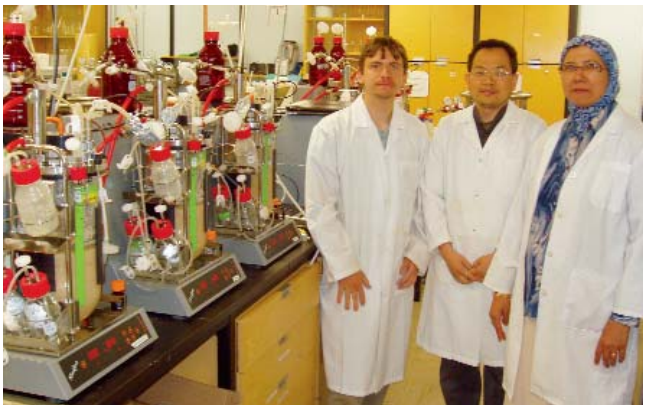
Dr. Thava Vasanthan and Dr. Feral Temelli, professors in the U of A's Department of Agricultural, Food and Nutritional Science, who both work extensively in barley fractioning provided additional scientific support. Vasanthan advised the technical research team on starch content and Temelli offered expertise on milling the test grains.

TERRY BULLICK

Communications consultant Terry Bullick of Bullick Writing & Communications helps the BBOP team tell its stories to agricultural producers, industry, media and government.

Bullick works with a wide range of clients in many industry sectors, among them the University of Calgary, the Calgary Health Trust and Totem Building Supplies. She is also the communications advisor for the Alberta Barley Commission and editor of the Commission's newsletter, *Barley Country*. Earlier this year, Bullick developed a series of communications for the Western Barley Growers Association agricultural commodity clearinghouse project.

"This is a project that's meant to give producers and industry new, scientifically based knowledge they can use to make business decisions about biorefining. My work is to put clear, concise information directly into their hands," Bullick says.



Left to right: Technical support team members Thomas Louzeck, Jingui Lan and Amera Gibreel.

BBOP – Information you can use

The project is generating reliable and scientifically based technical and business information on processing, operations, costs, revenues and market trends

The Barley Bioproducts Opportunities Project (BBOP) is designed to give barley producers information they can use in today's new and emerging valued-added markets.

"Our primary objective is to improve farm gate returns and to offer barley producers new and diversified business opportunities," says Mike Leslie, CEO of the Alberta Barley Commission. "BBOP has focused on four major areas: technical feasibility; business feasibility; business plan and marketing considerations; and knowledge and technology transfer plan."

This update is one of three that gives producers and regional producer organizations evidence-based information about investing and participating in renewable fuel or other bio-industrial projects. The project's first update was distributed in the fall of 2007; the third update (on business feasibility) will be distributed later this spring.

BBOP's goal is to provide producers, investors and funders with:

- Reliable scientific data on production processing and operations
- Reliable assumptions on costs, revenues and operating margins
- Reliable assumptions on end-use markets and market trends
- Operational management considerations including feedstock procurement, production and product marketing.

Additional information, such as the full scientific, is posted at www.wbga.org and www.albertabarley.com.

For more details, contact:

Carman Read, Project Manager
Barley Bioproducts Opportunities Project
e: carmanread@pentnet.net
p: 403.748.4425
c: 403.318.0972
m: 97 East Lake Ramp N.E.
Airdrie, Alberta T3A 0C3

The Barley Bioproducts Opportunities Project (BBOP) focused on evaluating barley's potential in rapidly evolving bio-based industries to provide Alberta producers and their customers with the information they need to invest in barley. BBOP is jointly managed by the Alberta Barley Commission and the Western Barley Producers Association.

BBOP manager
Carman Read
C & N Partners
e: carmanread@pentnet.net
p: 403.748.4425 c: 403.318.0972

BBOP administrator
Diane Savage
Western Barley Growers Association
e: wbga@wbga.org
p: 403.912.3998

BBOP monitoring
Darcy Kirtzinger
Alberta Barley Commission
e: dkirtzinger@albertabarley.com
p: 403.291.9111

BBOP communications
Terry Bullick
Bullick Writing & Communications
e: tbullick@telusplanet.net
p: 403.246.5225

Western Barley Growers Association contact
Doug McBain
e: dmcbain@wbga.org
p: 403.637.3880 c: 403.816.0645

Alberta Barley Commission contact
Mike Leslie
e: mleslie@albertabarley.com
p: 403.291.9111 c: 403.826.7729

BBOP address
c/o 97 East Lake Ramp N.E.
Airdrie, Alberta T3A 0C3