AUDUBON SUGAR INSTITUTE

2018-2021 REPORT

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Research · Extension · Teaching

Audubon Sugar Institute Strategic Planning Committee

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Audubon Sugar Institute Goals

To enhance the productivity and profitability of the Louisiana sugar industry and other sugar-processing-related industries.

To improve the practice of sugar manufacturing through education and technology transfer.

To conduct research toward a diversified sugar-processing industry.

To attract, retain and develop a world-class staff to serve our stakeholders.

To encourage use of low environmental impact technologies in sugar processing.

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Front cover photo by Olivia McClure. The four-tandem pilot plant mill at the Audubon Sugar Institute.
Back cover photo: Audubon hands-on sugar boiling training for the sugar industry.

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Luke P. Laborde Jr., Ph.D.

November 2021

Interim Vice President's Forward

As the Interim LSU Vice President for Agriculture, it is a pleasure to provide overview comments for this triennial issue of the Audubon Sugar Institute report. ASI continues to be an important part of the LSU AgCenter and a key partner in our state's sugar industry.

Sugarcane remains a very strong part of Louisiana's agricultural economy. Data from the Louisiana Summary identifies sugarcane as the third most valuable agricultural commodity following forestry and poultry. The total value of the sugarcane harvest, which includes the gross farm value and value-added, is $1.124 billion.

Reasons for the value:

- Higher acreage and higher acreage harvested for seed due to better planting ratios.
- Higher sugar and molasses prices.
- Higher average sugar yields per acre.

The production and refining processes for Louisiana sugarcane rely heavily on several engineering fields. ASI provides that expertise while fulfilling the AgCenter triad of research, extension and teaching. Its research programs seek to improve sugar manufacturing to support a diversified sugar-processing industry. Extension programs focus on training sessions with factory managers and their staff on ways to reduce sugar losses in processing, facilitate boiler operation compliance as well as analysis of molasses and other specialty samples. Internships and other specialized work-study programs are available for students interested in sugar processing.

The significance of ASI programs:

- Provide technological information and process support to the 11 sugar factories in Louisiana through annual factory operations seminars and mill visits during grinding and off-crop season.
- Improve mill efficiency through continued research projects such as mill extraction tests, bagasse boiler operation studies, optimization of low-grade boiling procedures, production and storage of very-high-purity and very-low-color sugar, survey of final molasses, syrup and juice.
- Provide laboratory analysis for the local factories during harvest, including the molasses survey and particle size analysis.

The three-way partnership among the American Sugar Cane League, the U.S. Department of Agriculture-Agricultural Research Service and the LSU AgCenter has enjoyed decades of success in jointly serving all aspects of the sugar industry. These shared efforts in variety development, production, harvesting and processing have helped sustain the sugar industry in south Louisiana that has thrived for more than 200 years. We are proud to be part of this team effort and look forward to future advances and success.

Lucien P. Laborde Jr., Ph.D.
Interim Vice President for Agriculture
Interim Dean of College of Agriculture

ASCL FORWARD

Jim Simon

The 226-year-old Louisiana sugarcane industry owes a tremendous debt to the Audubon Sugar Institute. Rooted in a history beginning in 1885 as the Louisiana Sugar Experiment Station, the station was tasked with "producing experts in the sugar industry." The mission of the Audubon Sugar Institute in 2021 remains the same.

From 1885 to 2003, the research center went through several evolutionary cycles. It was first established in Kenner, Louisiana, then moved to New Orleans on land that is now Audubon Park where it was christened the Audubon Sugar School. The school was later relocated to Louisiana State University in Baton Rouge for a time.

In 1977, the American Sugar Cane League and the state of Louisiana provided funding to convert the old Audubon Sugar School into the Audubon Sugar Institute. The institute, at times under LSU's engineering or chemistry schools, was finally associated with the LSU AgCenter in 1986. In 2004, the institute was moved off campus to St. Gabriel, Louisiana, a few minutes away from the LSU Sugar Research Station.

Agricultural research and sugar chemistry research have always gone hand in hand. The move in 2004 created a new atmosphere where Louisiana's 21st century sugar technology could flourish. As in the past, today's Audubon Sugar Institute trains and educates technologists but also maintains an international and diverse leadership research role in determining the feasibility of new commercial processes and technology for the future.

In the last 40 years, sugarcane tonnage and raw sugar production have doubled. Agricultural research has produced sweeter sugarcane varieties, but technology has improved sugar recovery. There is no doubt in my mind that future innovations nurtured by the Audubon Sugar Institute will propel Louisiana's sugar industry to even higher benchmarks. The institute's invaluable work will provide an avenue for continued sugar sustainability for Louisiana for another 200 years.

Jim Simon
American Sugar Cane League

DIRECTOR'S REPORT

I was honored to become the director of the Audubon Sugar Institute in June 2018, and it is a pleasure to give my first report. Before that time, the Louisiana sugar industry felt that the institute had not focused enough on them. One of my main goals was to bring ASI back in alignment with its key stakeholders and customers — the Louisiana sugar industry — to better serve their needs and give improved return on their investments into ASI. As a result, one of my first endeavors was to conduct a strategic plan.

Audubon Strategic Plan 2018

ASI, in conjunction with LSU AgCenter administration, established a strategic planning committee in the summer of 2018 after 17 years without strategic planning. The plan was undertaken to increase the value of ASI to stakeholders and customers, reflect the new leadership of ASI and create a road map to address where ASI would be going over the next decade to focus energy, resources and time. The 13 participants of the strategic planning committee were selected to cover all stakeholder and customer groups and included personnel from the American Sugar Cane League as well as ASI staff and LSU AgCenter administration:

The committee met on Aug. 27, 2018, in Baton Rouge after participating in SWOT (strengths, weaknesses, opportunities and threats) surveys online. The strategic planning committee developed goals and recommended periods of activity for each one. The three final timelines were broken down into one-year goals, two- to five-year goals, and tentative five- to 10-year goals.

2018-2028

Mission Statement

To foster a center of excellence for applied and original sugar research, which exceeds the expectations of our stakeholders in Louisiana and the international sugar industry, through innovative research, technology transfer and education.

1 Year Goals

Objectives

1. Staffing to include a chemical engineer and mechanical engineer.
2. Expanding stakeholders to include growers and refiners.
3. Improve communications with industry and stakeholders to include bimonthly Sugar Bulletin articles.
4. International.
5. Automation of factories.

2-5 Year Goals

Objectives

1. Training/short courses.
2. Utilizing pilot plant equipment.
3. Review international and other industry technologies.
4. Start Value Added Products (VAP) research.
5. Bagasse and mud uses.

Tentative 5-10 Year Goals

Objectives

1. Upgrade ASI facility and analytical laboratories.
2. Faster real-time data in the factories.

It was the hope of the committee that ASI would benefit from the resulting clarity, commitment and forward thinking the plan offered, and I can say that it has definitely helped me. From this plan we have been better able to address the opportunities and challenges that face the local and international sugar industries and, therefore, have been better able to serve these industries. This has made ASI stronger, more flexible, more service-oriented and a viable force for the future.

Staff hiring and training

Upon my arrival at ASI, I found a hardworking, dedicated staff with a wealth of experience and knowledge in sugarcane processing. To fulfill the new strategic goals, we needed to enhance this core group with additional staff. For example, we brought in temporary research instructors with a wealth of sugarcane knowledge to allow us to better serve the factories during the grinding season and to ensure practical research is conducted. The first was JoseManuel Henriquez, a retired fabrication superintendent with more than 50 years of experience working for multiple sugarcane factories in Central America and the U.S. His main focus at ASI has been on training and extension. The second was Maria del Carmen Perez, a processing engineer with more than 20 years of sugarcane processing research in Cuba as well as 20 years of experience working in international sugarcane factories. Stephania Imbachi Ordonez also joined ASI as a permanent research instructor. She already had five years of sugarcane research experience in Colombia as well as experience working as an engineer in a Colombian factory and was able to hit the ground running when she joined us in 2019. Other hires were a research associate, Alexa Triplett, who had four years of experience of sugarcane research at the U.S. Department of Agriculture, and Eldwin St. Cyr, with 24 years of experience in sugarcane research and technology, who came out of retirement to work at ASI as a research scientist technician. All staff members are now allowed to take at least one relevant training course to enhance their job performance.

Improved communications

Communications have improved inside and outside ASI. We have updated news each week for the staff, and select news articles are shared with others weekly on the new ASI Facebook page. A new Audubon Factory Corner series in the Louisiana Sugar Bulletin was started in 2018 and consists of bimonthly articles of practical interest to the factories. The Audubon webpage has been upgraded, and a new symposium series was started in 2018 to focus on important topics in the sugar industry. The first one was on sugar crops in foods. A second symposium was planned for 2020 focusing on evaporator designs and evaporators but unfortunately had to be cancelled due to the pandemic. We hope to rejuvenate the series in 2022.

New services

To serve our stakeholders and customers better and to improve the incoming revenue to ASI, a new analytical laboratory service was established in 2018. Since then, it has grown steadily with repeat customers. This service offers conventional and specialized analytical services for sugar factories, refineries and distilleries as well as related industries including foods and beverages, feeds, biofuels and agricultural commodities. Another new service is the free determination of the activity of enzymes used in Louisiana factories. We continue to find new ways to be of service to our stakeholders.

Research

The research publication rate of ASI staff has grown enormously since 2018 with approximately 100 publications between 2018 to 2021. Excellence in research is reflected by ASI staff receiving both national and international awards during this time as well as increased general funding by the American Sugar Cane League.

Diversity

ASI is proud to be one of the most diverse departments of the LSU AgCenter which may be because we reflect the diversity of the sugar industry.

Building updates

The state of Louisiana has continued to invest in the Audubon building including installation of a new roof and repairs made to the brick façade in 2018. The conference room was upgraded with wall-mounted monitors, an interactive white board, cameras and microphones to allow us to host meetings remotely and greatly improve our training capacity.

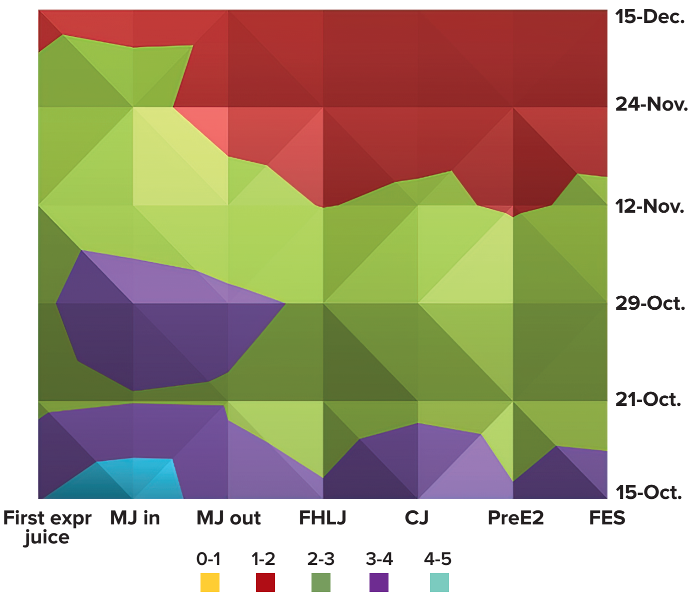
Finally, ASI faculty and staff would like to express their grateful appreciation to the LSU AgCenter, American Sugar Cane League and the Louisiana sugar industry for their continued support. Our hope is to further increase ASI's service to the sugarcane industry to allow it to remain competitive in today's global economy. The changes made to ASI in the past three years have now positioned this historical institute as a springboard for even greater successes in the future.

Gillian Eggleston
Director, Audubon Sugar Institute

Seasonal Sucrose Losses at the Cane Factory

By Gillian Eggleston

- Measurement of expensive (chemical) sucrose losses across sugarcane factories are notoriously difficult to measure directly or indirectly and are often underestimated or unknown. The traditional method of polarimetry purity measurements at the factory is not accurate enough because it is not specific to sucrose, but even more sophisticated techniques, such as high-performance liquid chromatography (HPLC) and gas chromatography (GC), underestimate as small sucrose losses may be smaller than the experimental error of the technique. As a consequence, increases in glucose/sucrose ratios on a Brix basis have been used.
- Six sucrose loss trials were conducted at one Louisiana factory across one processing season; per trial, 40 samples were collected across four upstream and downstream unit processes. Sucrose and glucose were measured using gas chromatography. Two equations were used to measure sucrose losses: (1) an increase in glucose/sucrose ratio on a Brix basis and (2) a decrease in sucrose on a Brix basis.



A two-dimensional view of a 3D surface chart for the changes in glucose (% on a Brix basis) across the season (October to December) in upstream and downstream factory samples. Concentration changes are depicted as variations in color. MJ=mixed juice, FHLJ=flash heated limed juice, CJ=clarified juice, PreE2=second pre-evaporator and FES=final evaporator syrup.

- It was found when actual losses were less than 0.5% that equation (2) based on a decrease in sucrose did not detect losses. Conversely, when high sucrose losses of greater than 0.5% occurred, losses based on equation (1) were lower than on equation (2) because simultaneous acid degradation of glucose occurred.

Season percent losses of sucrose across upstream and downstream unit processes. Sucrose losses in shaded areas were calculated from a decrease in sucrose (Equation 2); the rest were calculated from an increase in glucose (Equation 1).

	Sucrose Loss in MJ Tank %	Sucrose Loss in Clarifier Tank %	Sucrose Loss in Pre-evaporators %	Sucrose Loss from Pre-evaporator to Final Evaporator %	Total Sucrose Loss %
Oct. 15	0.057	1.34	1.35	0.37	**3.12**
Oct. 21	0.057	1.49	2.23	0.07	**3.85**
Oct. 29	0.184	0.04	nd†	0.42	**nd**
Nov. 12	0	0.28	1.82	0.37	**2.47**
Nov. 24	0	0.29	1.37	0	**1.66**
Dec. 15	0	0.33	0.72	1.03	**2.08**
Season Mean:	**0.050**	**0.630**	**1.50**	**0.38**	**2.56***

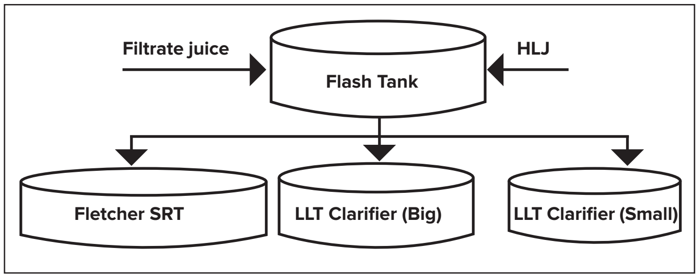
† nd=not determined.
*2.56% seasonal losses is equivalent to 4.89 pounds sucrose lost per short ton cane and $1.4 million based on a raw sugar price of 0.2525 U.S. dollars

- This research has given sugar technologists around the world important information on how to more accurately measure sucrose losses, which will allow for better diagnosis of process problems contributing to sucrose losses.

Comparison of Sucrose Losses Across Three Different Models of Short-Retention Time Clarifiers

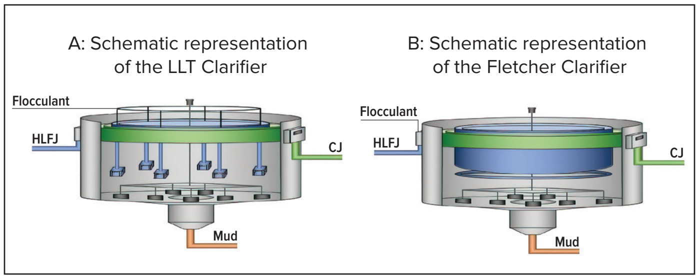
By Maria del Carmen Perez

- The design and retention time of a clarifier affects the amount of sucrose losses that occur during clarification due to the thermal, acid degradation reactions.
- This project was undertaken to study the effect of clarifier design and peripheral operations on clarification process efficiency, clear juice quality and sucrose losses. The study occurred at one Louisiana sugarcane factory, which had three short retention time (SRT) clarifiers with different designs. One Fletcher SRT clarifier and two LLT SRT clarifiers (big and small).



Three SRT clarifiers at the factory with different designs and how the flash tank is located in relation to the clarifiers.

- The Fletcher and LLT clarifiers had marked differences in their internal design. In the LLT clarifiers, the hot, limed juice was fed through a simple juice distribution system composed of several feed pipes uniformly distributed over the cross-sectional area. The exit points of the pipes were supplied with turbulence reduction devices (TRD). The big LLT had 18 TRDs, whereas the small LLT had nine TRDs, which caused significant differences in their internal flow patterns. In the Fletcher clarifier, the juice was fed through a circular and open channel which distributed the juice uniformly over the clarifier cross-sectional area. The juice from the flash tank was fed into all three clarifiers. There was an automatic flow control that maintained a constant and determined flow towards the LLT clarifiers, which meant that the flocculant addition was also under control. The rest of the juice, plus the filtrate juice, which was sent directly to the flash tank, was sent to the Fletcher clarifier without measurement or control, which implied that the flocculant addition was not controlled.



Schematic representation of the different LLT and Fletcher short retention type clarifiers and where flocculants were added.

- Five samples of heated limed flash juice (HLFJ) and clear juice (CJ) were collected each day of sampling across the season. The calcium and phosphates content, turbidity, pH, Brix and sugar losses were determined.
- The sucrose losses (season averages) in the Fletcher SRT clarifier were lower than in the small and big LLT clarifiers (0.210 ± 0.284, 0.336 ± 0.356, and 0.363 ± 0.410, respectively). A total of 527,591 pounds of raw sugar were lost across the clarification process during the processing season, which was equivalent to $133,217.

Seasonal sucrose losses.

Type of Clarifier	Fletcher	LLT Small	LLT Big
Sucrose losses (%)	0.210	0.336	0.363
Sucrose lost (lb./ton cane)	0.411	0.66	0.71
Losses across the season ($)	**$61,720**	**$41,793**	**$29,704**
Lb. sucrose lost across the season	244 436	165 515	117 639

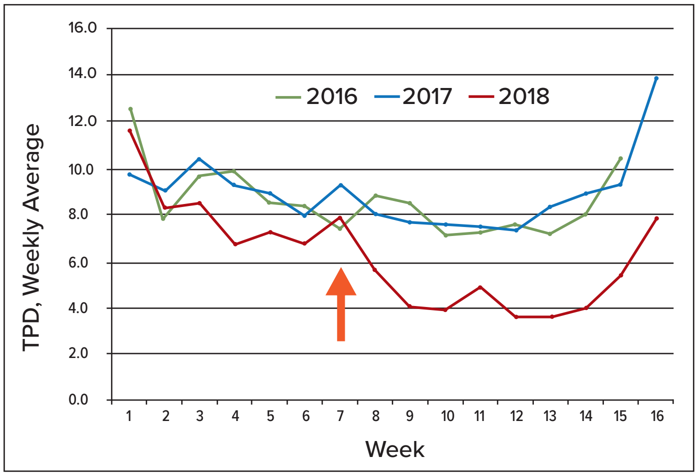
The values used in the calculations are season average (raw juice extraction=79.5%; Sugarcane ground across the season= 1013165 ton; Sucrose based on pol in raw juice=12.15%; Sucrose based on pol in raw sugar=98.71%) and the price of raw sugar used is $/lb.= 0.2525.

- There were no statistical differences among the values of calcium and phosphates in clear juice. The removal of calcium and phosphates in the three clarifiers were similar, with the LLT clarifiers performing slightly better than the Fletcher clarifier. There were no statistical differences among the clear juice turbidity and the turbidity removal for the three clarifiers; however, the performance of the LLT clarifiers were slightly better than the Fletcher.
- The most important conclusion from this project was the knowledge of the importance of the peripheral operations (heating, liming and flocculants) on clarification efficiency, CJ quality and sucrose losses. Although this factory operated only SRT clarifiers, it was still losing a considerable amount of sugar per season, which may be reduced by the increase of the clarification efficiency and its peripherals operations.

Reasons for Unusually Low Molasses Purities in Louisiana Factories in 2018

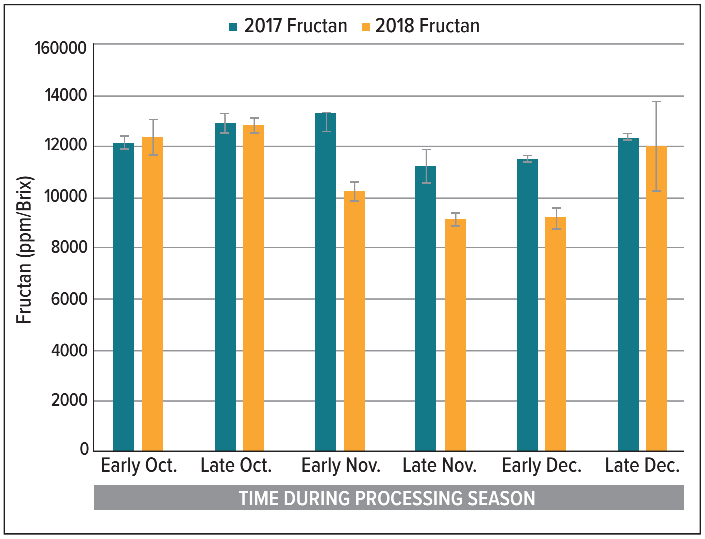
By Gillian Eggleston

- The greatest loss of expensive sucrose in a raw sugar factory is that which goes to final molasses.
- Target purity differences (TPDs) of final molasses (weekly composites) are calculated by subtracting a target purity (TP) from the true sucrose purity determined by high performance liquid chromatography, and this allows the factories to know how well they are recovering sugar from their massecuites (a lower TPD indicates greater efficiency in recovery). TP is related to the reducing sugar RS/ash ratio since the composition of the nonsucrose components in molasses influences the degree to which the molasses can be exhausted of sucrose.
- During the 2018 processing season, 10 of the 11 Louisiana sugarcane factories experienced markedly lower TPDs than normal as well as unusually low purities in final molasses. There were two phases of low TPDs separated by a freeze that occurred in week seven. The freeze caused a further lowering of the TPDs by increasing the RS/ash ratio, but the ratio did not explain the lower-than-normal TPDs and C-massecuite viscosities before the freeze.



Comparison of weekly average TPDs for all LA sugarcane factories for three processing seasons: 2016, 2017 and 2018. The arrow indicates when a freeze occurred in Louisiana in 2018 at approximately week seven.

- It was found that the concentration of total polysaccharides was a strong factor in the lower TPDs in 2018, specifically starch concentrations that were two-thirds less than normal and lower concentrations of dextran and fructans. Synergistic viscosity increases due to interactions between or among these polysaccharides may have been involved, and these are being further investigated at ASI.



Average fructan concentrations in final molasses from one Louisiana factory across both the 2017 and 2018 processing seasons in Louisiana.

- Using a new enzymatic method, considerable amounts of fructans were found in all the 2017 and 2018 final molasses from one Louisiana factory, indicating the presence and amount of this oligo/polysaccharides has been underestimated in Louisiana.
- This research has given sugar technologists important information that could lead to lower viscosities and, in turn, higher recoveries of sugar from final molasses in sugarcane factories.

Fructans Have Been Underestimated in the Louisiana Sugarcane Industry

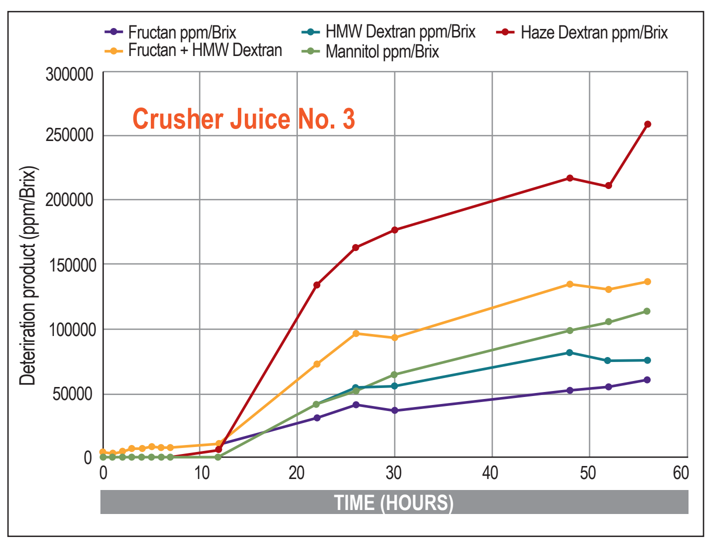
By Gillian Eggleston

- For over 100 years, sugarcane processors in Louisiana and the rest of the world have focused on the glucose polysaccharide dextran (linked by mainly α1→6 glycosidic bonds), which causes both factory and refinery problems. Fructans (also known as levans or inulins) are fructose poly- and oligosaccharides connected with β2→6 and β2→1 glycosidic bonds, but little is known on how they affect sugar processing.
- Using a new enzymatic (research) method kit from Megazyme that incorporates newly available recombinant enzymes, considerable amounts of fructans were consistently found in Louisiana crusher juices, rotary screen juices, massecuites, molasses and raw sugars. Fructans were strongly related to the concentration of sucrose in upstream and downstream products and a contributor to Haze dextran values.

Fructans occur in numerous cane products across Louisiana sugarcane factories.

Factory Sample	Fructan (% on Brix)	True Sucrose (% on Brix)	Fructose (% on Brix)	Glucose (% on Brix)
Crusher Juice	0.36 to 2.23	Not det.	Not det.	Not det.
Rotary Screen Juice	1.65 to 1.89	Not det.	Not det.	Not det.
Biofilm (slime)	14.34	Not det.	Not det.	Not det.
A Massecuite	0.39	85.97	2.20	2.42
B Massecuite	0.63	96.09	4.13	4.36
C Massecuite	0.80	60.13	6.73	5.69
A Molasses	0.59	72.51	4.55	5.10
B Molasses	0.82	55.96	7.54	8.11
C Molasses	1.00	41.45	9.31	7.90
A Raw Sugar	0.22	96.82	0.13	0.13
B Raw Sugar	0.32	91.36	1.16	1.19
C Raw Sugar	0.36	87.53	2.31	1.88

- A major source of fructans was confirmed to be the microbial deterioration of sugarcane outside or inside the factory, or both.
- Haze dextran, a nonspecific measure of dextran at the factory, measures fructans as well as dextran.

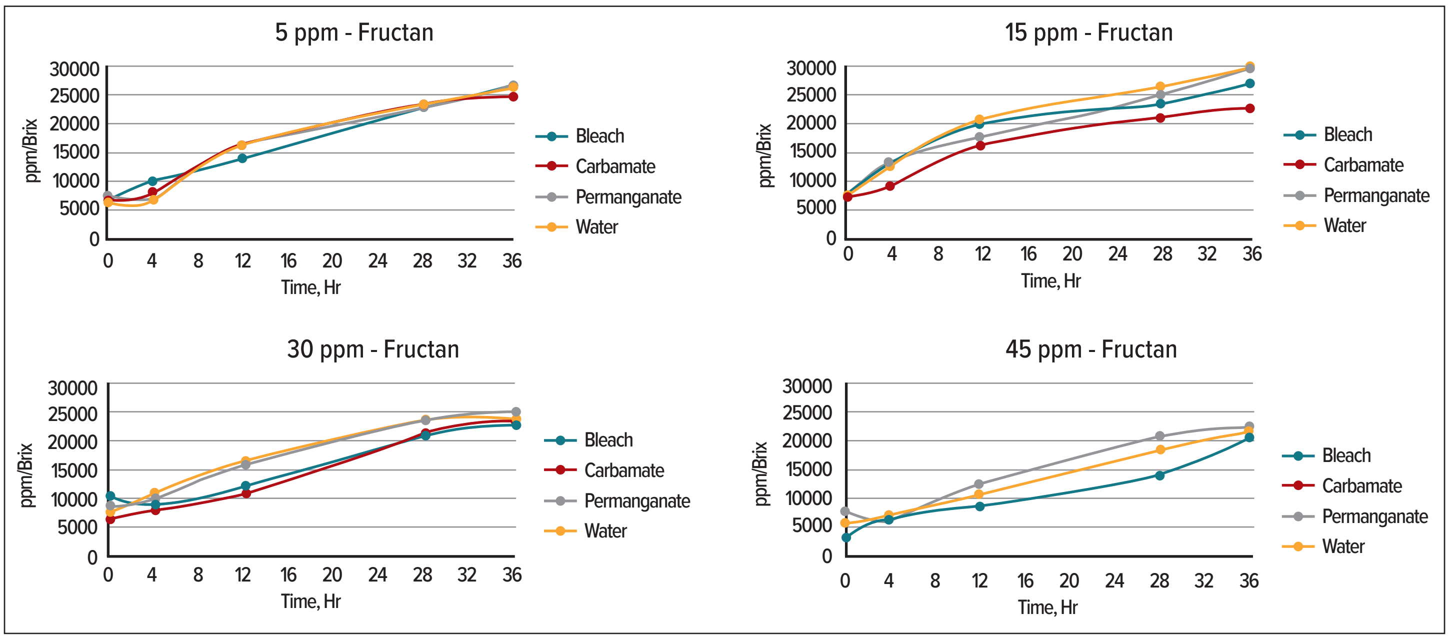


Deterioration of fresh crusher juice from a Louisiana factory at room temperature (approximately 25 degrees Celsius).

Control of Fructans, Dextran and Mannitol at the Sugarcane Factory with Commercial Biocides. Part I: Juice Deterioration Studies

By Stephania Imbachi-Ordonez

- Chemical biocides in combination with steam and hot water are used in sugarcane factories to mainly control dextran formation from mesophilic bacteria. Microbial fructans have recently been reported to be consistently present in large amounts in cane products from Louisiana factories.
- This study was undertaken to evaluate if current commercial biocides used in Louisiana factories can control the formation of fructans as well as dextran and mannitol. Bleach (sodium hypochlorite) and sodium permanganate, both oxidizing biocides, and sodium carbamate, a non-oxidizing biocide, were added to coarsely filtered crusher (first extraction) juices obtained from Louisiana factories. Each biocide and each control (deionized water) were added to the juice at 5, 15, 30 and 45 ppm doses, and the juice was allowed to deteriorate at room temperature (approximately 25 degrees Celsius).
- At greater than or equal to 5 ppm, both carbamate and bleach generally controlled fructan, dextran, mannitol and reduced sucrose losses. Carbamate was the most persistent in controlling sucrose losses probably because it was a nonoxidizing biocide. Results for permanganate were considerably less clear and consistent than for bleach and carbamate, and only slight biocidal action was exhibited at greater than 30-45 ppm, which is cost-prohibitive.



Effect of different doses of three commercial biocides on controlling fructan in sugarcane juice.

- Addition of the basic biocides (bleach, carbamate and permanganate had initial pH values of 13.69, 11.22, and 8.25, respectively) to cane juice extracted from nondeteriorated cane (initial pH 5.36 at approximately 25 degrees Celsius) did not overcome the natural buffering capacity of the juice. Furthermore, in the presence of the basic biocides, up to 14% less calcium hydroxide in the form of milk of lime (MOL) was required to obtain a target limed juice pH of 8.30 at 92 degrees Celsius for juice extracted from mildly deteriorated and acidic (initial pH 5.23 at approximately 25 degrees Celsius) than for juice from the nondeteriorated cane. This was attributed to the weaker buffering capacity of the more acidic cane juice. Overall, lime consumption was more dependent on the buffering capacity of the juice rather than on the biocide added and warrants further investigation.

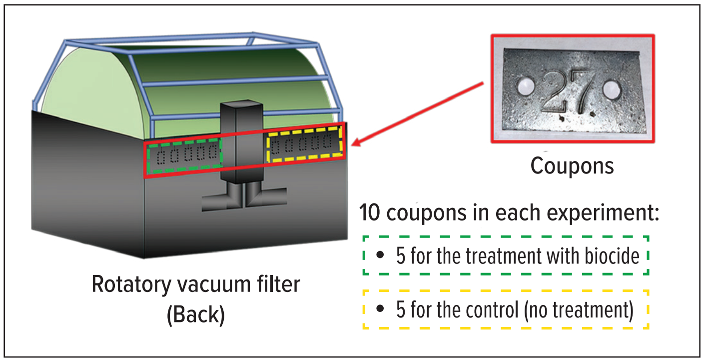
Changes in calcium hydroxide Ca(OH)2 consumption to obtain a target limed pH of 8.3 at 92 C after application of various concentrations of biocides to fresh cane juices.

		Fresh Cane Juice 2					Fresh Cane Juice 3				
Biocide Added	Dose (ppm)	Initial pH at 25 C	% Difference from Control	Final Limed pH at 92 C	Ca(OH)2 added (mg/L)	% Difference from Control	Initial pH at 25 C	% Difference from Control	Final Limed pH at 92 C	Ca(OH)2 added (mg/L)	% Difference from Control
Control	0	**5.36**		**8.29**	**1,504**		**5.23**		**8.33**	**1,708**	
Water	5	5.36	0.0	8.30	1,489	1.0	5.20	0.6	8.30	1,684	1.4
Water	15	5.36	0.0	8.33	1,473	2.0	5.30	+1.3	8.32	1,684	1.4
Water	30	5.30	1.1	8.29	1,564	+4.0	5.32	+1.7	8.33	1,624	4.9
Water	45	5.30	1.1	8.30	1,564	+4.0	5.20	0.6	8.34	1,654	3.2
Bleach	5	5.30	1.1	8.30	1,594	+6.0	5.18	1.0	8.35	1,624	4.9
Bleach	15	5.34	0.4	8.30	1,564	+4.0	5.20	0.6	8.36	1,654	3.2
Bleach	30	5.30	1.1	8.30	1,594	+6.0	5.23	0.0	8.35	1,654	3.2
Bleach	45	5.34	0.4	8.31	1,582	+5.2	5.20	0.6	8.32	1,624	4.9
Carbamate	5	5.31	0.9	8.30	1,564	+4.0	5.18	1.0	8.33	1,684	1.4
Carbamate	15	5.30	1.1	8.30	1,564	+4.0	5.40	+3.3	8.29	1,684	4.9
Carbamate	30	5.33	0.6	8.30	1,564	+4.0	5.16	1.3	8.29	1,624	4.9
Carbamate	45	5.38	+0.4	8.30	1,579	+5.0	5.28	+1.0	8.31	1,624	4.9
Permanganate	5	5.30	1.1	8.30	1,624	+8.0	5.26	+0.6	8.32	1,684	1.4
Permanganate	15	5.32	0.7	8.30	1,594	+6.0	5.23	0.0	8.34	1,684	1.4
Permanganate	30	5.32	0.7	8.29	1,594	+6.0	5.17	1.2	8.30	1,624	4.9
Permanganate	45	5.33	0.6	8.30	1,618	+7.6	5.26	+0.6	8.27	1,624	4.9
Bleach +											
Carbamate	22.5 each	5.30	1.1	8.30	1594	+6.0	5.30	+1.3	8.30	1,624	49
Permanganate + Carbamate	22.5 each	5.39	+0.6	8.29	1489	1.0	5.23	0.0	8.32	1,624	4.9

Control of Biofilm Formation at the Sugarcane Factory with Commercial Biocides

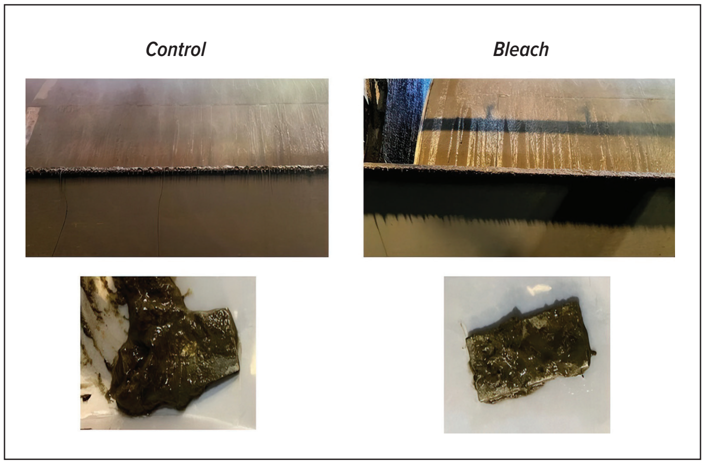
By Stephania Imbachi-Ordonez

- This study was undertaken to evaluate if current commercial biocides used in Louisiana factories can control the formation of slimy biofilms there. Using a novel technique of attaching rough iron coupons to the inner sidewall of one rotary vacuum filter (RVF) at one Louisiana factory, it was possible to evaluate the effect of biocides on the formation of biofilm.



Use of rough iron coupons in the factory biofilm study. Attachment of coupons to the back (inside surface) of the factory's rotary vacuum filter is also shown.

- Bleach (sodium hypochlorite) and sodium permanganate, both oxidizing biocides, and sodium carbamate, a nonoxidizing biocide, were sprayed (1 gallon) on the factory-placed coupons every two days for five days. Since the biocide doses to control fructans at the factory were unknown, each biocide and control (water at approximately 25 degrees Celsius) were added at a 12.5% concentration.
- Fructan and dextran exopolysaccharides were both major components of biofilm. Bleach significantly (p less than 0.05) decreased the biofilm mass formation (53.8%), protein (83.3%) and mannitol (45.5%) production on the biofilm formed on the coupons located in the mud filter. Carbamate and permanganate (in less proportion) also reduced the biofilm, protein, mannitol and dextran production, but without any significant differences.



Photographs of the back wall of the RVF at one Louisiana factory in 2020, which had been applied with bleach (12.5%) or no treatment (control), and examples of biofilms formed on coupons (below).

- The overall efficiency of the biocides evaluated was:

Bleach > Carbamate >> Permanganate > Control (Water)

- Future investigations are now needed to find the minimum concentration of each biocide to control biofilm formation in the factory and associated sucrose losses. The methodology developed in this study with rough iron coupons was effective for the evaluation of biofilm formation at the factory and could be used in other areas of the factory.

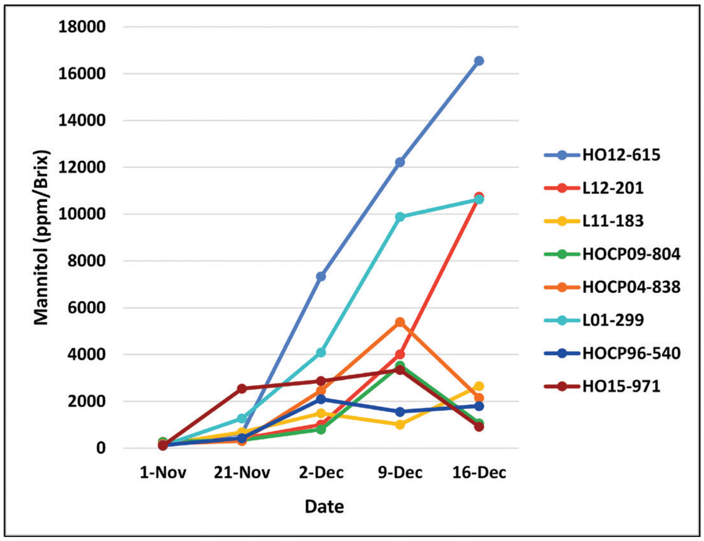
Cold Tolerance of Commercial Sugarcane Varieties in Louisiana

By Harold Birkett

- Louisiana is susceptible to damaging freezes and, as a consequence, evaluates sugarcane varieties for cold tolerance as part of freeze management. An early freeze (22 degrees Fahrenheit) occurred on Nov. 13, 2019, and a plant cane trial in Cheneyville, Louisiana, with seven commercial sugarcane varieties and six experimental clones, was converted into a cold tolerance test.
- The test was sampled on Nov. 14, Nov. 21, Dec. 2, Dec. 9 and Dec. 16, 2019. Each sample was hand-cut at the base, not stripped of leaves and tops were cut off at the leaf whorl. Juice was extracted with a pre-breaker-press at the Sugar Research Station in St. Gabriel, Louisiana, and residual fiber and juice were analyzed. Juice analyses included Brix, pol, pH, titratable acidity, total polysaccharides, mannitol and fructans.

Juice purity values (%) of commercial and candidate sugarcane varieties following the freeze on Nov. 13, 2019.

Variety	Juice Purity (%) Nov. 14	Juice Purity (%) Nov. 21	Juice Purity (%) Dec. 2	Juice Purity (%) Dec. 9	Juice Purity (%) Dec. 16
HoCP 96-540	80.7	81.4	82.2	80.4	80.7
L 01-299	80.5	82.0	78.7	79.9	70.3
HoCP 04-838	85.4	86.2	81.0	84.8	89.0
HoCP 09-804	89.5	82.5	73.8	87.1	86.3
L 11-183	84.7	81.1	75.7	83.6	84.4
L 12-201	85.8	85.0	76.1	79.9	74.8
Ho 12-615	86.7	82.1	78.3	70.5	66.1
Ho 13-739	82.8	81.7	81.5	84.8	80.2
L 14-267	87.9	84.5	84.8	83.4	82.2
HoCP 14-885	88.5	86.0	83.8	85.6	84.0
L 15-306	83.2	82.1	79.6	79.3	81.1
HoL 15-508	85.7	85.1	80.8	84.9	81.1
Ho 15-971	87.0	86.9	82.3	81.4	83.1



Mannitol values of commercial sugarcane varieties following the freeze on Nov. 13, 2019.

- By using the quality parameters, the cold tolerance characteristic of each sugarcane variety was calculated.

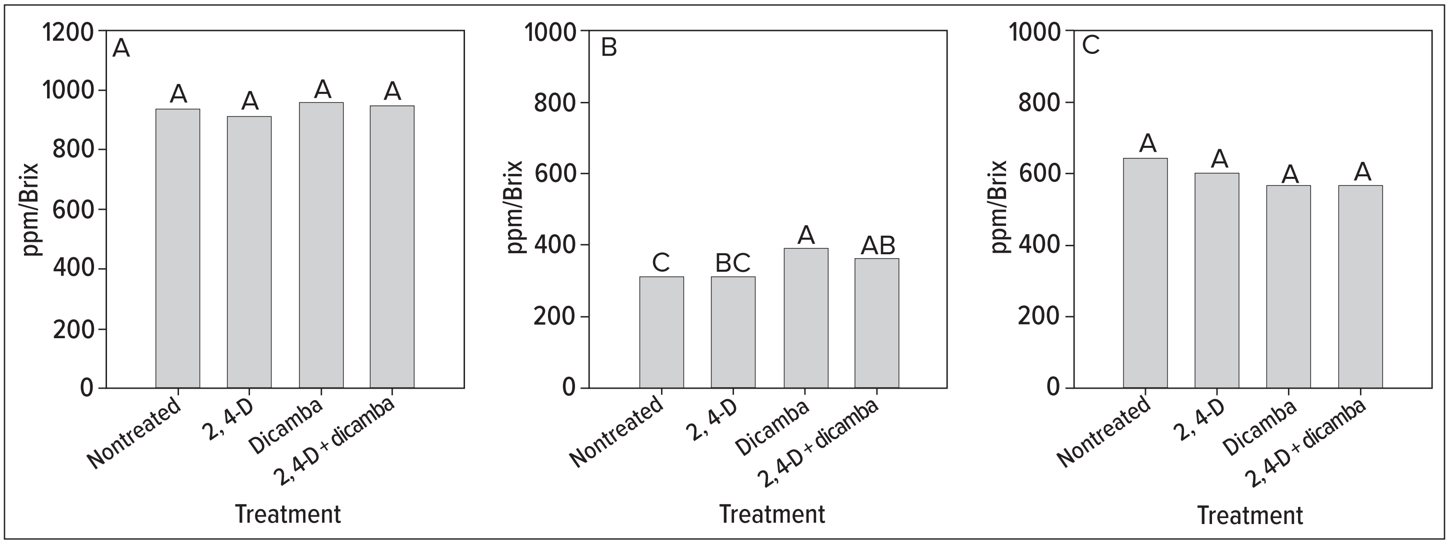
Sugarcane variety ratings for cold tolerance based on the freeze on Nov. 13, 2019. Ratings were calculated from five quality traits.

Sugarcane Variety	Cold Tolerance Rating
HoCP 96-540	Good
L 01-299	Moderate
HoCP 04-838	Good
HoCP 09-804	Moderate
L 11-183	Moderate
L 12-201	Poor
Ho 12-615	Poor
Ho 13-739	Moderate
L 14-267	Moderate
HoCP 14-885	Moderate
L 15-306	Moderate
HoL 15-508	Moderate
Ho 15-971	Moderate

Effect of Auxin Herbicides on Starch Accumulation and Color of Sugarcane in Louisiana

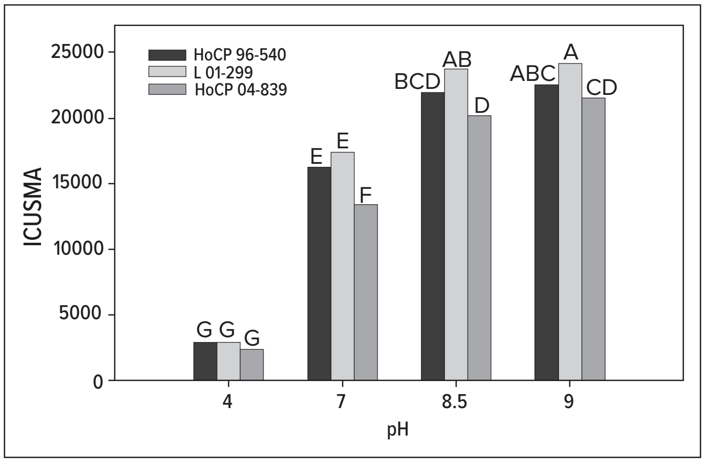
By Gillian Eggleston

- Weeds such as morningglory infest Louisiana sugarcane fields and reduce crop yields. To control such weeds, synthetic auxin herbicides are applied to field sugarcane during the critical growth period. It was unknown if herbicides affected sugarcane quality such as starch content and color of extracted juice.
- A two-year study from 2018-2019 was undertaken with weed scientist Douglas Spaunhorst of the U.S. Department of Agriculture's Agriculture Research Service Sugarcane Research Station in Houma, Louisiana, to investigate the effect of three herbicides (2,4-D, dicamba, and a premix formulation of 2,4-D and dicamba) treatments on three commercial Louisiana sugarcane varieties (L 01-299, HoCP 96-540 and HoCP 04-838).
- No visible abnormalities in sugarcane growth were observed following the herbicide treatments.
- Treatments with dicamba or 2,4-D did not increase or decrease total or insoluble starch in extracted sugarcane juice. However, when compared to the untreated control, 16% to 25% more soluble starch was present in juice from L 01-299, HoCP 96-540 and HoCP 04-838 sugarcane that were exposed to dicamba and the pre-mix formulation of dicamba plus 2,4-D. This is most likely related to natural diastase activity in the sugarcane.



Total starch (A), soluble starch (B), and insoluble starch (C) values pooled across HoCP 96-540, L 01-299, and HoCP 04-838 treated with 2,4-D (Weedar64), dicamba (Sterling Blue), and a pre-mixture of dicamba plus 2,4-D (Brash). Treatment means that are followed by the same letter are not statistically different at the 5% probability level.

- Late-season applied synthetic auxin herbicides did not significantly influence color measured at pH 4.0, 7.0, 8.5 or 9.0; however, pH by cultivar interactions influenced color at pH 7.0 or greater, i.e., phenolic colorants.



Influence of HoCP 96-540, L 01-299, and HoCP 04-838 LA sugarcane varieties on color measured at pH 4.0, 7.0, 8. and 9.0. Treatment means that are followed by the same letter are not statistically different at the 5% probability level.

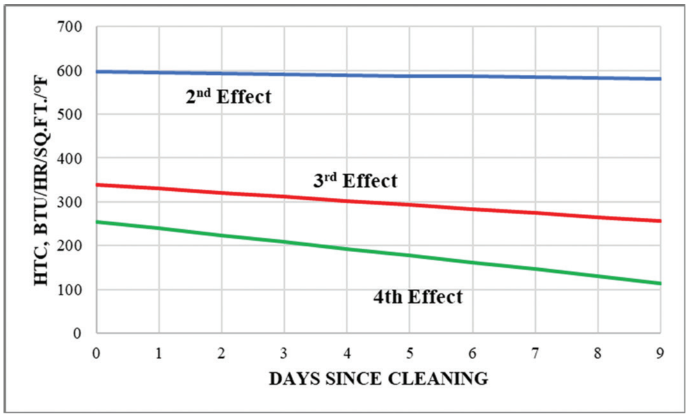
- Overall, this study documented that the synthetic auxin herbicides dicamba and 2,4-D plus dicamba were beneficial in controlling morningglory weeds and pose no threat to processing difficulties often caused by excessive starch and colorants in processing streams at both the factory and refinery.

Evaporator and Heater Performance Monitoring

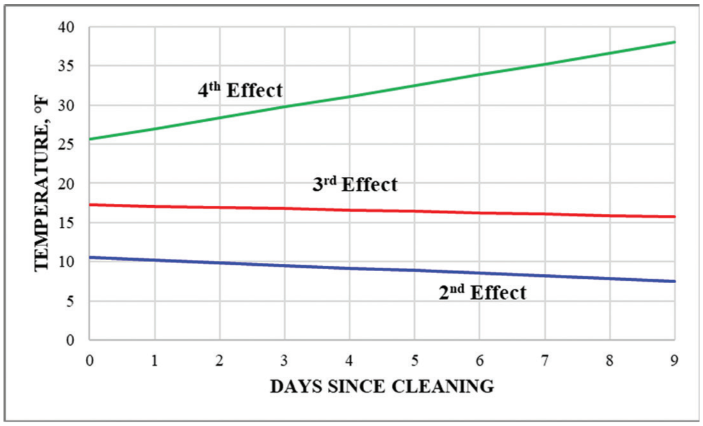
By Harold Birkett

Evaporators

- The evaporator station is one of the major stations of the raw sugar factory. How scaling of the evaporator calandria tubes affects the heat transfer coefficients (HTC) and evaporation rates of the individual effects, and the set in general, is useful in optimizing both the frequency of cleaning and the severity of the cleaning that is necessary.
- One factory in Louisiana installed the necessary equipment (condensate flow meter and thermometers for calandria steam temperature and juice boiling temperature) to accurately determine the heat transfer coefficients and evaporation rates of the last three effects of its three sets of quadruple effect evaporators.
- The degree of decline of the heat transfer coefficients can be used to infer the degree of tube fouling in each individual vessel and thus the necessary cleaning time and/or cleaning chemical concentration requirements for the individual vessels. The heat transfer coefficients achieved following cleaning are a useful guide as to the effectiveness of the cleaning.

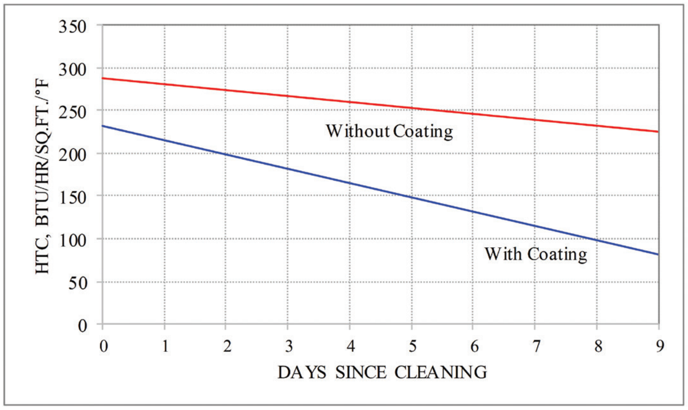


Change in heat transfer coefficients versus days after cleaning.



Change in difference between calandria steam temperature and juice temperature versus days following cleaning.

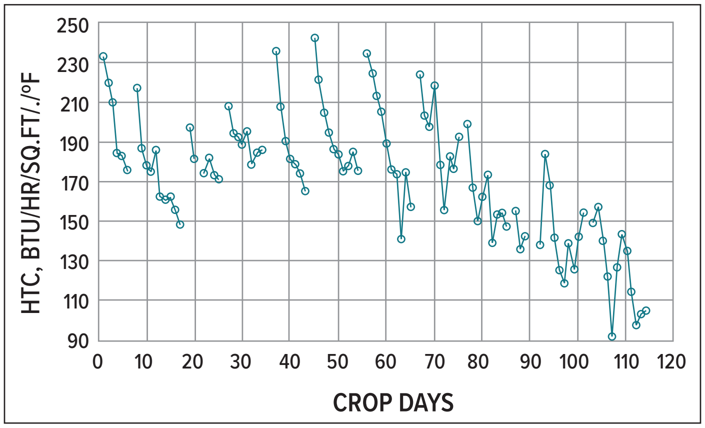
- For the 2019 season, one Louisiana factory installed all new tubes in the last effect of a quadruple effect evaporator. The tubes were coated by a New England company with a thin polymer that was vapor deposited on the tubes. The composition of the proprietary polymer was not disclosed. In summary, we found (1) that the coating slightly reduced the heat transfer coefficient versus the uncoated tubes, (2) the coating increased the rate of scaling of the tubes, and (3) the coating disintegrated after about two months of operation. The data was based on the actual measured heat transfer coefficients described above.



Heat transfer coefficient of the last effect versus time after cleaning for the period with and the period without the tube coating.

Juice Heaters

- The factory also determined the heat transfer coefficient of the heaters by measuring the juice flow through the heaters, the inlet and outlet juice temperatures through the heaters, and the steam temperature (pressure) in the heaters.
- It was found that the HTC in the heater declined following each cleaning. Typically, the heat transfer coefficient declined about 25% over a five-day period. Heat transfer coefficients also reduced for the latter part of the crop.



Heat transfer coefficients for a primary juice heater over the crop.

Mill Performance Tests

By Harold Birkett

- Mill performance tests are requested each year by factories interested in improving tandem mill extraction.
- For each of the 11 sugarcane factories in Louisiana, multiple samples of prepared cane and bagasse from each mill in the tandem were collected for various analyses, which included moisture, pol, fiber and open cells. Routine sugar factory laboratory methods were used. Results of interest from 11 mill tests over the past three crops (2018-2020) are given in the table below.

Summary of Louisiana mill test results from 2018 to 2020.

Sample	Average	High	Low
Open cells % prepared cane	83.39	89.77	78.28
Moisture % cane	71.20	72.61	69.33
Pol % cane	12.16	14.05	10.67
Fiber % cane	13.26	14.46	12.26
First mill moisture % bagasse	58.72	63.28	54.98
First mill pol extraction, %	64.39	74.62	57.44
Last mill moisture % bagasse	51.77	55.01	47.33
Last mill pol % bagasse	1.92	2.87	1.57
Last mill fiber % bagasse	40.97	44.21	38.27
Tandem pol extraction, %	95.13	96.02	94.12

- Similar results for each mill in the tandem were given to factory personnel indicating which mills in the tandem needed individual attention. Results provided mill engineers with information necessary to make changes to the mill that could decrease sugar losses. An increase in tandem pol extraction of 1% can mean an extra 2.5 pounds sugar/ton cane.
- A sample mill at USDA (Chacahoula) that is used for comparing sugarcane varieties was tested in August 2019 for pol extraction. Results indicated that the extraction was lower than desired, and the mill was refurbished in 2020.

Bagasse Boiler Tests

By Harold Birkett

- Sugar processors at Louisiana sugarcane factories often require bagasse boiler tests for efficiency and compliance.
- Sixty-one tests were conducted over a three-year period (2018-2020) at Louisiana sugarcane factories. Operating conditions were recorded while temperatures and oxygen were measured. Bagasse samples were collected for moisture and ash analyses.

Results of bagasse boiler testing.

Parameter	Average	High	Low
Steam flow, lbs/hr	134,114	269,714	58,000
Steam pressure, psig	230	677	174
Preheated air, °F	461	612	265
Flue gas, °F	413	514	321
Bagasse moisture, %	50.71	56.69	45.42
Bagasse ash, %	5.03	10.89	2.46
Oxygen, %	8.64	12.94	4.41
Excess air, %	73.53	160.45	25.95
Efficiency, %	61.42	67.73	53.13
Lbs steam/lb bagasse	2.25	2.75	1.92

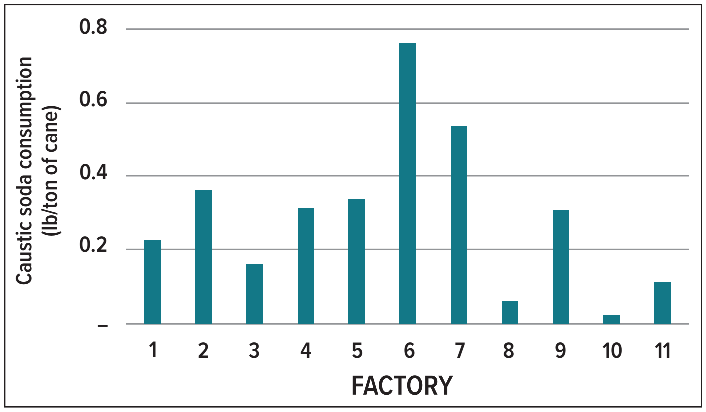
- Improving boiler performance allowed for more efficient steam production while staying in compliance with government regulations.

Benchmarking of Evaporator Cleaning Practices at Louisiana Factories in 2020

By Stephania Imbachi-Ordonez

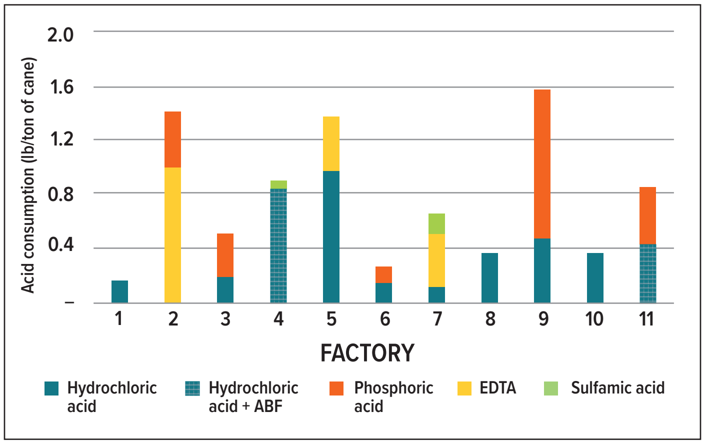
- Multiple-effect evaporation at a sugarcane factory is the principal stage that determines the energy efficiency of the factory. However, if the heat transfer coefficient in evaporators decreases, the efficiency of evaporation and final syrup Brix will decrease and the energy balance of the factory will destabilize. The main cause of the decrease of the heat transfer rate in the evaporation station is the accumulation of scale (fouling) on the heat transfer surfaces.
- This study summarized the practices to clean the evaporators of scale, which were used at all 11 Louisiana factories during the 2020 processing season. The performances of each factory were also evaluated in terms of the amount of chemicals used, frequency of cleanings and evaporator station efficiency.
- Ten factories determined when cleaning was required at regular intervals, with an average frequency of nine to 11 days. In some cases, the determination of the exact day of the cleaning depended on the operation efficiency (e.g., drop in the final evaporator syrup Brix, increasingly high operating evaporator levels). One factory frequently did an acid cleaning every seven days and only every 15 days did a caustic soda cleaning after acid cleaning.
- The chemical cleaning procedure followed by most of the Louisiana factories was: (1) Drain the juice from the evaporator vessels. (2) Rinse the evaporator with water by filling up or spraying water. (3) Boil caustic soda. (4) Rinse the evaporator with water by filling up or spraying water. (5) Boil acid. (6) Rinse the evaporator with water by filling up or spraying water.

- The common chemical sequence was boiling caustic soda and then acid (10 factories); however, one factory did the opposite; eight factories boil the chemicals with exhausted steam (indirect contact heating) with water added to maintain the level of the chemicals inside the evaporators. The other two factories boiled the chemicals with high-pressure steam injection using jet nozzles (direct contact heating) without water addition. Regarding the level of the chemical inside the evaporators, six factories worked with a level just above the calandria tubes, two factories worked with a level of approximately 35-50%, and two factories approximately 70-80%.
- All the Louisiana factories used caustic soda as the basic treatment, and one factory used a combination of caustic soda and soda ash (100-150 pounds/vessel). A caustic soda concentration greater than 20% is usually required, which was close to the Louisiana factories' caustic soda dosage concentration (20-28%).



Factory caustic soda consumption during the 2019 processing season.

- All factories used hydrochloric acid (HCl) for cleaning evaporators with copper tubes, with factory No. 11 and No. 4 using a combination of HCL and ammonium bifluoride (ABF). For the evaporators with stainless steel tubes, five factories used phosphoric acid, one factory used sulfamic acid and two factories used EDTA. The hydrochloric, phosphoric and sulfamic acid dosage concentrations were between 1% and 3%, with some exceptions (the concentration in factory No. 9 was 5% and factory No. 5 was 14%).
- In the factories with the lowest total chemical consumption (factories No. 1, No. 8, No. 10 and No. 11), all the evaporators had copper tubes. Factory No. 3 was the exception because only 64% of its tubes were made of copper. Factory No. 8 did acid cleaning first followed by caustic soda cleaning, which was reported not to affect the cleaning performance.



Acid consumption (2019 grinding season data).
Concentrations: Hydrochloric acid 32%, Phosphoric acid 75%, EDTA 40%, Sulfamic acid 99.9%.

- There were no clear reasons for the higher chemical consumption of the other factories. Further analysis will be done after the characterization of the scale samples taken from different factories during the 2020 grinding season. The same scale samples will be used to test the chemical dosage concentrations. These tests will be repeated using factory calandria tubes with scale.

Monitoring Mud Consistency at Sugarcane Factories to Improve Mud Filtration

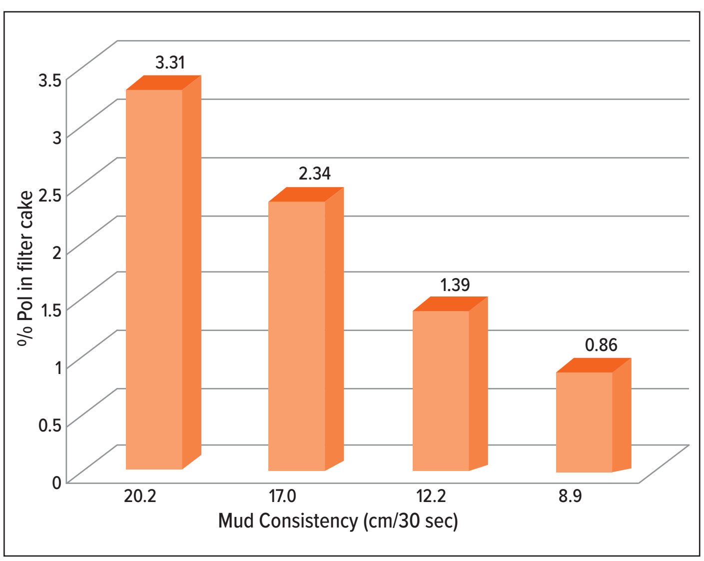
By JoseManuel Henriquez

- The clarification and mud filter stations of the raw sugar factory are some of the last remaining sections that have not been automated. Unfortunately, underflow mud characteristics have not been clearly defined or measured, causing operators to rely heavily on visual and touch assessment of the quality of the mud. Moreover, mud "flowability" cannot always be predicted by viscosity (resistance to applied torque) due to surface tension and density effects.
- This study was undertaken to find a simple instrument that could be used by the station operators to produce a reliable quantitative value on mud "flowability," which will allow standardization of the mud fed to the filters to prevent increased recycling of filtrate juice, lower the pol of filter cake, minimize lost time and make it easier to handle the mud at the filter station.

- The study occurred at four Louisiana factories across the 2018 processing season, which represented the complete spectrum of the current technologies used in Louisiana: multiple tray clarifiers, short retention time clarifiers, rotary vacuum filters and vacuum belt filters. Three portable instruments were initially tested and the Bostwick-type consistometer, which measures the flow of a standard volume of mud under its own weight, was found to be useful while falling needle and falling ball viscometers were not.

Bostwick-type consistometers used to directly measure the flowability of mud at the factory site. The longer trough length (31 centimeters) was found to have more practical use.

- Across the season, a regular trend was found where the higher the mud consistency value (light mud) then the higher the pol in filter cake and vice versa.



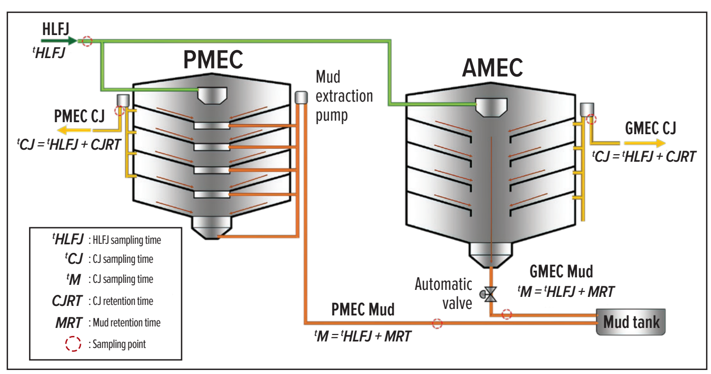
The relationship between the season average % fiber in mud and % pol in filter cake. Each point represents an average of data from at least five dates. The Pearson R value was -0.908.

- One Louisiana factory had already automated mud "consistency" values with a Ziegler consistency monitor and probe, which depends on the viscosity of the mud. A strong relationship (R=-0.895) was regularly found between the Bostwick-type mud consistometer values and the Ziegler readings at this factory, which indicated that the portable consistometer could be used to calibrate the automation system.
- Overall, the simple, robust and inexpensive Bostwick-type consistometer instrument has given operators a practical first step in the automation of the filtration operation since it provides quantitative values that can be used as a standard reference.

Comparative Performance of Factory Clarifiers with Automatic or Pump Mud Extraction Systems

By Maria del Carmen Perez

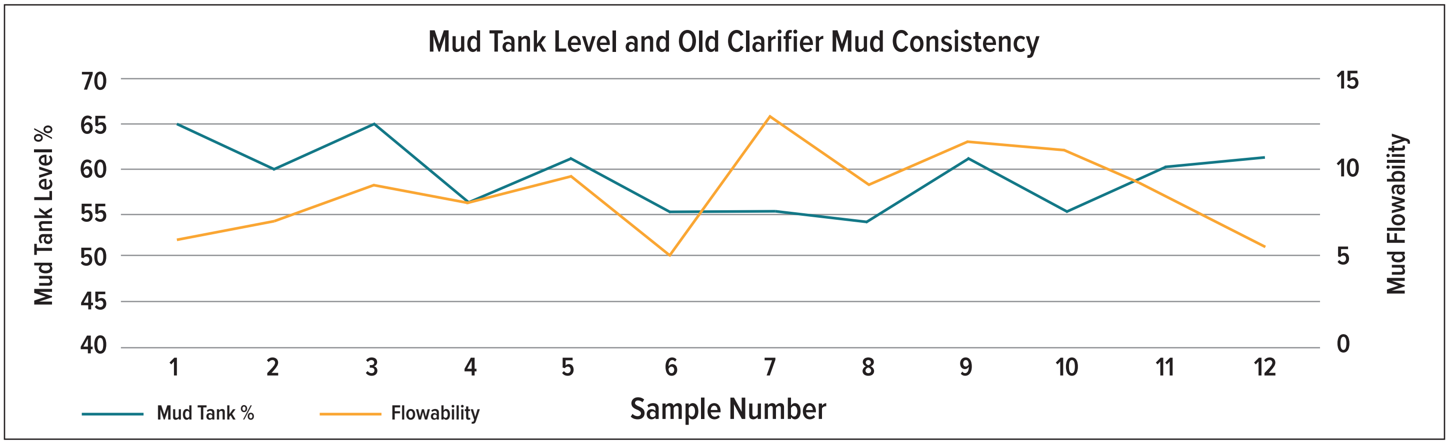
- The clarification process is one of the most important processes in raw sugar production. Most Louisiana sugarcane factories now operate hot or intermediate temperature lime clarification. The main objectives of clarification processes are to remove suspended and turbid particles and to supply a juice of optimum quality to the back end of the factory.
- The main goal of this study was to compare the performance between two high retention time (HRT) clarifiers operating in parallel with a gravity mud (automatic) extraction system (AMEC) or a pump mud extraction system (PMEC) during the 2019 Louisiana processing season at one Louisiana sugarcane factory.



Relationship between mud tank level and mud consistency.

- Five samples were collected six times across the season. Samples of heated limed flashed juice (HLFJ), clear juice (CJ) and mud were collected, taking into account retention times with a 30-minute interval between samplings. The calcium and phosphates content, turbidity, pH, Brix, sugar losses, flocculants consumption and mud consistency were measured in the samples.

- As expected, there was no significant effect of the mud extraction system and the quality of the clear juice or sucrose losses. In contrast, the mud extraction system, along with other factors, affected ($P<0.05$) the quality of the mud, with the pump extraction system (PMEC) tending to give higher mud consistency (11.2 ± 2.6 cm/30 sec), i.e., lighter muds, with lower variability than the (AMEC) system (9.5 ± 3.4 cm/30 sec).
- As the mud tank level decreased, there was an increase in mud consistency (resistance to flow) and vice versa.



Relationship between mud tank level and mud consistency.

- The total sugar lost in this factory was 0.225%, which was equivalent to 0.415 pounds/ton. Overall, 480,279 pounds of raw sugar were lost across the season with a cost of $12,127.
- The biggest disadvantage of an automatic mud extraction system happens at the time of mud extraction. If there is not enough mud accumulated in the clarifier, juice will be extracted instead of mud. On the other hand, if due to some situation in the mud filters the tank level remains stable, no mud will be removed, and its level will be increased inside the clarifier, causing its malfunction.
- One of the most important conclusions from this project is that if the automatic extraction system is used it should be operated by the mud density or mud level inside the clarifier, never by the mud tank level.
- Overall, this research has provided important information about the mud extraction systems in clarifiers, the impact they have on the mud quality and, therefore, on the filter station behavior and sugar losses.

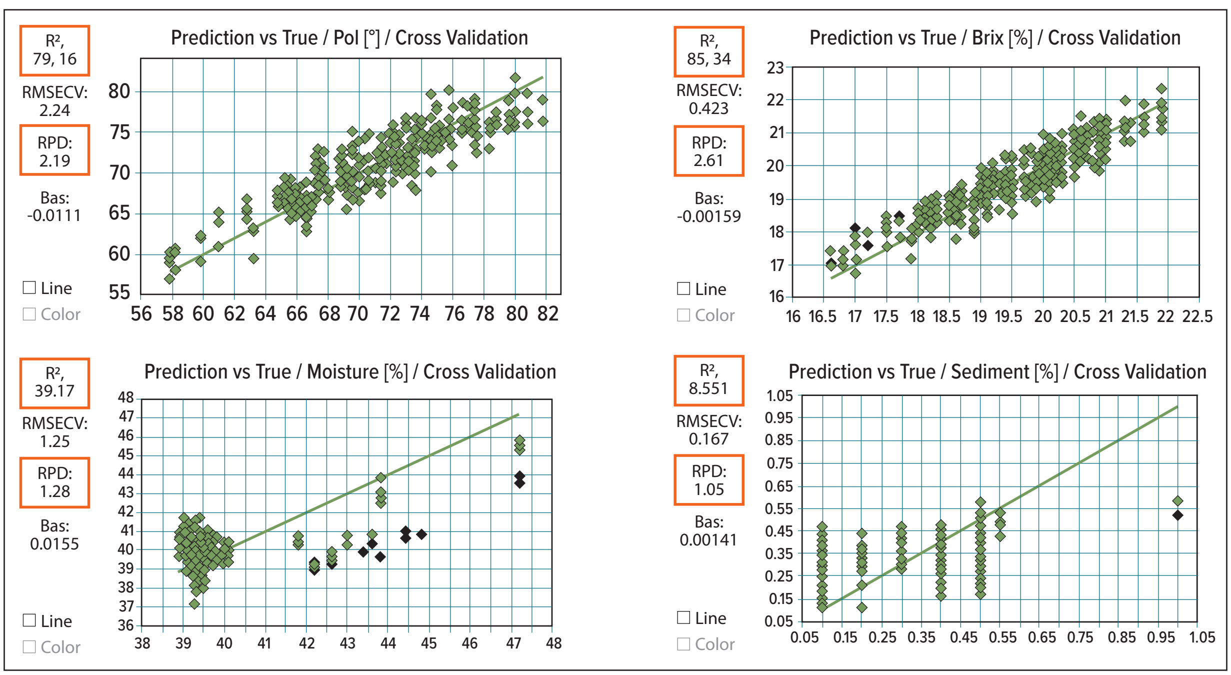
Upgrading the Bruker Benchtop NIR Instrument at ASI for Researching a New Cane Payment Method for Louisiana

By Stephania Imbachi-Ordonez

- In the past 30 years, there has been the introduction and increasing use of near-infrared spectroscopy (NIRS) into the worldwide sugar industry. This is because NIR spectroscopy can provide stable and accurate analysis results of multiple components in a cane sample within seconds. Currently, Louisiana factories use a cane payment formula based on wet chemistry and because of excessive time requirements, not all cane trucks can be evaluated for cane payment.
- A preliminary study was undertaken to upgrade a benchtop Bruker MPA NIR instrument at ASI in order to start building calibration models to replace the wet chemistry and develop a new cane payment system for Louisiana. Successful calibration models will be expected to incorporate the large range in quality variations found in cane delivered to Louisiana cane factories.
- Initially, the MPA NIRS instrument at ASI was successfully updated with the latest version of software (OPUS 8.5) and was found to be functioning correctly. The instrument was subsequently transported and set up at a Louisiana factory at the beginning of November in the 2020 processing season, and 108 samples of shredded sugarcane were analyzed.

Photographs of the benchtop Bruker NIR instrument at a Louisiana factory during the 2020 processing season (left) and shredded cane used for cane payment (right).

- The correlation coefficient R2 for the preliminary calibration models for pol and Brix were tolerable, with values of 79.16% and 85.34%, respectively, and are expected to improve with more samples. However, the R2 for moisture and sediment content were relatively low (39.17% and 8.551%, respectively), probably due to inherent problems with the wet chemistry methods.



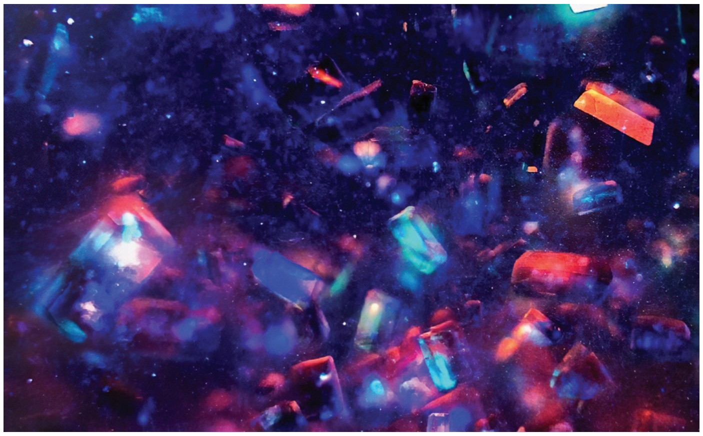
Preliminary cross validation for pol, Brix, moisture and sediment content in initial cane samples (wet chemistry versus NIRS).

- The accuracy of the calibration models could be affected by the preparation of the sample as well as results from the wet chemistry methods. To improve the accuracy of the calibration models, more samples will be analyzed during the 2021 processing season and the wet chemistry of the factory laboratories will be also reviewed.

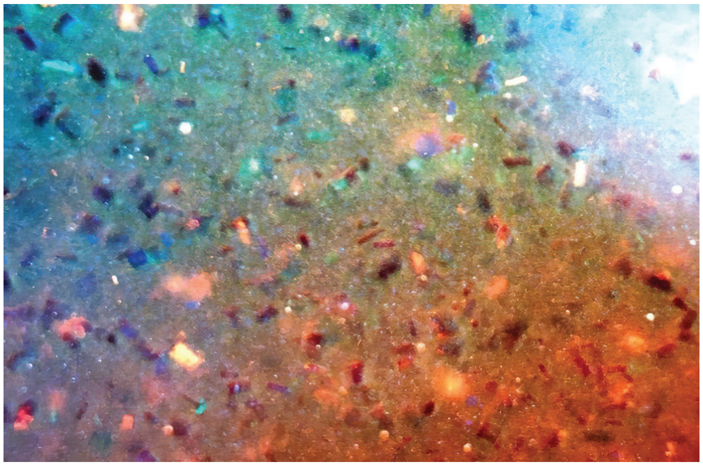
Factory Trial of a Crystal-Measuring Camera

By Stuart L. Goudeau

- Sugar crystal size and quality inside the vacuum pan can be very difficult to accurately determine in a sugar factory. Samples can be taken from a proof stick while the pan is in operation, but then the sample must be taken to another location to be examined under microscope or analyzed with an expensive and sophisticated particle size measuring instrument. This takes time and allows the sample to cool, which can cause false grain to form and can cause other changes to the existing crystals, leading to an inaccurate determination of crystal quality.
- Trials were run at two Louisiana factories over the entire 2019 processing season to test a new camera and software system developed by a European company to show crystals growing in real-time and allow size measurements in real time. The equipment consisted of a camera mounted to an existing sight glass and a laptop computer with the crystal size measuring software stationed nearby. At one Louisiana factory, trials were performed on an A pan, two B pans and a C pan. At the other factory, trials were only performed on a B pan.
- The trials consisted of starting the crystal measurement software at the beginning of the strike and ending it at the end of the strike. Collected massecuite samples at the end of the strike were analyzed in the factory laboratory with an independent particle size analyzer to compare crystal measurements. Data was collected continuously on crystal growth rate and size. This data was sent to the European company daily and used to adjust calculations in the measuring software program to obtain a more accurate reading.



Pictures of a B Strike using the camera mounted to the sight glass.



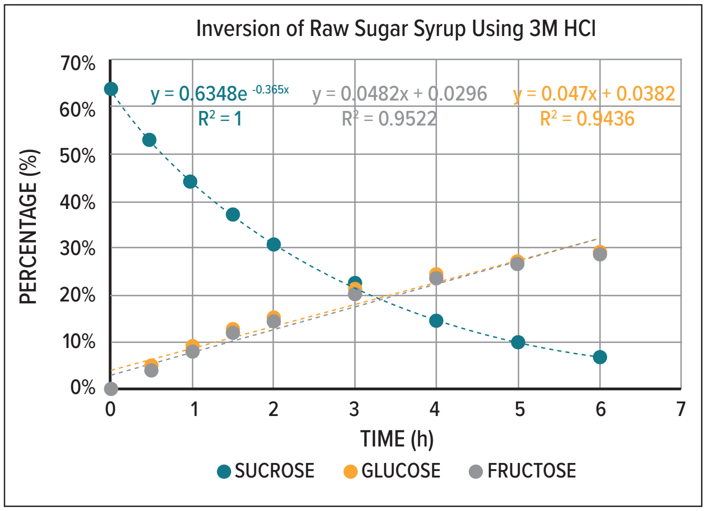
Pictures of a C Strike using the camera mounted to a sight glass.

- One important aspect of determining crystal quality is to ensure there is good circulation of the crystals. Crystals adhere to the sight glass very easily and then must be washed to be removed. This does not allow an accurate measurement to be taken. Another challenge in obtaining accurate measurements is the dark nature of the massecuite. This makes penetrating the surface crystals difficult and, therefore, provides fewer crystals to measure. The larger the quantity of crystals that can be measured, the more accurate the reading will be.
- Future work could include inserting a camera into a vacuum pan where it can take measurements from the massecuite being circulated in the pan. This may give more accurate results regarding crystal size.

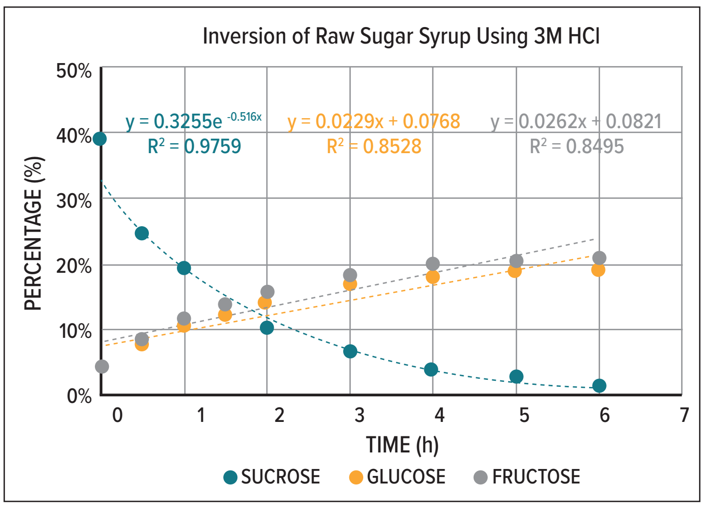
Trials on Adding Extra Invert Sugar to Obtain Lower Final Molasses Purities

By JoseManuel Henriquez

- During the 2018 processing season, the Louisiana sugar industry experienced unusual weather patterns of rain and freezing. After the November freeze there was a very surprising phenomenon of very low molasses purity together with high levels of invert or reducing sugars. All the factories found that their final molasses purity dropped to below 30% and stayed there until the end of the season.
- The objective of this study was to try to recreate the same conditions experienced during the 2018 season, testing various levels of reducing sugars and evaluating their effect on the final molasses purity.
- To increase the content of reducing sugars in B molasses, three sources of reducing sugars were used: inverted raw sugar syrup with 3M hydrochloric acid (HCl), inverted B molasses with HCl (37%) and commercial sources of glucose and/or fructose.



Inversion rate of 65 Brix syrup from raw sugar treated with 3M HCl at 60 degrees Celsius.



Inversion rate of B molasses treated with commercially available HCl (37%) at 60 degrees Celsius.

- An economic benefit estimation was undertaken, and findings indicated it would be more profitable if commercial invert sugars were added in the factory to increase sugar recovery (i.e., commercial inverts sugars would cost 26 cents/TC compared to 56 cents/TC for the cost of B molasses) inversion. The net profit of the addition of commercial invert sugars would be 43 cents/TC and 26 cents/TC for the addition of inverted B molasses.
- After the initially promising economic results with the addition of commercial invert sugars, this scenario was extrapolated to fit a factory's daily operations. It was calculated that the cost of implementing the addition of invert sugars to lower final molasses purities would cost $22,692/day (based on 37,820 pounds reducing sugars at 60 cents per pound). On the other hand, the benefits of implementation were calculated as $3,476 per day extra to the factory (based on increased sugar, increased final molasses production and their respective values). Thus, the cost of implementing at the industrial scale vastly outweighed any gains on additional sugar recovery, and the project was stopped.

Validation of Industrial Method to Measure Soluble and Insoluble Starch at the Sugarcane Factory or Refinery

By Gillian Eggleston

- In recent years it has been discovered that soluble and insoluble starch both persist into raw and refined sugars and sometimes in large quantities, with both detrimentally affecting processing. Thus, it became imperative that a method was developed to measure both soluble and insoluble starch in cane products.
- Cole et al. (2019) developed an inexpensive industrial method that uses concentrated sodium hydroxide (NaOH) and hydrochloric acid (HCl). The method is simple, rapid and uses chemicals and equipment familiar to the international sugar industry.

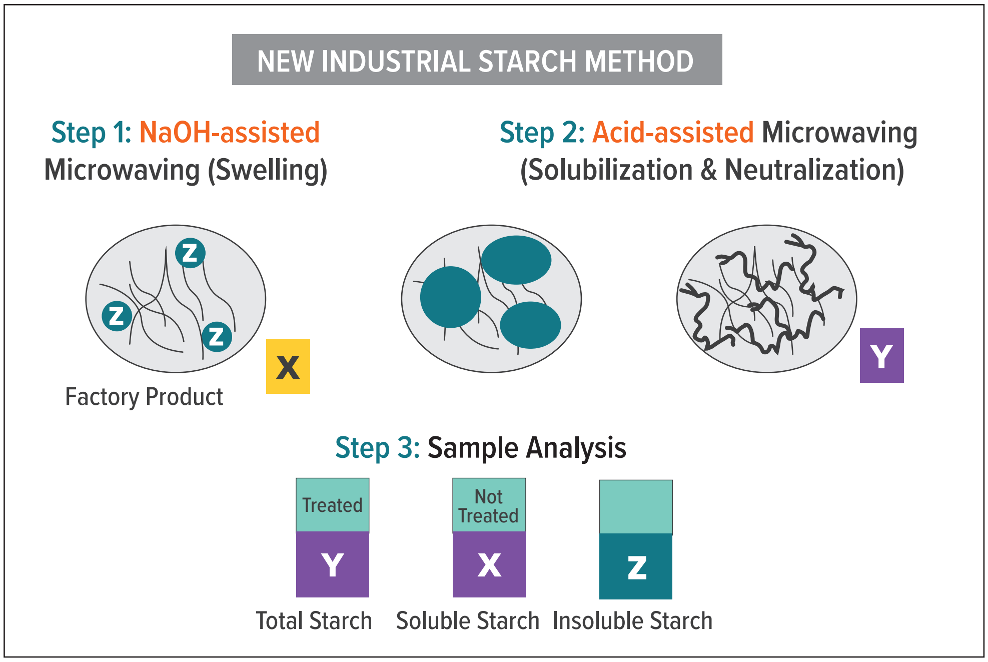


Illustration depicting the major steps used solubilize insoluble sugar cane starch in factory and refinery products using the new industrial starch method to measure total, soluble and insoluble starch in raw sugar.

- Following the ICUMSA (International Commission for Uniform Methods in Sugar Analysis) harmonized guidelines for single laboratory validation of methods of analysis, six levels of calibration standards were run, evenly spaced over the concentration range 16 to 500 mg/L. Each calibration standard was run in triplicate, and the calibration standards were run in a random order. The fit was strongly linear over the concentration range (R2=0.9999) and the curve did not pass through the origin. A linear regression analysis of the curve allowed a limit of detection of 18.4 mg/L to be calculated; the final valid concentration range was: **18.4 to 500.0 mg/L**. The most important feature about this method is that it will detect high starch concentrations in raw sugars greater than the existing 250 ppm starch limits set for the ICUMSA GS1-17 starch method.
- Factory raw sugars were first screened to identify and select three separate raw sugars that contained low, medium or high concentrations of starch. Each raw sugar was then run, in duplicate, with the new industrial starch method in successive runs (eight), therefore, N=16. It was clearly shown that the CV % values were very acceptable for total, soluble and insoluble starch in the high and medium starch raw sugars but not for the raw sugar containing very low starch. This was not surprising since the total starch in the very low starch sugar was only 2.9 mg/L, which is lower than the 18.4 mg/L limit of detection for the method. The CV values for the total and soluble starch values in both the high and medium starch raw sugars were similar, whereas the insoluble starch values were slightly higher. The latter is most likely attributable to the insoluble starch value being measured by difference.

- For total starch in the high and medium starch raw sugars, the mean CV was 3.5%. For soluble starch in the high and medium starch raw sugars, the mean CV was 3.2%. For insoluble starch in the high and medium starch raw sugars, the mean CV was 9.4%.
- These results will be presented to ICUMSA.

Precision data for raw sugars containing very low, medium and high concentrations of starch following the industrial starch method.

Sample	N	Mean (mg/L)	Standard Deviation (mg/L)	CV %
	Total Starch			
Raw Sugar 1 (High Starch)	16	93.81	2.77	3.0
Raw Sugar 2 (Medium Starch)	16	41.24	1.60	3.9
Raw Sugar 3 (Very Low Starch)	16	2.91	0.51	17.4
	Soluble Starch			
Raw Sugar 1 (High Starch)	16	82.10	2.37	2.9
Raw Sugar 2 (Medium Starch)	16	35.09	1.19	3.4
Raw Sugar 3 (Very Low Starch)	16	2.55	0.30	12.5
	Insoluble Starch			
Raw Sugar 1 (High Starch)	16	11.71	1.24	10.6
Raw Sugar 2 (Medium Starch)	16	6.15	0.51	8.2
Raw Sugar 3 (Very Low Starch)	16	0.36	0.42	116.8

- For total starch in the high and medium starch raw sugars, the mean CV was 3.5%. For soluble starch in the high and medium starch raw sugars, the mean CV was 3.2%. For insoluble starch in the high and medium starch raw sugars, the mean CV was 9.4%.
- These results will be presented to ICUMSA.

Validation of Guangzhou Monoclonal Antibody Method to Measure Dextran in Factory Cane Products

By Gillian Eggleston

- High amounts of dextran in sugarcane products cause processing problems in sugarcane factories and refineries, including false elevated pol values, viscosity issues, slow crystallization rates and elongated crystals.
- A rapid and sensitive dextran method for the sugarcane industry, based on a specific monoclonal antibody-dextran interaction, was developed at the Guangdong Sugarcane Industry Research Institute, China (Liang et al., 2011; Wang et al., 2016). It is currently being used in seven countries and in more than 64 sugarcane and sugar beet factories. A monoclonal antibody method called SucroTest was previously developed in cooperation with the Audubon Sugar Institute and sold by Midland Laboratories, then EcoLabs in the U.S. The EcoLabs test was expensive at around $15 per analysis and is no longer available. A comparison of the EcoLabs method and the Guangzhou method has shown that both methods were similar on precision, accuracy, cross-reactivity and detection range, but the Guangzhou method was more accurate for low concentrations of dextran, low molecular weight dextran and is considerably less costly at approximately $6 to $8.50 per test.

Comparison of industrial methods to measure dextran in cane products.

	Dextran Method		
	EcoLab Antibody Method	Guangzhou Antibody Method	Haze Method
Availability	X	✓	✓
Cost per Analysis	$15	$6-8.50	<$1
Specific for Dextran	✓	✓	X
Detect Dextran <20,000 Da (Low Mol Wt)	X	✓	X
Sensitive to Dextran >2 million Da (High Mol Wt)	High	High	Low
Rapid	✓	✓	X

- After the ICUMSA harmonized guidelines for single laboratory validation of methods of analysis, six levels of calibration standards were run, evenly spaced over the concentration range. Each calibration standard was run in triplicate and the calibration standards were run in a random order. The fit was strongly linear (R2=0.9964) and the curve did not pass through the origin. A linear regression analysis of the curve allowed a limit of detection of 90.5 mg/kg (ppm/Brix) to be calculated; the final valid concentration range was 90.5 to 1333.0 mg/kg.
- Factory crusher (first extraction) juices, final evaporator syrup, final molasses and raw sugars were first screened to identify samples that contained low and high concentrations of dextran. Each sample was then run, in duplicate, with the method in successive runs (eight); therefore, N=16. It was clearly shown that the RSD % values (equivalent to CV values) were very acceptable for both low and high dextran concentrations in all four cane product types.

Precision data for crusher juices, final evaporator syrups, final molasses and raw sugars containing low and high concentrations of dextran following the Guangzhou monoclonal antibody.

Sample	N	Mean Dextran (mg/kg)	Standard Deviation (mg/kg)	Rel. Std. Dev. (RSD) of Repeatability (%)
	Low Dextran Concentrations			
Crusher Juice	16	279.0	20.8	7.5
Final Evaporator Syrup	16	299.9	16.6	5.5
Final Molasses	16	390.0	26.4	6.8
Raw Sugar	16	251.4	14.9	5.9
	High Dextran Concentrations			
Crusher Juice	16	1208.3	49.5	4.1
Final Evaporator Syrup	14*	999.2	62.1	6.2
Final Molasses	16	1275.1	42.0	3.3
Raw Sugar	16	1270.3	66.3	5.2

*An outlier was found in the high dextran-evaporator syrup results and those points were removed.

- The results were presented to the 32nd Session of ICUMSA on June 15, 2021, and the following three recommendations were accepted:
  1. Accept as an ICUMSA GS7 (2021) Method "Dextran in Cane Juices and Syrups by Antibody Method – Tentative" following acceptable single laboratory validation results.
  2. Accept an ICUMSA GS7 (2021) Method "Dextran in Cane Molasses and Raw Sugars by Antibody Method – Tentative" and conduct an international inter-laboratory analysis trial.
  3. Undertake validation studies with this method for sugar beet products.

Validation of Mannitol Kits for Use at the Sugarcane Factory

By Gillian Eggleston

- The ability of factory personnel to rapidly screen individual consignments of sugarcane for deterioration as well as sugarcane products across the factory would be beneficial for improving overall manufacturing efficiency. Mannitol has been established as a sensitive indicator of sugarcane deterioration around the world.
- A reliable and rapid enzymatic method to measure mannitol levels in sugarcane juices was developed by Eggleston and William Harper in 2006 and modified by Eggleston in 2009. The method utilizes mannitol dehydrogenase (MDH) to convert mannitol to fructose in the presence of the co-enzyme nictonamide-adenine-dinucleotide (NAD). The NADH formed is directly related to the amount of mannitol in the cane product and is easily measured at 340 nm using a factory spectrophotometer. In 2010, this method became an international method (ICUMSA GS8-12 method) and is the basis of a Biosentec kit that is now being ubiquitously used in the European sugar industry (approx. $4.65 per analysis). The intent of the original method, however, was for users to purchase their own chemicals to keep the cost down to approximately U.S. 65 cents per analysis. Unfortunately, the source of MDH enzyme was from abroad and not readily available in Louisiana. Now, another new kit, based on the enzyme method, is available from Megazyme and is used in the Colombian sugarcane industry. This kit cost is approximately $4 per analysis but has the advantage of being easily purchased and delivered to Louisiana within two to three days.

The Megazyme enzymatic mannitol kit contents.

- This Megazyme kit was evaluated at ASI in 2018 and used at Louisiana factories during the 2018 grinding season.
- Some adjustments to the Megazyme method were necessary since cane sample particles interfere with the enzymatic assay. Fortunately, it was found that centrifuged juice from the factory core laboratory could be used. The whole kit instructions were written up as a method for the factories.
- The linearity of the method was excellent (R2=0.9999 over a concentration range of 0 to 1200 ppm), and the precision was very acceptable at less than 3.5% even at the lower concentrations of mannitol. Another real advantage of the method is that no standard curve or check standards are necessary. Results the table below show that the calculated mannitol concentrations using the mannitol kit equation were as accurate as those obtained using a standard curve and only slightly higher than those obtained from the standard curve. Overall, it was found to be a very easy method and accurate to within ± 3.9%.

A comparison of the accuracy of the results calculated from the kit method equation or from a standard curve.

	Mannitol Concentration (ppm/Brix)	
Theoretical	**Mannitol Kit Equation**	**Mannitol Kit Standard Curve**
25	27.5	24.7
50	51.7	48.7
100	102.0	98.7
250	247.5	243.4
500	495.1	489.4
750	726.8	719.7
1,000	980.4	971.7

- Overall, the kit was readily available, uses equipment already available at the factory, and the method is simple, accurate and precise.

Exploration of Sugarcane Products as a Major Source of Nutritional Antioxidants

By Gillian Eggleston

- Consumers in the United States and globally are becoming increasingly familiar with health-benefitting antioxidants and are looking for foods and beverages that are good sources of antioxidants.
- Extracted cane juice contains a complex mixture of plant phenolic compounds including flavonoids that are often colored, but some are noncolored. Phenolic compounds also form in sugarcane products from heat-induced processes, including burning field cane.

Classes of phenolic compounds found in sugarcane and their structure.

Class	Structure	Examples in Sugarcane
Hydroxybenzoic acids	C6-C1	coumaric acid, 4-hydroxybenzoic acid, vanillic acid
Hydroxycinnamic acids, phenylpropanoids	C6-C3	caffeic acid, ferulic acid
Flavonoids	C6-C3-C6	tricin, naringen, luteolin, apigenin, quercetin, rutin, kaemferol, anthocyanin
Lignins	(C6-C3)n	
Condensed tannins	(C6-C3-C6)n	

- The total phenolic compounds (TPC) can be measured in cane products across the factory and those sold commercially.
- The TPC range for cane juices was withing the range reported for commercial apple, grapefruit, orange and pineapple juices but not as high as for cranberry, red grape and pomegranate juice (up to 2,882 mg/L) that are rich sources of phenolic antioxidants. However, food-grade cane molasses contained very high amounts of TPC which were comparable to pomegranate juices.

Total phenolic contents (TPC) and antioxidant capacities of cane food products and products formed in the factory (USA).

Commercial Cane Product	Brand	Total Phenolic Content TPC (mg/L)	Antioxidant % RSA	Antioxidant ORAC µmol TE/g
Cane Juice Mixer Original	A	567 ± 11	10.2	nd[a]
Cane Juice Lime and Mint	A	728 ± 138	8.8	nd
Cane Juice Strawberry	A	633 ± 16	21.2	nd
Cane Juice	B	418 ± 10	12.2	nd
Cane Syrup (brown)	C	1,454 ± 7	10.5	12.7
White Cane Syrup	D	105 ±5	0	0.3
Cane Syrup (brown)	E	946 ± 36	10.0	8.7
Organic Molasses (unsulphured)	F	3,024 ± 72	18.3	nd
Blackstrap Molasses (unsulphured)	G	2,988 ± 60	11.4	nd
Blackstrap Molasses (unsulphured)	H	2,977 ± 49	17.7	nd
Full Flavor Molasses (unsulphured)	H	2,941 ± 109	13.2	nd
Cane Vinegar	C	280 ± 32	8.4 ± 0.5	11.2 ± 1.7

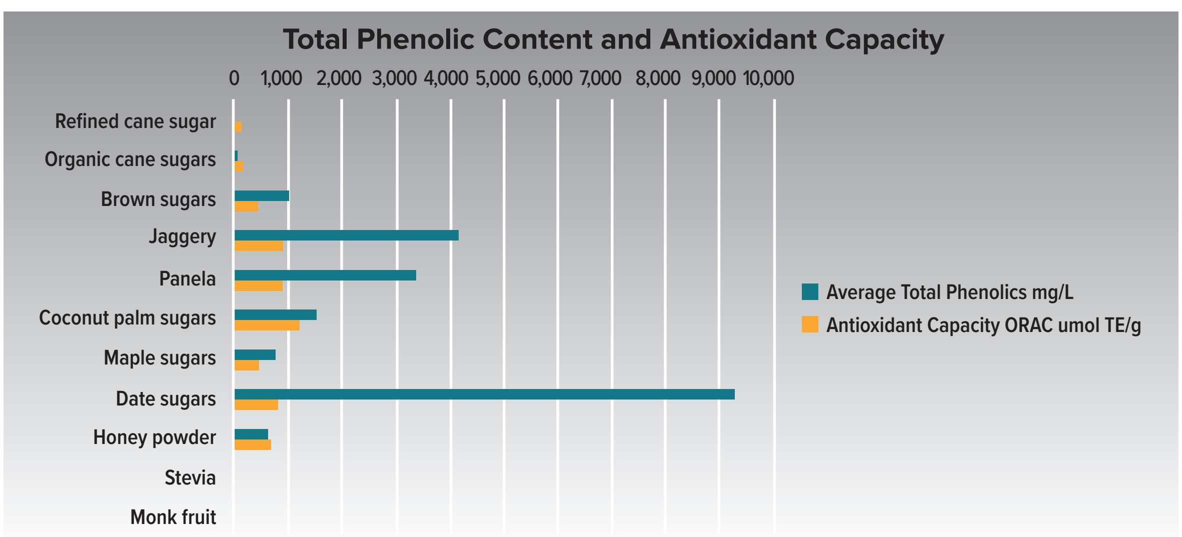
[a]nd = not determined.

Natural, Nutritious Solid Sweeteners from Sugarcane That Meet New Consumer Demands

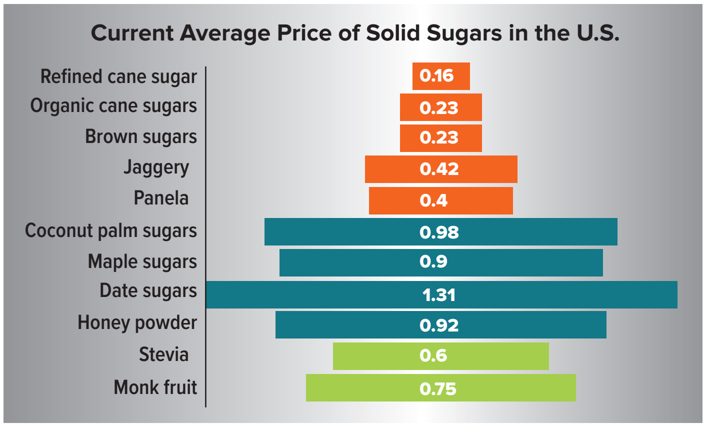
By Gillian Eggleston

- Sucrose has been greatly scrutinized in the past decade mainly for its calories, even though sales have increased globally, and it still remains sustainable as the gold standard of sweeteners as well as the most widely used sweetener. Ironically, the present and accelerating consumer-driven trend toward healthier, sustainably produced, and more natural foods and ingredients has started to further redeem sucrose and less refined sugars from sugarcane as natural sweeteners.
- Natural sweeteners, as compared to artificial and highly processed sweeteners, are the least processed sweeteners and contain a greater range and higher quantity of nutrients, including antioxidants, minerals and vitamins.
- Centrifuged (e.g., light brown and dark brown sugars) and noncentrifuged (e.g., jaggery and panela) brown sugars from sugarcane are having huge growth as natural sweeteners because they are markedly less expensive and equally — if not more nutritious — than other natural sweeteners, including solid sugars from coconut palm, honey, maple, date, stevia and monk fruit.

Various solid sweeteners produced from sugarcane as well as other natural solid sweeteners found in grocery shops in the United States. The natural sweeteners include, top row: cane sugars; middle row: date sugar, honey powder and panela; bottom row: pure maple and organic brown coconut sugars.



Comparison of average total phenolic contents (mg/L) and ORAC antioxidant capacity (µmol TE/g) of solid sweeteners currently in the U.S. marketplace, including brown centrifuged and noncentrifuged sugars.



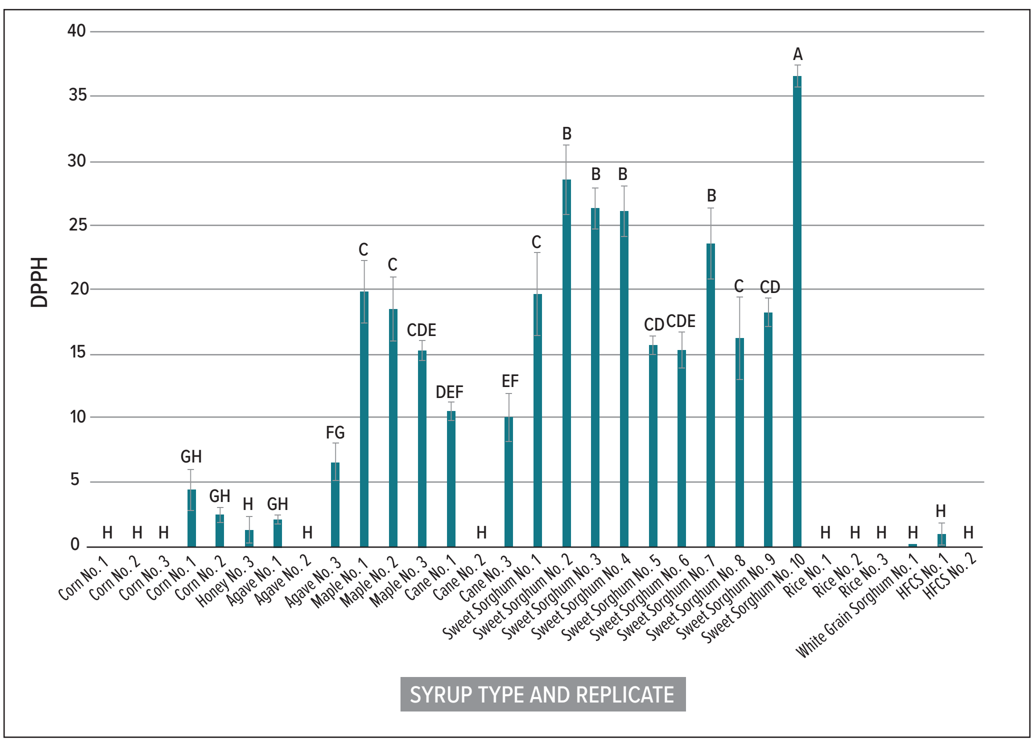
Comparison of average prices in U.S. dollars of solid sweeteners currently in the American marketplace, including brown centrifuged and noncentrifuged sugars.

- In response to the new consumer demands, the sugarcane industry is increasingly implementing sustainable practices to supply natural cane sugars. Comprehensive educational marketing campaigns in individual countries and worldwide are now needed to inform consumers about the natural, nutritional and other positive aspects of cane sugars.

Phenolic Contents, Antioxidant Potential and Color in Sugar Syrups

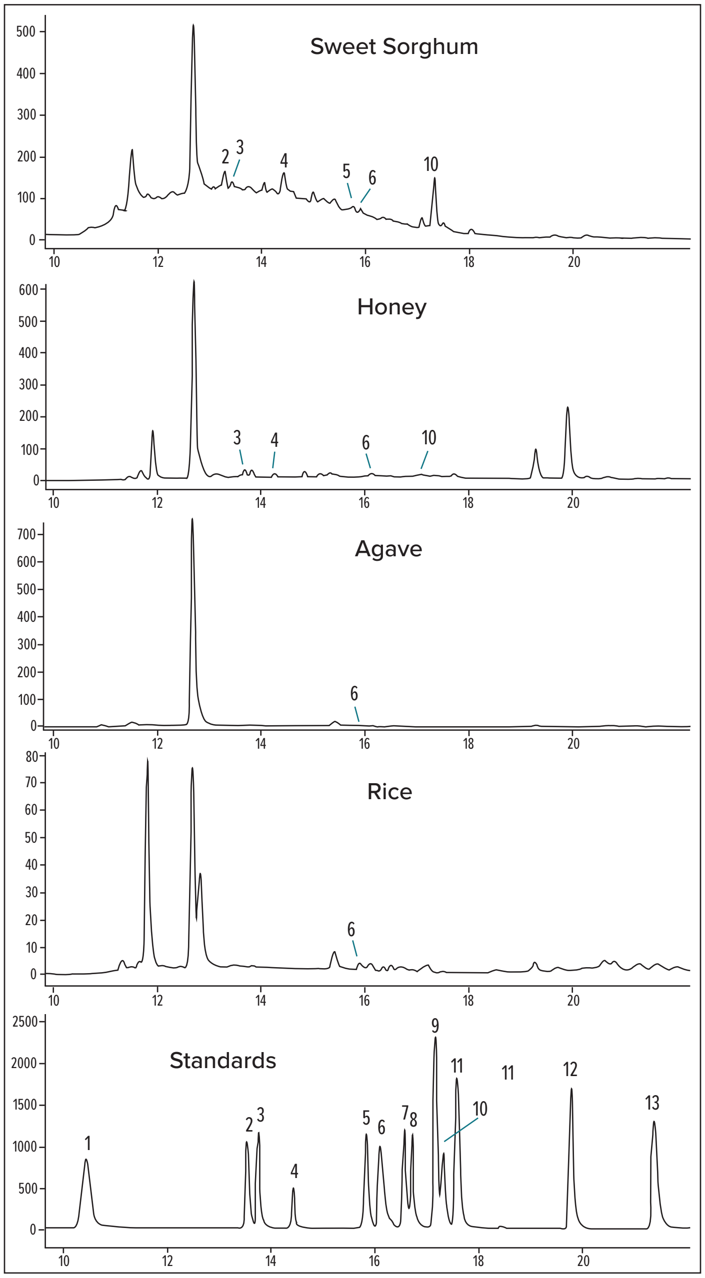
By Gillian Eggleston

- Changes in consumer tastes and preferences for healthy, clean label, natural and minimally processed sweeteners have set the stage for the introduction of sweet sorghum and cane syrups as natural sweeteners produced in volume. Knowledge of the bioactive content of these syrups compared to other common food-grade syrups will expand their utilization.
- The phenolic, antioxidant activity and related color data for commercial high fructose corn syrup (HFCS), corn, honey, maple, agave, rice, sugarcane, grain and sweet sorghum syrups (31 in total) were compared.
- Sweet sorghum syrups contained significantly ($P<0.05$) higher total phenolics, antioxidant capacities (measured by two methods: DPPH radical scavenging activities and ORAC) and color values. Brown sugarcane syrups manufactured from brown sugars or juices contained moderately high antioxidant capacities and total phenolic contents, whereas cane syrups manufactured from refined cane sugar had negligible contents.



Antioxidant capacities (mean DPPH radical scavenging activities) of commercial syrups. Means followed by a different uppercase letter are significantly different at the 5% probability level.

- A new high performance liquid chromatography (HPLC) method was developed at ASI, using a C18 column and diode array detection at 280 nm, to detect and quantify phenolic compounds in the syrups. Sugarcane syrups contained ellagic acid, apigenin and catechin.



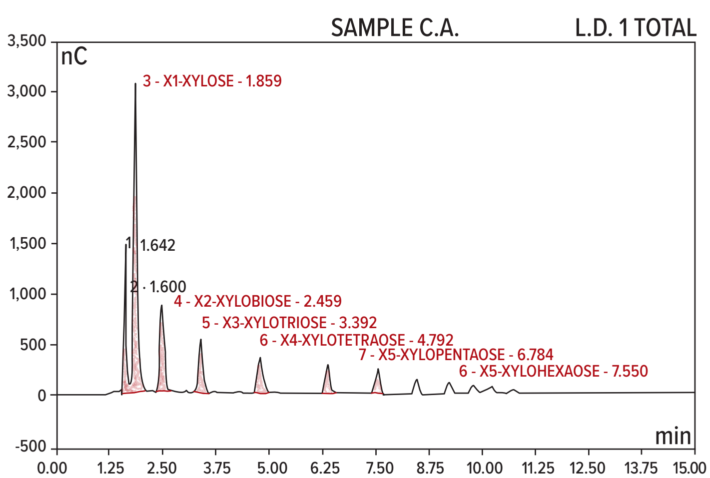
HPLC chromatograms (λ=280 nm) of commercial syrups and a mixture of standard phenolic compounds. Peaks: 1) gallic acid, 2) protocatechuic acid, 3) chlorogenic acid, 4) catechin, 5) vanillic acid, 6) ellagic acid, 7) naringin, 8) hesperidin, 9) p-coumaric acid, 10) sinapic acid, 11) ferulic acid, 12) caffeic acid, 13) apigenin.

- Overall, HFCS, corn, and white grain sorghum and rice syrups demonstrated low bioactivity. The total phenolic contents, antioxidant capacities and color values of the sweet sorghum syrups were related to each other and relatively high compared to other syrups.

Prebiotics from Cane Bagasse

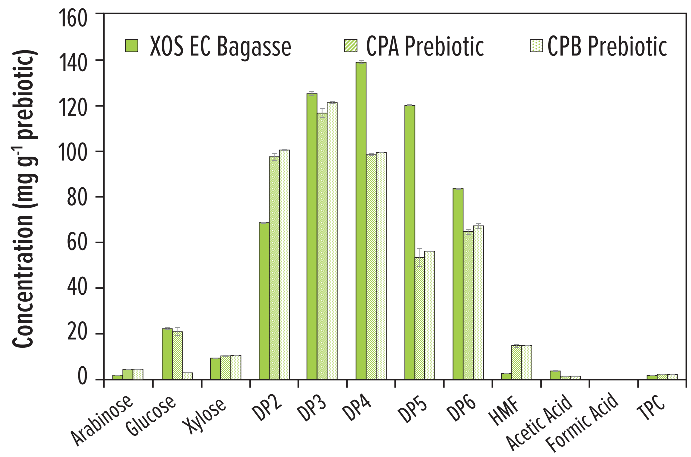
By Giovanna M. Aita

- Prebiotics are a group of nondigestible oligosaccharides or functional food ingredients that beneficially affect the human or animal host's health by selectively stimulating the growth of advantageous gastrointestinal bacteria (Bifidobacterium spp., Lactobacillus spp.) for maintenance of gut health and functionality.
- Prebiotics can be grouped into established commercial prebiotics (inulin, fructooligosaccharides, galactooligosaccharides, lactulose, polydextrose) or emerging prebiotics (isomaltooligosaccharides (IMO), xylooligosaccharides (XOS), lactitol).
- XOSs are nontoxic, stable at acidic pH, heat resistant and can achieve positive biological effects at low daily doses and low caloric content, properties that are the same or more desirable than the already established prebiotics. XOSs are present in plants in very low amounts, so there is a great need and opportunity to isolate XOSs with varying degrees of polymerization from the hemicellulose (xylan) fraction of lignocellulosic biomass, e.g., bagasse, a source that offers both economic and environmental advantages.
- A process was developed that involved the use of diluted sulfuric acid for the selective extraction of XOSs from energy cane (EC) bagasse followed by the combined use of activated carbon (AC) and ethanol to achieve a high purity and quality of XOS. The prebiotic activity of XOS EC bagasse was evaluated by carrying in vitro studies on Bifidobacterium adolescentis ATCC 15703.
- The conversion of energy cane bagasse into XOS was best achieved with 0.1% (v/v) sulfuric acid, at 150 degrees Celsius for 60 minutes. Under these conditions, the xylan was hydrolyzed to a variety of xylose oligomers ranging from DP2 to DP6. DP2, DP3 and DP4, which are considered the most interesting XOSs for food industry applications. A new ion chromatography method was developed to detect and quantify the oligomers.



Ion chromatograph of xylooligosaccharides obtained from treated bagasse.

- Hydrolysates were concentrated into a syrup (24 Brix) under vacuum. The recovery of XOS and removal of nonsugar compounds from the syrup were successfully accomplished by a simple and robust method that combined the use of AC adsorption, water washing and ethanol gradient desorption.
- The XOS (XOS EC bagasse crude sample) extracted and recovered from the syrup had a purity of 93%, which was comparable to the purities observed with two commercially available XOS prebiotics (extracted from corncobs), CPA (89%) and CPB (93%).



Chemical composition of XOS EC bagasse crude sample and two commercially available XOS prebiotics extracted from corncobs (CPA, CPB). TPC: Total phenolic compounds, HMF: Hydroxymethylfurfural.

- XOS EC bagasse crude sample exhibited prebiotic properties by stimulating the growth of B. adolescentis ATCC 15703 and by producing lactic acid. The observed prebiotic activities were comparable to the commercial prebiotics CPA, CPB (xylose oligomers) and IMO (glucose oligomers).

Prebiotic effect of xylooligosaccharides (XOS) derived from energy cane bagasse (XOS EC bagasse) and commercially available prebiotics (IMO, CPA, CPB) on the growth and fermentation of Bifidobacterium adolescentis ATCC 15703.

Fermentation*	Glucose	Xylose	IMO	XOS EC Bagasse	CPA	CPB
Absorbance at 600 nm	1.52 ± 0.02	1.08 ± 0.04	1.28 ± 0.05	1.00 ± 0.01	1.05 ± 0.02	1.08 ± 0.02
Sugars consumed (%)	70 ± 0.91	39 ± 1.83	85 ± 0.75	86 ± 0.69	80 ± 0.98	86 ± 0.83
Lactic Acid (mg mL-1)	4.66 ± 0.23	2.68 ± 0.13	3.43 ± 0.17	3.49 ± 0.17	3.56 ± 0.18	3.31 ± 0.17

*= Fermentation values at 48 h.

Lignocellulosic Syrup

By Giovanna M. Aita

- Lignocellulose biomass, e.g., bagasse, is a promising renewable resource that can be used in the production of syrups, a feedstock with great potential as a source of fermentable sugars in the processing of fuels, bio-hydrogen, microbial lipids and other chemicals.
- A challenge in syrup production from lignocellulose biomass is the presence of nonsugar compounds (e.g., organic acids, phenolic compounds, furaldehydes) in the hydrolysate generated during the hydrolytic process, which negatively impact downstream processes such as enzymatic hydrolysis and fermentation.
- Activated carbon (AC) is one of the most widely applied methods for removing these nonsugar compounds from hydrolysates due to its low cost, high capacity of adsorption and ease of use. Activated carbon type, dose, hydrolysate pH and contact time are also major factors that affect its adsorption efficiencies. The effectiveness of detoxification also depends on the type of lignocellulose hydrolysate, conditions of pretreatment and enzymatic hydrolysis.
- Nonsugar compounds generated during the pretreatment of energy cane bagasse with ammonium hydroxide were successfully removed from hydrolysates by AC treatments. At optimum conditions, powdered AC and granular AC removed 40% acetic acid, 75% formic acid, 100% levulinic acid, 90% HMF, 100% furfural and 98% total phenolic compounds with less than 10% total sugar losses.

Effect of powdered and granular activated carbon (AC) treatments at optimized conditions.

		Powdered AC	Granular AC
Optimized Conditions	**AC Dose**	9.21%	12.64%
	pH **Contact Time**	1.96 10 min	1.91 51.60 min
Formic Acid Removal (%)		77.68 ± 0.51	75.59 ± 0.92
Acetic Acid Removal (%)		40.33 ± 0.59	37.98 ± 0.88
Levulinic Acid Removal (%)		100 ± 0	96.54 ± 0.80
HMF Removal (%)		89.32 ± 0.38	90.43 ± 0.85
Furfural Removal (%)		100 ± 0	100 ± 0
Phenolic Compounds Removal (%)		98.87 ± 0.83	97.93 ± 0.78
Total Sugar Loss (%)		9.65 ± 0.32	9.78 ± 0.51

HMF = Hydroxymethylfurfural.

- The particle size of the AC significantly affected AC adsorption efficiency. Powdered AC required a lower dose and a shorter contact time to achieve maximum removal of nonsugar compounds compared to granular AC. Therefore, powdered AC adsorption was selected for the removal of nonsugar compounds from hydrolysates.
- Lignocellulosic syrup was produced by evaporating powdered AC-treated dilute ammonia pretreated energy cane bagasse hydrolysates at 70 degrees Celsius under vacuum to a final 65 Brix. This syrup contained 407.55 g/L glucose, 204.34 g/L xylose, 0.92 g/L acetic acid, 2.75 g/L potassium, 1.17 g/L calcium, 0.49 g/L magnesium and 8.81% ash. The nonsugar compounds present in the syrup were below inhibitory levels to microorganisms during fermentation.

Chemical composition of untreated and powdered activated carbon (AC) treated dilute ammonia pretreated energy cane bagasse enzymatic hydrolysate and lignocellulosic syrup.

	Untreated Enzymatic Hydrolyzate	Powdered AC Treated Hydrolyzate	Lignocellulosic Syrup
Glucose (g/L)	17.41 ± 0.56	16.59 ± 0.51	407.55 ± 8.33
Xylose (g/L)	10.25 ± 0.24	8.96 ± 0.32	204.34 ± 5.82
Formic Acid (g/L)	2.81 ± 0.15	0.64 ± 0.03	ND
Acetic Acid (g/L)	1.74 ± 0.13	1.02 ± 0.07	0.92 ± 0.11
Levulinic Acid (g/L)	0.97 ± 0.09	ND	ND
HMF (g/L)	0.02 ± 0	ND	ND
Furfural (g/L)	0.05 ± 0.01	ND	ND
TPC (g/L)	0.61 ± 0.04	0.01 ± 0	ND
Ash (% w/w)	< 0.5	< 0.5	8.81

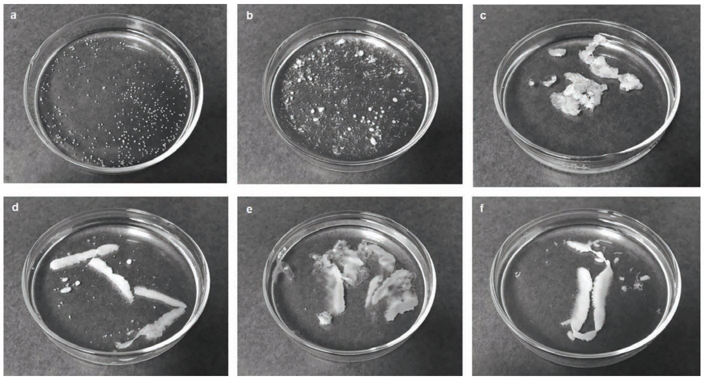
ND = None detected; TPC = Total phenolic compounds.

- Powdered AC adsorption is a promising alternative in the removal of nonsugar compounds from dilute ammonia pretreated energy cane bagasse hydrolysates and for producing acceptable fermentable-quality lignocellulosic syrups.

Fumaric Acid

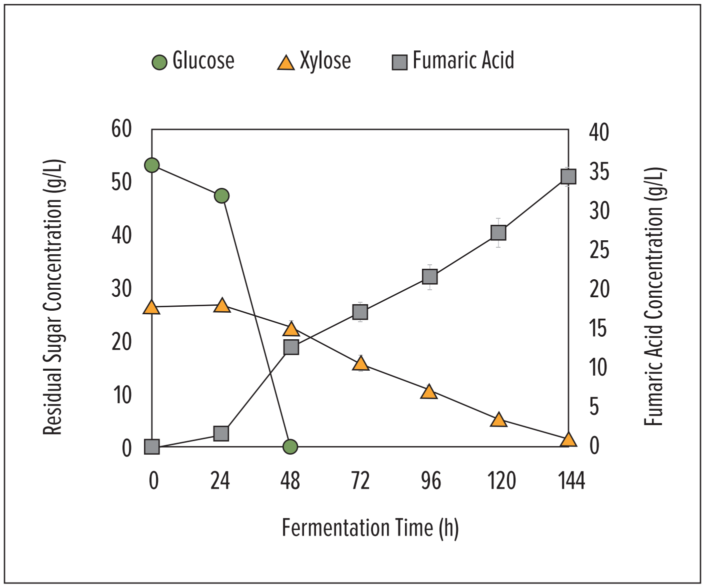
By Giovanna M. Aita

- Fumaric acid is a dicarboxylic acid that has been identified by the U.S. Department of Energy as one of the “top 12” building-block chemicals that can be potentially manufactured using lignocellulosic biomass, e.g., bagasse. Fumaric acid can serve as an acidulant in food and animal feeds and as the raw material in the production of polymer resins, plasticizers, esters and inks. These products have high market values.
- Fumaric acid can be biologically synthesized by fungi through a two-stage fermentation process: seed culture stage and acid production stage. Major challenges exist at each stage and include control of fungal morphology and medium composition during the seed culture stage and carbon to nitrogen (C/N) ratio during the acid production stage for achieving high fumaric acid production.
- Pure glucose is the most favorable carbon source for fumaric acid fermentation by filamentous fungi. However, using pure glucose as carbon source significantly increases production costs and sacrifices potential food supplies. Attempts have been made to achieve ideal fermentation yields using various sugar and nutrient-enriched materials with little success.
- Powdered activated carbon-treated lignocellulosic syrup, a syrup mostly containing glucose and xylose sugars, derived from dilute ammonia pretreated energy cane bagasse, was evaluated as a potential carbon source in the production of fumaric acid by *Rhizopus oryzae* ATCC 20344.
- Optimum seed culture medium conditions for *R. oryzae* ATCC 20344 included the use of 2.0 g/L urea as the nitrogen source and adjusting the medium to pH 3.0, which allowed for the formation of preferred compact (d ≈1 mm), smooth and uniformly dispersed fungal pellets.



Morphologies of Rhizopus oryzae ATCC 20344 cells grown under different seed culture media conditions (nitrogen source and medium pH). (a) urea at pH 3.0, (b) yeast extract at pH 3.0, (c) urea at pH 4.0, (d) yeast extract at 4.0, (e) urea at pH 5.0, and (f) yeast extract at 5.0.

- Optimum acid production medium required 0.2 g/L urea as the nitrogen source with a C/N ratio of 400 for achieving maximum fumaric acid production yields. Under optimum conditions, 53 g/L glucose and 27 g/L xylose present in the lignocellulosic syrup-enriched medium were depleted after 144 h fermentation and resulted in a fumaric acid production of 34.20 g/L, a yield of 0.43 g/g and a productivity of 0.24 g/L/h.



Fumaric acid production and sugars consumption by Rhizopus oryzae ATCC 20344 using lignocellulosic syrup as the only carbon source.

- Overall, lignocellulosic syrup, a renewable feedstock from dilute ammonia pretreated energy cane bagasse, has the potential to substitute pure sugars (glucose and xylose) as the carbon source for fumaric acid production by *R. oryzae* ATCC 20344.

Protein and Lipids from Sugarcane Processing Byproducts

By Giovanna M. Aita

- Soybean, fish and corn are protein ingredients commonly used in various animal feeds and have become a perpetual cause of dispute in the current food versus feed competition. There is an urgent need to replace these conventional feed ingredients with ones that are both sustainable and economically beneficial, such as organic wastes (e.g., agricultural residues) and agricultural byproducts (e.g., blackstrap molasses).
- One of the bioconversion agents is black soldier fly larvae (BSFL). Unlike some species of flies, black soldier flies do not bite or spread diseases, so the harvested protein and fatty acids from BSFL could be applied as a low-cost, high-protein feed for livestock.

- Blackstrap molasses and bagasse, two byproducts of the sugarcane industry, were investigated as diet ingredients for BSFL during a 10-day feeding trial.
- Our findings indicate that sugarcane processing byproducts (blackstrap molasses and bagasse) could serve as added nutritional ingredients in the formulation of BSFL diets to deliver a nutritious (e.g., protein, lipids) insect value meal with potential for being incorporated in animal feeds. Biomass weight, protein and fat contents of BSFL were dependent on the rearing substrate and the diet's protein to carbohydrate ratio.

Proximate composition of BSFL reared on cricket feed (a protein-based reference substrate), blackstrap molasses and various diet combinations at the end of 10-day trials, containing cricket feed and sugarcane processing byproducts (blackstrap molasses, bagasse) as potential animal feed additives.

Parameters	Cricket Feed	Cricket Feed Molasses Bagasse (6:2.6:1)**	Cricket Feed Molasses Bagasse (2:3.3:1)**	Cricket Feed Molasses Bagasse (1:7:2)**	Blackstrap Molasses
Initial Feed pH	5.62	5.59	5.64	5.69	5.84
Feed pH after 10 days	4.60	4.24	4.08	4.18	4.38
Initial Feed Moisture (%)	69.51 ± 0.07	68.90 ± 0.12	67.73 ± 0.04	65.74 ± 0.23	69.68 ± 0.14
Feed Moisture after 10 days	74.06 ± 0.96	71.55 ± 0.66	71.18 ± 0.68	69.26 ± 2.18	72.82 ± 0.07
Larval Survival (%)	93	97	94	96	99
Crude Protein (g Kg-1, dry weight)*	418a	391ab	346bc	310c	305c
Chitin (g Kg-1, dry weight)*	33a	33a	31a	33a	24b
Chitin Corrected Protein (g Kg-1, dry weight)*	405a	379ab	334bc	298c	296c
Crude Fat (g Kg-1, dry weight)*	385c	394c	493ab	456b	546a
Ash (g Kg-1, dry weight)*	46c	51c	75b	48c	84a

* Values within a row followed by different letters are significantly different ($p < 0.05$).
** Mixed diet substrate ratio, cricket feed: blackstrap molasses: bagasse.

- The protein values decreased with increasing carbohydrate content in the larval diets. Seventeen amino acids were identified including methionine, the most limiting amino acid for fish and poultry diets.

Amino acid profiles of BSFL reared on cricket feed (a protein-based reference substrate), blackstrap molasses and various diet combinations containing cricket feed and sugarcane processing by-products (blackstrap molasses, bagasse) as potential animal feed additives.

Amino Acids (g Kg-1 dry weight)	Cricket Feed	Cricket Feed Molasses Bagasse (6:2.6:1)*	Cricket Feed Molasses Bagasse (2:3.3:1)*	Cricket Feed Molasses Bagasse (1:7:2)*	Blackstrap Molasses
Essential: Valine	18.4	22.9	18.1	17.1	16.0
Essential: Methionine	4.1	5.1	3.3	2.2	2.0
Essential: Cysteine	0.5	0.6	0.6	0.6	0.6
Essential: Isoleucine	12.2	16.1	13.3	12.6	11.7
Essential: Leucine	20.6	26.6	21.8	20.2	18.7
Essential: Phenylalanine	13.1	15.8	12.2	10.4	8.7
Essential: Lysine	15.2	18.7	15.0	13.5	13.0
Essential: Histidine	7.0	8.5	6.2	5.0	5.0
Essential: Threonine	10.6	15.9	12.9	12.3	11.5
Essential: Arginine	11.9	15.0	12.1	10.2	10.1
Non-Essential: Aspartic acid	9.6	9.0	10.6	10.4	17.4
Non-Essential: Glutamic acid	18.9	19.8	22.4	24.7	32.5
Non-Essential: Tyrosine	18.2	21.8	14.4	11.5	7.1
Non-Essential: Serine	14.6	18.7	16.1	16.3	16.9
Non-Essential: Glycine	14.1	18.3	15.2	14.9	14.3
Non-Essential: Alanine	17.6	27.6	24.3	25.1	25.4
Non-Essential: Proline	18.6	14.7	14.0	13.1	10.0

* Mixed diet substrate ratio, cricket feed: blackstrap molasses: bagasse.

Fatty acid profiles of BSFL reared on cricket feed (a protein-based reference substrate), blackstrap molasses and various diet combinations containing cricket feed and sugarcane processing byproducts (blackstrap molasses, bagasse) as potential animal feed additives.

Fatty Acids (g Kg-1 dry weight)	Cricket Feed	Cricket Feed Molasses Bagasse (6:2.6:1)*	Cricket Feed Molasses Bagasse (2:3.3:1)*	Cricket Feed Molasses Bagasse (1:7:2)*	Blackstrap Molasses
C12:0	529.1	528.6	474	378	443.7
C14:0	69.8	73.3	68.4	57.6	75.6
C18:0	36.7	31.3	27.8	30.8	32.1
C18:2 trans	17.8	16.9	10.5	10.8	13.4
C18:2 (n-6) cis	96.7	93	66.7	74.9	79.5
C18:3	25.9	39.7	23.1	20.7	20.7

* Mixed diet substrate ratio, cricket feed: blackstrap molasses: bagasse.

- The observed crude fat values of BSFL increased with added amounts of carbohydrates in relation to the protein content in both control feeds and mixed diets. Saturated fatty acids were the most predominant group. Lauric acid was the most present, which has antimicrobial activity and the potential of being used as a replacement of antibiotics in animal feeding.
- Unsaturated fatty acids (UFA) were also detected in BSFL. Linolenic acid and linoleic acid were the most present. These essential UFAs act as building blocks for the synthesis of long chain polyunsaturated fatty acids, which play an important role in maintaining cell membrane and brain functions and may also prevent cardiovascular diseases.
- The high crude fat content seen in BSFL reared on only blackstrap molasses could find additional use as a lipid substitute in poultry and fish diets and as a source for bio-oil, biodiesel and lubricant.
- The findings from this study could be the basis for future studies dealing with the combined effect of sugarcane byproducts (e.g., molasses, bagasse, vinasse and organic wastes such as vegetable waste, fruit waste) as mixed diets on the nutritional composition of BSFL meal and the incorporation of BSFL meal in pet food, livestock and aquaculture feed formulations.

Ramping Up Training at Audubon from 2018-2021

An important goal from the ASI strategic plan (2018 to 2023) is to expand training, which will include short courses for current factory technologists as well as the next generation of sugar technologists. As part of this new training initiative, the training facilities at Audubon have been updated and modernized.

New training facilities in the large conference room at the Audubon Sugar Institute.

This includes:

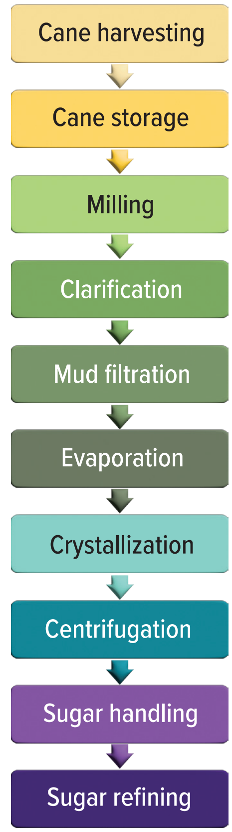
- Virtual transmission, of course.
- Smartboard technology.
- Training availability in English and Spanish (on request).
- Course content enhancement by visits to the Audubon pilot plant.
- Optional factory visits available on request.

New Short Courses

Introduction to the Technology of Raw Sugar Production (1½ days)

By Stephania Imbachi-Ordonez and Lenn Goudeau

- This course was designed for people with no or limited sugar manufacturing experience who want to learn how raw and refined sugar is produced and gain an understanding of the principles involved.
- The training course includes information on all the steps in sugar production process: cane harvesting, cane storage, milling, juice clarification, mud filtration, evaporation, crystallization, centrifugation, sugar handling and sugar refining. It also includes information about cane payment systems, mass balances across sugar factories, and sucrose losses, environmental issues related to sugar production and utilities (water, steam and energy).



Content of the new "Introduction to the Technology of Raw Sugar Production" course at the Audubon Sugar Institute.

- The first course was given in 2020 and is already becoming popular with factory personnel, sugar researchers and even people outside of the sugar industry.

2021 Course participants from LaSuCa sugarcane factory in Louisiana as well as Stephania Imbachi-Ordonez (far left).

TRAINING

All Aspects of Sucrose Losses in Raw Sugar Manufacture (1 day)

By Gillian Eggleston

- This course was designed for technical staff working in raw sugar factories.
- The training course includes information on why sucrose losses represent large technical and economic problems at the factory, the different types of sucrose losses, including determined and undetermined losses, and apparent, microbiological, chemical and physical losses. The course also includes information on where losses occur at the sugarcane factory (outside and inside), accurate measurement of losses, including the economic costs of losses, and methods to reduce and control the different types of losses at the factory.

Gillian Eggleston gives the Sucrose Losses (Perdidas de Sacarosa en Fabrica) Short Course virtually to 145 people in Guatemala and other Central and South American countries on July 15, 2021. The course was translated into Spanish.

Training for Fabrication Superintendents: Roundtable Conversation (1 day)

By JoseManuel Henriquez

- Training designed for fabrication superintendents working in raw sugar factories.
- Includes a nonformal exchange of ideas and shared experiences, as well as training by experts. Highlighted topics of interest depend on current issues. Can include:
    - Adequate timing for the startup of the grinding season: early versus late startup dates.
    - Preparation of seed for granulation: amount, equipment used and time grinding.
    - Massecuite boiling systems.
    - Chemical cleaning of evaporators.
    - Combating dextran and starch: sanitation and chemicals.
    - Demisters and separators installed in evaporator and pans.
    - Steam and exhaust supplies for fabrication.
    - Chemical products used in the factory.
    - Plans in effect to exhaust final molasses.
    - Documenting results during the season to gain the most amount of practical information.

JoseManuel Henriquez oversees a roundtable training of fabrication superintendents and observers on March 10, 2021.

JoseManuel Henriquez oversees a roundtable training of fabrication superintendents and observers on March 10, 2021.

Sweeteners: Choices, Production and Functionalities in Products (2 days)

By Gillian Eggleston

- The course includes current sweetener legislation, a brief history of sweeteners, commercial sucrose and molasses, corn sweeteners, artificial (high-intensity sweeteners), sugar alcohols, saccharide sweeteners, natural sweeteners (includes brown centrifuged and non-centrifuged cane sugars), and mixed sweetener interactions in foods and beverages.

Ongoing Courses

Sugar Boiling for the Sugar Industry

By Harold Birkett and Lenn Goudeau

- This popular hands-on course is for people with no or limited sugar boiling experience or those who want to learn how to boil (crystallize) sugar and understand the principles involved.
- The course includes background information on sugar crystallization and how a vacuum pan works. Trainees are taught, using pilot plant equipment at Audubon, how to concentrate syrup to supersaturation, seed and grow a sugar grain strike, boil A, B, and C strikes, and gain a practical grasp of sugar boiling.

Introduction to Sugar Boiling Short Course instructor Lenn Goudeau (far right) reviewing false grain with students on June 13, 2018.

Sugar boiling short course student Abebayehu Tafesse checks crystal growth during class on June 13, 2018.

Chief Chemist Short Course (2 days)

By Harold Birkett

- This hands-on course is for factory chief chemists, process engineers or managers who need to understand how factory manufacturing reports are calculated, interpreted and checked against theoretical considerations.
- The course includes hand calculations along with computers to prepare, correct and check factory manufacturing reports. The reports are used to analyze factory operations.

Bench Chemist Short Course (3 days)

By Jeanie Stein

- The bench chemist short course is a hands-on class for people who have little or no experience working in a laboratory or are unfamiliar with sugar factory analyses and will be employed as bench chemists in a raw sugar factory.
- The course covers sampling and analytical techniques used in raw sugar factories, including analysis of incoming cane, bagasse, mud, juice, syrup, massecuite, molasses and raw sugar.

New Courses in Development

Apprenticeship in Factory Sugar Operations (1 year)

In the past, long-term ASI training has focused on Master of Science and/or Ph.D. training, and while this is worthwhile, it has not always fulfilled the needs of industry personnel. At the recommendation of the ASI Training Advisory Committee, particularly member Frank Jamieson, a new type of course based on past industrial apprenticeships is being developed and will be available in 2022. It is envisaged to last one year starting at the end of February. From February to June the unit processes of raw sugar manufacture from cane harvesting to refining will be covered in detail by factory instructors, Audubon instructors or guest trainers at Audubon. Training will also include hands-on experience in the Audubon analytical laboratories and Audubon pilot plant as appropriate. During the grinding season, the apprentice will work at the factory but also work in the different areas of the factory where course work was focused. The apprentice will keep a journal detailing course work learned at the factory, and the journal will be reviewed weekly by the apprentice's supervisor. When and where applicable, cross-training can occur. After the grinding season the apprentice will give a presentation on what they have learned during the course. A final diploma will be awarded.

Ethanol Production From Sugarcane (1 week)

More and more countries are producing either fuel or potable ethanol from sugarcane and have requested a short course. Such a course is currently being developed at Audubon and will cover all aspects, including: industrial measurement of ethanol yields, raw materials, fermentation processes (fundamentals, yeast selection and stressors, contamination, batch and continuous processes distillation, and dehydration).

Workshops Available

A number of workshops are also available from ASI (1 to 2 days):

- Deteriorated Sugarcane
- Green Cane Harvesting and Processing
- Starch and Starch Enzymes
- Dextran and Dextranases
- Sugar Losses
- Color and Decolorization Processes
- Sugar Factory Microbiology/Biocides
- Sugar Industry Fermentation
- Sugar Chemistry

Harold Birkett

- Core laboratory visits were made to several factories to review procedures and methods and to provide factory personnel and growers an understanding of both core lab and factory reports. It is important that each core lab provides correct information for cane payment and predicted factory yield.
- Cold tolerance tests were conducted in St. Gabriel, Louisiana, following the freeze of Nov. 13, 2019, in collaboration with personnel from the LSU AgCenter Sugar Research Station, the American Sugar Cane League and the U.S. Department of Agriculture (Houma). Among the variables measured for several commercial sugarcane varieties were pH, apparent purity, titratable acidity and polysaccharides. The information obtained was very useful to growers as it gives an indication of varietal cold tolerance and to factories as an indication of the degree of cane deterioration that may be expected. More about these tests can be found in Cane Processing Research Reports.
- Hands-on training and information were provided on a number of issues to several factories. Many of the requests centered around assistance with analyses (to determine pol, dextran, phosphate, color, etc.). There were several requests for literature searches regarding mud losses, reheaters, scrubbers, viscosity, molasses exhaustion, cane wax, etc.
- Material and energy balances were completed at the request of many factories. These balances were used by factory personnel for equipment sizing, estimating steam usage and estimating capacities.
- Losses were an issue at some of the factories over the 2018-2020 period. Assistance was given with sampling and analyses of bagasse, final molasses, filter cake and entrainment losses.
- Two independent syrup producers requested and received information and assistance with testing of their commercial products.
- Evaporator cleaning using formic acid was briefly investigated at the request of a local chemical company. Results showed no advantage in using formic acid over conventional cleaning.

JoseManuel Henriquez

- **Mud consistency** as measured by a Bostwick-type consistometer (the flow of 75 milliliters of mud under its own weight) at the factory was demonstrated at various Louisiana factories to be a simple, reliable and inexpensive measure of mud flowability at the factory site. Use of the consistometer by the operators of multiple factories was encouraged. It was also demonstrated to be a practical first step in the automation of the mud filtration operation and compared very well (R value was -0.895) with automated Ziegler meter viscosity readings at one factory. This was important as operators had had to rely too heavily on visual and touch assessment of the quality of mud.
- Multiple visits were made to Louisiana factories to train and support new **fabrication superintendents**.
- Training was given to a new **chief chemist** on reporting and boiling house calculations.
- At the request of one factory, the **chemical cleaning** of evaporator stainless steel calandria tubes was investigated.
- **Equipment capacity** was confirmed in some factories by actually measuring dimensions and calculating volumes.
- Engaged with process supervisor at one factory to **reduce high turbidity in clarified** juice by making necessary measurements and ensuring that best management practices were being followed.
- Improved **seed suspension preparation** for crystallization by using a highly concentrated surfactant (TensoActive) instead of isopropyl alcohol, which worked much better.
- Improved **low pH of crusher juice** from the first mill at one factory by showing the staff that they needed a well-defined policy of handling cane in the factory cane yard, e.g., first in first out, as well as good cane management from field to factory.
- One factory had a **decrease in the amount of cane** delivered to the factory for a season for various reasons. Helped to adjust the factory's estimates of cane in the field and improved communication between growers, field staff and factory processors.
- Identified parameters that needed **automation** at the vacuum pan station of one factory. Took factory data to show problems.
- **Assessed the process operation** at two factories.
- Suggested necessary equipment for **boiling house control** at one factory to provide more valuable data that could be practically used by processors.
- **Molasses conditioning** was improved at one factory to melt unwanted grain crystals.
- Recommended necessary cleaning of evaporator **entrainment separators** in the off-season and created a cleaning protocol.
- Advised a company on the modified design of existing **belt filters** currently used in factory mud filtration stations.

Updates on the Audubon Pilot Plant

The main building of the Audubon Sugar Institute is 27,000 square feet, but its capacity is expanded with an additional machine shop, welding shop and two pilot plants of 3,000 square feet. In the past few years there have been updates to the pilot plant.

The four-tandem pilot plant mill at the Audubon Sugar Institute.

Audubon has a four-roller milling tandem that was obtained in 2012 on a federal grant to produce syrup for the manufacture of biofuels. The mills were originally designed to accommodate many different feedstocks. Since the completion of the grant, the equipment has been modified to perform better with sugarcane billets. This has been accomplished with the help of engineering staff from Facilities Planning, part of the LSU AgCenter. In the spring of 2018, the four-milling tandem was reinstalled and tested at the Audubon pilot plant. Each mill had been completely refurbished at an offsite location by retired sugar mill experts working at American Ingenuity, an engineering company located in Prairieville, Louisiana. The modifications include the following items:

- New turnplates.
- Modified turnbeams.
- New crown wheels.
- New top roll flanges.
- Repaired/rebuilt scrapers.
- Modified Donnelly chutes.

Loading cane into the feed hopper of the pilot plant mill at the Audubon Sugar Institute during a mill test.

After the successful test of the redesigned milling tandem, additional work needed to be done to the cane preparation equipment and to the automation program. The newly identified modifications to the cane preparation side of the pilot plant were completed in the spring of 2019 and included:

- Adjustment to both sets of knives to bring them closer to the main conveyor belt.
- Fabrication of a new kicker (a drum device that helps to feed material into the shredder).
- Adjustments to the shredder to tighten clearances and minimize obstructions that can cause chokes in the feed chute.

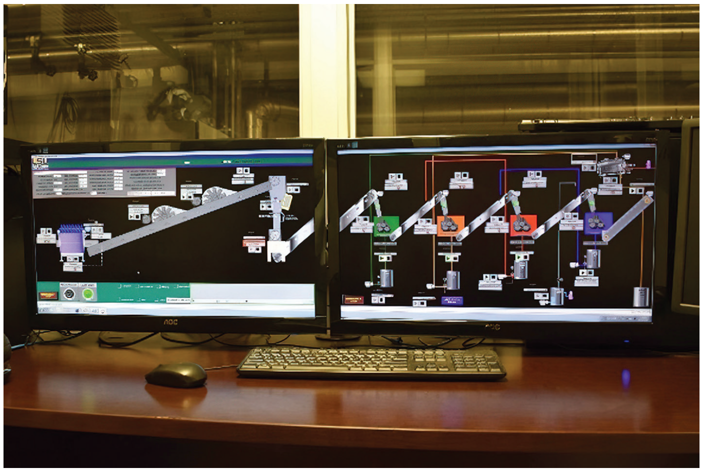
The preparation side of the tandem mill pilot plant at the Audubon Sugar Institute.

PILOT PLANT

In the autumn of 2019, Triad Electric and Controls company was hired to work to improve the central automation of the milling equipment. Triad personnel evaluated the mill control program and began revising the control system in the spring of 2020. After the start of the 2020 processing season, the recent mill modifications were once again tested with sugarcane provided by the LSU AgCenter Saint Gabriel Sugar Research Station. The test was successful, except for the following items:

- Removal of contractions in the Donnelly chutes to minimize choking issues.
- Improvement in the way cane is fed onto the intermediate carriers to minimize “gaps” on the conveyor.
- Additional safety features are needed in the program to ensure safe operation.

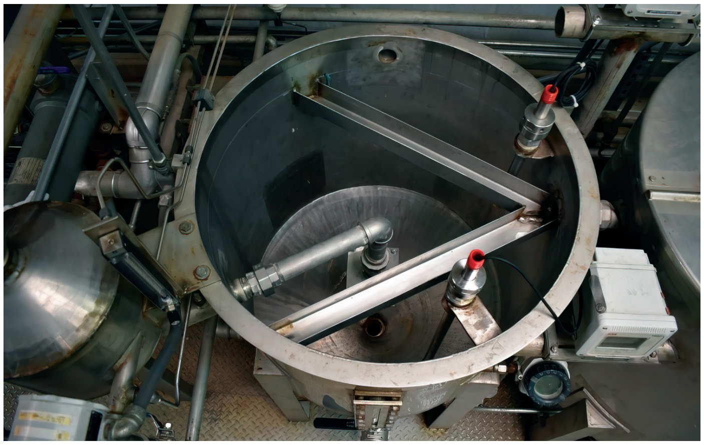
These final improvements were given approval to proceed. Another final test of the preparation and milling side of the equipment was set for the fall of 2021, at which point all the programming issues, as well as the minor remaining mechanical issues, were addressed. Meanwhile, the operational cane preparation system has been successfully used by a company to test their proprietary biomass.



Control system screens in control room of the pilot plant at the Audubon Sugar Institute.

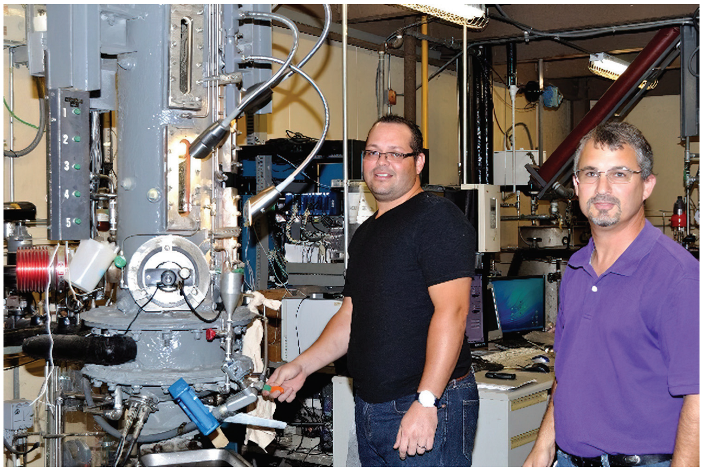
A new batch clarifier was successfully tested in July of 2018. It can be used to clarify juice supplied from the pilot plant milling tandem or juice transported to Audubon from a sugarcane factory or similar facility. Cold, intermediate temperature and hot juice clarification methods can all be operated. Juice collected from the mills can be pumped directly to a juice heater, then flashed and sent to the clarifier using a fully automated process.

- Lime and flocculant are automatically pumped to the clarifier when called for by the computer program.
- Two pH meters, located at different elevations inside the clarifier, communicate with the control system to meter the addition of lime.
- Upgrade of the automation program is still needed at this time.



The automated batch clarifier in the pilot plant.

In 2021 the computer that controls the pilot plant vacuum pans was replaced and the operating system was upgraded. The vacuum pan program was running on and old version of Windows and had become insecure. The vacuum pan is essential for “hands-on” training during the popular Audubon sugar boiling classes each year.



Use of the Audubon sugar vacuum pan for sugar boiling (crystallization) training.

The Audubon pilot plant equipment is available for collaborative research or can be leased.

PUBLICATIONS & PRESENTATIONS

Harold Birkett

Birkett H, and Stein J. (2018). Core lab. Proc. 2018 Factory Seminar, ASI-LSU-AgCenter publication, 6-7.

Birkett H, and Stein J. (2018). Milling and boiler test results – 2017. Proc. 2018 Factory Seminar, ASI-LSU-AgCenter publication, 3-5.

Birkett H. (2019). Reducing factory water usage and pumping costs. Sugar Bull., 97, 17-18.

Birkett H. (2019). Evaporator performance monitoring. Sugar Bull., 98, 19-22.

Birkett H, and Stein J. (2019). Milling and boiler test results – 2018. Proc. 2019 Factory Seminar, ASI-LSU-AgCenter publication, 1-3.

Eggleston G, Lima I, Schudmak C, Hulett R, Waguespack H, Birkett H, Gay J, Landry A., and Finger A. (2019). First year operation of a mechanical detrasher system at a Louisiana sugarcane factory – Impact on processing and value-added products. Internat. Sugar J., 121, 574-583.

Gravois K, Waguespack, H, Stein J, Birkett H, and Duet M. (2019). Cold tolerance of commercial sugarcane varieties during the 2019 harvest season. Sugarcane Research Annual Report 2019, 124-128.

Viator H, Aita G, Aragon D, Ehrenhauser F, Salassi M, and Birkett H. (2019). Sugarcane biofuel production in the USA, In: Khan M, Khan I (eds) Sugarcane Biofuels. Springer, Cham. DOI 10.1007/978-3-030-18597-8_14.

Birkett H, Gomez IP, and Stein J. (2020). Evaporator performance monitoring. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 1-10.

Birkett H, Gomez IP, and Stein J. (2021). Evaporator and heater performance monitoring. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 1-13.

Stephania Imbachi-Ordonez

Imbachi-Ordonez S. (2020). How a statistical analysis of a sugarcane factory's data can help you. Sugar Bull., 99, 17-19.

Imbachi-Ordonez S. (2021). Benchmarking of evaporator cleaning practices at Louisiana factories in 2020. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 14-23.

Imbachi-Ordonez S. (2021). Benchmarking of evaporator cleaning practices at Louisiana factories in 2020. Sugar Bull., 99, 19-22.

Imbachi-Ordonez S, Aponte F, and Montes B. (2021). Use of graphic methodologies to analyze yearly factory data for improved identification of problems and solutions. Internat. Sugar Journal, 123, in press.

Imbachi-Ordonez S, Eggleston G, Triplett A, Goudeau S, and Gaston P. (2021). Control of fructans, dextran, and mannitol at the sugarcane factory with commercial biocides. Part I: Juice deterioration studies. Internat. Sugar J., in press.

Imbachi-Ordonez S, Eggleston G, Triplett A, Goudeau S, and Gaston P. (2021). Control of fructans, dextran, and mannitol at the sugarcane factory with commercial biocides. Part II: Factory Biofilm Study. Internat. Sugar J., in review.

Imbachi-Ordonez S. (2021). Benchmarking of evaporator cleaning practices at Louisiana factories in 2020. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 14-23.

Imbachi-Ordonez S, Gaston P, Eggleston G, and Schudmak C. (2021). Upgrading the Bruker benchtop NIR instrument at ASI for researching a new cane payment method for Louisiana. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 31-37.

Imbachi-Ordonez S, Eggleston G, Triplett A, Goudeau S, and Gaston P. (2021). Do commercial biocides control dextran and fructan at sugarcane factories? Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 38-50.

JoseManuel Henriquez

Henriquez JM, Gaston P, Eggleston G, and Birkett H. (2019). How to monitor mud consistency at sugarcane factories to improve mud clarification. Proc. 2019 Factory Seminar, ASI-LSU-AgCenter publication, 15-23.

Henriquez JM, Eggleston G, Gaston P, Birkett H, Moon YH, and Aita, G. (2020). Monitoring mud consistency at sugarcane factories to improve mud filtration. Internat. Sugar J., 122, 267-273.

Henriquez JM, Imbachi-Ordonez S, Goudeau S, Gaston P, Verret C, and Eggleston G. (2020). Trials on adding extra invert sugar to obtain lower final molasses purities. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 41-51.

Henriquez JM. (2019). Current methods to control mud consistency in Louisiana. Sugar Bull., 98, 15-17.

Henriquez JM. (2020). Alternative method to Zeigler in the control of mud consistency in a Louisiana factory. Sugar Bull., 98, 15-17.

Henriquez JM. (2020). The importance of being a fabrication superintendent or process manager in a sugar factory. Part I. Sugar Bull., 99, 19-21.

Henriquez JM. (2021). The importance of being a fabrication superintendent or process manager in a sugar factory. Part II. Sugar Bull., 99, 17-19.

Giovanna Aita

Fang D, and Aita G. (2018). Fermentation of fumaric acid from lignocellulosic syrup by Rhizopus Oryzae ATCC® 20344TM. BioEnergy Res., 11, 330-340.

Fang D, and Aita G. (2018). Optimization of activated carbon detoxification of dilute ammonia pretreated energy cane bagasse enzymatic hydrolysate by response surface methodology. Indust. Crops and Products, 115, 166-173.

Fang D, and Aita, G. (2018). Detoxification of dilute ammonia pretreated energy cane bagasse enzymatic hydrolysate by soluble polyelectrolyte flocculants. Indust. Crops and Products, 112, 681-690.

Oladi S, and Aita G. (2018). Interactive effect of enzymes and surfactant on the cellulose digestibility of un-washed and washed dilute ammonia pretreated energy cane bagasse. Biomass Bioenergy, 109, 221-230.

Ahmad S, Anjum AM, Aita GM, Khan M, and Khan I. (2019). Source–sink relationship of sugarcane energy production at the sugar

mills. In: Khan M., Khan I. (eds) Sugarcane Biofuels. Springer, DOI 10.1007/978-3-030-18597-8_14.

Aita G, and Moon YH. (2019). Crystal size analysis for Louisiana sugar factories. Sugar Bull., 97, 15-16.

Aita G, and Deng F. (2019). Production of fumaric acid from bagasse. Proc. 30th ISSCT, 292-298.

Eggleston G, and Aita G. (2019). Exploration of sugarcane products as a major source of antioxidant phenolic extracts in commercial foods and beverages. Proc. 30th ISSCT, 285-291.

Oladi S, and Aita G. (2019). Recovery of non-sugar compounds from bagasse hydrolysates. J. Innovations in Energy Sciences, 1, 1-9.

Moon YH, and Aita G. (2019). Crystal size analysis for Louisiana sugar factories: 2018/2019 grinding season. Proc. 2019 Factory Seminar, ASI-LSU-AgCenter publication, 31-34.

Aita G, Deng F, Oladi S, and Cheong D. (2019). Syrup production for fuels and chemicals from bagasse. Louisiana Agriculture Magazine, Spring Issue.

Aita G, and Deng F. (2019). Fumaric acid production from bagasse. Louisiana Agriculture Magazine, Spring Issue.

White P, Webber C, Viator R, and Aita G. (2019). Sugarcane biomass, dry matter, and sucrose availability and variability when grown on a bioenergy feedstock production cycle. BioEnergy Res., 12, 55–67.

Aita G, and Moon YH. (2020). Prebiotics from energy cane bagasse. Prebiotics. Zuckerindustrie, 145, 488-494.

Eggleston G, and Aita G. (2020). Exploration of sugarcane products as a major source of antioxidant phenolic extracts in commercial foods and beverages. Internat. Sugar J., 122, 690-696. Republished in the International Sugar Journal World Sugar Yearbook 2021, 60-67.

Aita, G. (2020). Bioconversion of blackstrap molasses to protein and lipids by BSF larvae. Sugar Bull., 98, 19-21.

Eggleston G, and Aita G. (2020). Exploration of sugarcane products as a major source of antioxidant phenolic extracts in commercial foods and beverages. Internat. Sugar J., 122, 690-696.

Aita G, and Moon YH. (2020). Bioconversion of Cane Sugar Processing by-products to protein and lipids by black soldier fly (BSF) larvae. Internat. Sugar J., 122, 50-58.

Aita G, and Moon YH. (2020). Prebiotics from energy cane bagasse. Zuckerindustrie, 145, 488–494.

Liu C, Li M, Mei C, Han J, Yue Y, Ren S, French A, Aita G, Eggleston G, and Wu Q. (2020). Cellulosic nanofibers from rapidly microwaved-delignified energy cane bagasse and their application in drilling fluids as rheology and filtration modifiers. Indust. Crops and Products, 150, 112378.

Aita G, and Moon YH. (2020). Bioconversion of sugarcane by-products to protein and lipids by black soldier fly larvae. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 52-58.

Aita G, and Deng F. (2020). Bagasse as a source for fumaric acid production. Internat. Sugar J., 122, 278-283.

Aita G. (2021). Extracellular polysaccharides produced by Leuconostoc spp. Sugar Bull., 99, 27-29.

Aita G, Moon YH, Verret C, and Foster T. (2021). Energy Cane Bagasse as a Source of Prebiotics. Internat. Sugar J., 123, 30-39.

Aita G, and Moon YH. (2021). Polysaccharide-producing microbial organisms from Louisiana crusher juice. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 51-56.

Eggleston G, Aita G, and Triplett, A. (2021). Circular sustainability of sugarcane: Natural, nutritious, and functional unrefined sweeteners that meet new consumer demands. Sugar Tech. DOI 10.1007/s12355-021-00994-4.

Aita, G. (2021). Fumaric Acid. International Sugar Journal. Blackboard Series. December Issue.

Aita, G. (2021). Xylooligosaccharides: Bagasse Sugars as Prebiotics. International Sugar Journal. Blackboard Series. October Issue.

Aita, G., Moon, Y H. (2021). Microbial Polysaccharides at the Sugar Factory. International Sugar Journal. Blackboard Series. September Issue.

Maria del Carmen Perez

Perez MC, Imbachi-Ordonez S, Diaz J, Acevedo L, LeBlanc D, Gaston P, and Eggleston G. (2020). Clarification studies at three sugarcane factories across the 2019 Louisiana grinding season. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 11-22.

Perez MC, and Imbachi-Ordonez S. (2020). Variations in sugar losses across clarifiers at three sugarcane factories during 2019. Sugar Bull., 99, 17-19.

Perez MC, Imbachi-Ordonez S, Diaz J, Acevedo L, LeBlanc D, Gaston P, and Eggleston G. (2020). Clarification studies at three sugarcane factories across the 2019 Louisiana grinding season. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 11-22.

Perez MC, Imbachi Ordonez S, Diaz J, Acevedo L, LeBlanc D, Gaston P, and Eggleston G. (2020). Clarification studies at three sugarcane factories across the 2019 Louisiana grinding season. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 11-22.

Perez MC, Imbachi-Ordonez S, Diaz J, Gaston P, and Eggleston G. (2021). Comparative performance of factory clarifiers with automatic or pump mud extraction systems. Internat. Sugar J., 123, 246-254.

Perez MC, Diaz Y, Brown G, Gaston P, and Eggleston G. (2021). Preliminary report on the replacement of Octapol® for core juice analyses in Louisiana. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 57-65.

Gillian Eggleston

Eggleston G. (2018). When dextran rears itself at the factory - How to break it down with dextranase enzyme. Sugar Bull., 97, 17-18.

Eggleston G, Finley J, and deMan J. (2018). Carbohydrates. In: Principles of Food Chemistry, Food Science Text Series, deMan J, Finley J, Hurst J and Lee CY (Eds). Chapter 4, Springer, New York, fourth edition, 165-229.

Eggleston G, Stewart D, Aponte F, Montes B, Boone S, and Verrat C.

(2018). How to use and interpret the results from a HPLC system at a sugarcane factory. Internat. Sugar J., 20, 210-217.

Eggleston G, Gober J, Legendre D, and St. Cyr E. (2019). Seasonal chemical sucrose losses in upstream and downstream products at a sugarcane factory. Zuckerindustrie, 144, 705-713.

Cole MR, Eggleston G, Gaines D, and Heckemeyer M. (2019). Development of an enzyme cocktail for the bioconversion of untapped starch in by-products from sweet sorghum processing. Indust. Crops and Products, 133, 142-150.

Cole M, Eggleston G, and Gaines D. (2019). Development of a factory/refinery method to measure total, soluble, and insoluble starch in sugar products. Internat. Sugar J., 121, 122-133.

Orna MV, Eggleston G, and Bopp A. (2019). Introduction: Chemistry feeds the world. In Chemistry's Role in Food Production and Sustainability: Past and Present. Ed.: Orna MV; Eggleston G; Bopp A., ACS Symposium Series 1314, Oxford Univ. Press, Chapter 1, 3-16.

Eggleston G. (2019). History of sugars and sweeteners. In Chemistry's Role in Food Production and Sustainability: Past and Present. Ed.: Orna MV; Eggleston G; Bopp A. ACS Symposium Series 1314, Oxford Univ. Press, Chapter 5, 63-74.

Eggleston G, and Triplett A. (2019). Mannitol kits at the factory – what they can do for you. Proc. 2019 Factory Seminar, ASI-LSU-AgCenter publication, 4-14.

Eggleston G. (2019). Losses of sucrose across Louisiana evaporators have been underestimated. Sugar Bull., 98, 17-19.

Eggleston G. (2019). Revolutionary technologies. Bacterial deterioration, clarification, and NIR spectroscopy. Internat. Sugar J., 121, 112.

Spaunhorst DJ, Triplett A, St. Cyr E, and Eggleston G. (2019). Do late-season applied synthetic auxin herbicides influence starch and color in commercial sugarcane cultivars? Proc. 2019 Factory Seminar, ASI-LSU AgCenter publication, 35-41.

Lima I, Jimenez A, Eggleston E, Pabon B, and Sarir E. (2019). Pilot plant study on the use of powdered activated carbon to remove various impurities from a sugarcane refinery liquor. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 237-249.

Wierdak A, Clayton C, Watts N, Lima I, Walker A, Eggleston E, Parker C, and Sarir E. (2019). Powdered activated carbon to adsorb colorants from sugar beet syrup. A pilot plant study. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 30-44.

Bett-Garber KL, Lea JM, Eggleston G, Bechtel P, and Bice D. (2019). Sensory flavor characteristics of sweet sorghum syrup. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 110-121.

Cole M, Eggleston G, Gaines D, Heckemeyer M, and Klasson KT. (2019). Development of an enzyme processing cocktail for sweet sorghum processing by-products. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 207-219.

Cole M, and Eggleston G. (2019). Development of a factory/refinery method to measure total, soluble, and insoluble starch in sugar products. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 56-70.

Eggleston G, Triplett A, Bett-Garber K, Bechtel P, and Bice D. (2019). A comparison of the macronutrient and mineral composition of sweet sorghum and other commercial syrup sweeteners. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 250-267.

Eggleston G, Bett-Garber K, Triplett A, Boue S, Bechtel P, and Bice D. (2019). Total phenolics, antioxidant activity, and color in sweet sorghum syrups compared to other commercial syrup sweeteners. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 341-353.

Klasson KT, Qureshi N, Heckemeyer M, and Eggleston G. (2019). Biobutanol production from sweet sorghum biorefinery byproducts. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 274-281.

Eggleston G, Schudmak C, Hulett R, Waguespack, Jr H, Birkett H, Gay J, Landry A, Lima I, St. Cyr E, Stein J, and Finger A. (2019). First year operation of a mechanical detrasher system at a Louisiana sugarcane factory. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 220-236.

Eggleston G, and Triplett A. (2019). The nature of floc problems in alcoholic beverages sweetened with cane sugars and how to remove them. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 122-133.

Eggleston G, Stewart D, Montes B, Triplett A, St. Cyr E, and Boone S. (2019). Evaluation of hydrogen peroxide as a decolorizer in upstream juice products at a sugarcane Factory. Proc. Adv. Sugar Crop Process. Conv. Conference, 2, 194-206.

Verret G, Foster T, and Eggleston G. (2019). 2018 Molasses survey results – lowest molasses purities recorded. Sugar Bull., 98, 17-19.

Eggleston G, Stewart D, Triplett A, St. Cyr E, Verret C, Montes B, and Foster T. (2020). Reasons for the unusually low molasses purities in Louisiana sugarcane factories across the 2018/19 processing season. Internat. Sugar J., 122, 706-716.

Lima I, Jimenez AM, Eggleston G, Pabon B, Sarir E, and Thompson J. (2020). Scale up studies for the simultaneous removal of colorants and residual enzyme from a refinery sugar liquor using powdered activated carbon – A pilot plant study. Internat. Sugar J., 122, 488-495. Republished in the International Sugar Journal World Sugar Yearbook 2021, 32-40.

Henriquez JM, Imbachi Ordonez S, Goudeau S, Gaston P, Verret C, and Eggleston G. (2020). Trials on adding extra invert sugar to obtain lower final molasses purities. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 44-54.

Spaunhorst DJ, Triplett A, St. Cyr E, and Eggleston G. (2020). Effect of synthetic auxin herbicides on starch accumulation and color in sugarcane. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 59-67.

Triplett A, Eggleston G, Gaston P, and Stewart S. (2020). Fructan – how we have underestimated this polysaccharide in Louisiana. Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 23-33.

Eggleston G, Stewart D, Verret C, Triplett A, Montes B, Foster T, St. Cyr E, and Gaston P. (2020). Why molasses purities were unusually low during the 2018 sugarcane grinding season in Louisiana.

Proc. 2020 Factory Seminar, ASI-LSU-AgCenter publication, 68-78.

Eggleston G, Birkett H, and Henriquez JM. (2020). The early freeze in the 2019 Louisiana grinding season: Factory concerns. Sugar Bull., 98, 15-17.

Spaunhorst D, Triplett A, St. Cyr E, and Eggleston G. (2021). Effect of synthetic auxin herbicides applied during sugarcane grant growth on starch accumulation and color. Sugar Tech, https://doi.org/10.1007/s12355-021-00972-w.

Triplett A, Eggleston G, Gaston P, and Stewart D. (2021). Fructans have been underestimated in the Louisiana sugarcane industry. Internat. Sugar J., 123, 50-58.

Lima I, Jimenez AM, Eggleston G, Pabon B, Sarir E, and Thompson J. (2021). Pilot plant studies demonstrate the ability of a powdered activated carbon to simultaneously remove multiple impurities from a refinery syrup. Sugar J., 83, 13-20.

Eggleston G, Boue S, Bett-Garber K, Verret C, Triplett A, and Bechtel P. (2021). Phenolic contents, antioxidant potential and associated colour in sweet sorghum syrups compared to other commercial syrup sweeteners. J. Sci. Food Agric., 101, 613-623.

Lima I, Clayton C, Tir A, Parker C, Sarir E, and Eggleston G. (2021). Design and operation of a scaled-up pilot plant for the removal of sugar beet extract colorants using powdered activated carbon syrup. Sugar Tech, 23, 167-177.

Triplett A, Cole M, and Eggleston G. (2021). Validation of an industrial method to measure insoluble and soluble starch in raw sugars. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 66-84.

Triplett A, and Eggleston G. (2021). ICUMSA validation of Guangzhou monoclonal antibody method to measure dextran in factory cane products. Proc. 2021 Factory Seminar, ASI-LSU AgCenter publication, 85-98.

Spaunhorst DJ, Triplett A, St. Cyr E, and Eggleston G. (2021). Two-year assessment on how synthetic auxin herbicides effect starch accumulation and color in Louisiana sugarcane. Proc. 2021 Factory Seminar, ASI-LSU-AgCenter publication, 99-107.

Eggleston G, and Goudeau S. (2021). Ramping up training in sugar technology at the Audubon Sugar Institute. Sugar Bull., 99, in press.

Godshall MA, Eggleston G, Thompson J, and Kochergin V. (2021). Sugar. In Kirk-Othmer-Encyclopedia of Chemical Technology, Wiley: New York, in press.

Others

Verret C, and Tisechkina I. (2018). The 2017 molasses survey. Proc. 2018 Factory Seminar, ASI-LSU-AgCenter publication, 13-18.

Ehrenhauser F, Gordillo M, and Gaston P. (2018). Size dependent quality of Louisiana bagasse. Proc. 2018 Factory Seminar, ASI-LSU-AgCenter publication, 1-2.

Ehrenhauser F, and Gaston P. (2018). De-ashing sugar streams for increased sugar recovery. Proc. 2018 Factory Seminar, ASI-LSU-AgCenter publication, 21-22.

ICUMSA® International Commission for Uniform Methods of Sugar Analysis

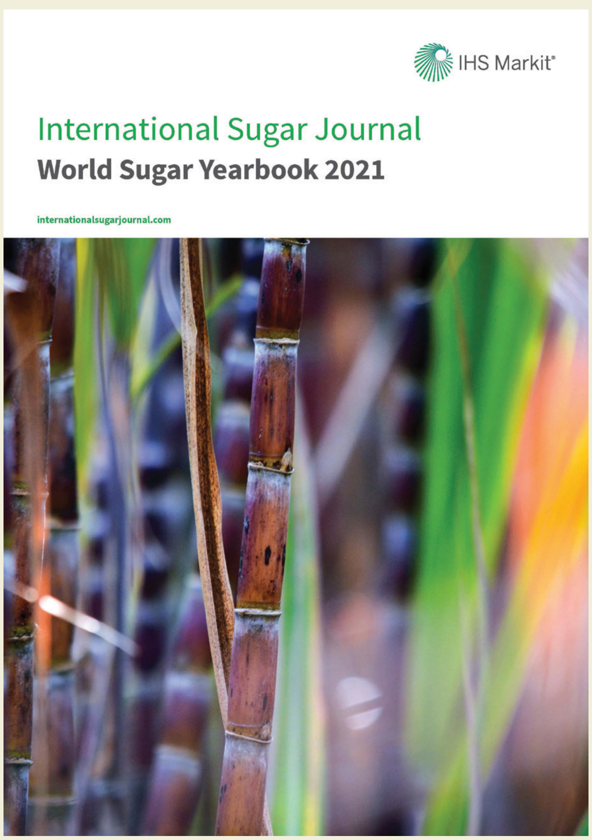
- ICUMSA General Subject 7 Cane Processing General Referee: Gillian Eggleston
- ICUSMA Associate Referees: Alexa Triplett and Chardcie Verret

International Society of Sugar Cane Technologists

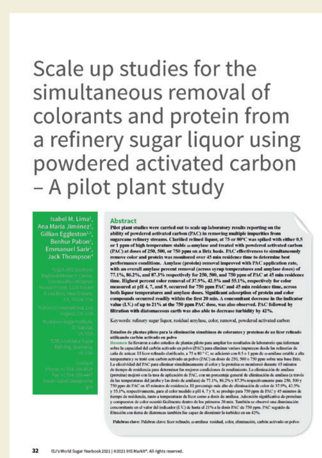
- ISSCT Chair of Factory Commission: Gillian Eggleston
- ISSCT: Member of Co-Products Commission: Giovanna Aita

- Special Issue: July-August 2021, Diversification of Sugar Crops for Value Addition. Guest Editors: Giovanna Aita and Gillian Eggleston

Two Audubon Papers Selected for the World Sugar Yearbook 2021




Exploration of sugarcane products as a major source of antioxidant phenolic extracts in commercial foods and beverages*

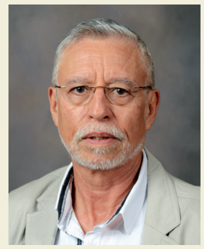

Scale up studies for the simultaneous removal of colorants and protein from a refinery sugar liquor using powdered activated carbon – A pilot plant study

Faculty of the Audubon Sugar Institute 2018-2021

Dr. Gillian Eggleston
Director and Professor
Chemistry

Dr. Giovanna Aita
Professor
Microbiology

Dr. Harold Birkett
Associate Professor
Chemical Engineering



JoseManuel Henriquez
Instructor/Extension
Chemical Engineering
(Temporary)

Stephania Imbachi-Ordonez
Instructor/Research
Chemical Engineering

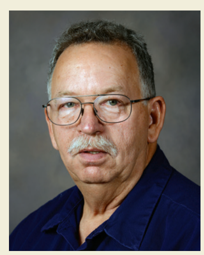
Maria del Carmen Perez
Instructor/Research
Chemical Engineering
(Temporary)

Staff at the Audubon Sugar Institute 2018-2021

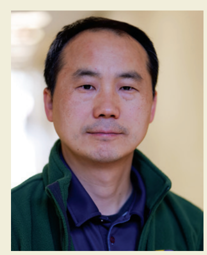
Tyrenee Foster
Research Associate

Peter Gaston
Research Associate

Lenn Goudeau
Research Associate



James Poissot
Maintenance Repair Master

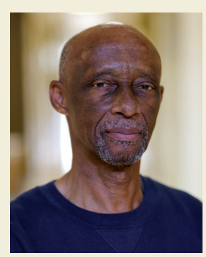


Dr. Young Hwan Moon
Senior Scientist Specialist

Alexa Triplett
Research Associate

Chardcie Verret
Supervisory Research Associate/Central Laboratory Director

Faye Muse
Admin. Coordinator IV



Eldwin St. Cyr
Research Scientist Technician

Not pictured: Jeanie Stein
Research Associate

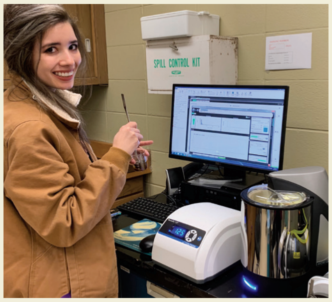
Students, Interns and Visiting Scientists at the Audubon Sugar Institute 2018-2021

- Joel Ramkhelawan, Food Sciences, Ohio State University, Graduate Student Representative, Consortium for Advanced Bioeconomy Leaders and Educators (CABLE, 2021-2022).
- Dr. Giovanna M. Aita and her mentee Joel Ramkhelawan represented CABLE at the Advanced Bioeconomy Leadership Conference (ABLC) in San Francisco, California, on Oct. 27-29, 2021.

Ramkhelawan

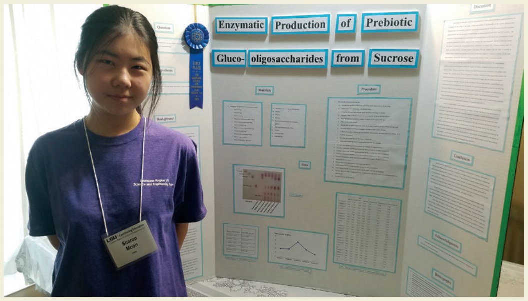
Millicent Yeboah-Awudzi, School of Nutrition and Food Sciences, Louisiana State University, and graduate student representative for the Consortium for Advanced Bioeconomy Leaders and Educators (CABLE, 2019-2020). CABLE is a nationwide organization of 20 universities led by the Ohio State University and supported by the United States Department of Agriculture, National Institute of Food and Agriculture (USDA NIFA), which aims to provide students with a year of leadership development in the bioeconomy.
Mentor: Dr. Giovanna Aita

Yeboah-Awudzi



Hager

Chelsea Hager, an intern at Cora Texas and undergraduate student at LSU, spent two weeks at ASI to be trained on how to use the particle size analyzer. Hager ran various sugar samples to monitor the growth of sugar crystals during sugar processing (May 2019).
Mentors: Dr. Giovanna Aita and Dr. Young Hwan Moon



Moon

Sharon Moon, sophomore at Baton Rouge High School (2019-2020): Research Project: Moon worked on the enzymatic production of prebiotic gluco-oligosaccharides from sucrose under Dr. Giovanna Aita's mentorship. Moon placed second at the 66th Annual Louisiana Science and Engineering Fair (State Fair) virtually held at LSU from March 16-18, 2020.

Chelsea Tyus, left, and her faculty mentor Giovanna M. Aita

Chelsea Tyus, School of Nutrition and Food Sciences, Louisiana State University and Graduate Student Representative for the Consortium for Advanced Bioeconomy Leaders and Educators (CABLE, 2018-2019).

Students, Interns and Visiting Scientists at the Audubon Sugar Institute 2018-2021

Aleena Kazmi, biochemistry, Louisiana State University and undergraduate student representative for the Consortium for Advanced Bioeconomy Leaders and Educators (CABLE, 2017-2018).
Mentor: Dr. Giovanna Aita

Kazmi

Fang Deng, School of Nutrition and Food Sciences, Louisiana State University, (Ph.D. student, 2018)
Research Topic: Lignocellulosic Syrup Production from Energy Cane Bagasse and Fumaric Acid Fermentation.
Mentor: Dr. Giovanna Aita

Aleena Kazmi, biochemistry, Louisiana State University, (A. Wilbert's Sons' Internship)
Research Topic: Optimization of Ethanol Yields from Lignocellulosic Biomass.
Mentor: Dr. Giovanna Aita

Dustin Foster, a B.S. student at the Department of Chemistry at Louisiana Tech University in Ruston, was the summer intern at ASI from November 2018 to June 2019.
Research Topic: HPLC analyses of phenolic compounds in sugars, syrups, and vinegars.
Mentors: Dr. Giovanna Aita and Chardcie Verret.


Foster

Vitor Teixeira, a Ph.D. student at FATEC (Faculty of Technolology), Jabotical, Sao Paulo State, Brazil, was a six-month intern at ASI from November 2018 to June 2019.
Research Topic: Physico-Chemical Characterization of Sweet Sorghum Vinegars Compared to Other Commercial Sugars and the Fermentation of Sweet Sorghum juice.
Mentors: Dr. Giovanna Aita and Dr. Gillian Eggleston


Teixeira

Elinor Prados, a sophomore at St. Joseph's Academy in Baton Rouge, spent two weeks in September 2020 at ASI working on a science fair project on the effects of flocculation aids on the clarification process of sugarcane juice.
Mentor: Stephania Imbachi-Ordonez.

Eleanor McFeaters, an intern at Louisiana Sugar Refining and an undergraduate student at LSU, is working on her thesis proposal called "Implementing SysCAD Dynamic Process Simulation Technology to Optimize Sugar Refinery Vacuum Pan Boiling Sequences." She is being mentored by a professor from the Biological and Agricultural Engineering Department at LSU and Stephania Imbachi-Ordonez from ASI.

Dr. Marsha Cole, a visiting scientist from the Department of Chemistry at Louisiana Tech University in Ruston, Louisiana, worked at ASI in the summer of 2019 on further developing and transferring an industrial method to measure soluble, insoluble and total starch at sugar factories and refineries. She worked with Dr. Gillian Eggleston.

International Awards

2019 Maurice Paturau Award for Best Paper, Co-Products Commission

Eggleston, G., Aita, G. “Exploration of Sugarcane Products as a Major Source of Antioxidant Phenolic Extracts in Commercial Foods and Beverages”

30th Congress of the International Society for Sugar Cane Technologists, San Miguel de Tucuman, Argentina.

2019 August John Vitos Award for Best Poster, Co-Products Commission

Aita, G., Moon, Y. H., Verret, C., Foster, T. “Energy Cane Bagasse as a Source for Prebiotics”

30th Congress of the International Society for Sugar Cane Technologists, San Miguel de Tucuman, Argentina.

National Awards

2018 Outstanding Poster Award

Eggleston, G., Stewart D, Montes B, Triplett, A., St. Cyr E., Boone S. “Evaluation of Hydrogen peroxide as a Decolorizer in Upstream Juice Products at a Sugarcane Factory.”

Advances in Sugar Crop Processing and Conversion conference, New Orleans, Louisiana.

2018 Outstanding Presentation Award

Cole, M., Eggleston G. “Development of a Factory/Refinery Method to Measure Total, Soluble, and Insoluble Starch in Sugar Products.”

Advances in Sugar Crop Processing and Conversion conference, New Orleans, Louisiana.

2019 Denver T. Loupe Outstanding Paper Award, Manufacturing Section

Eggleston, G., Legendre, D., Gober, J., St. Cyr, E. “Seasonal Chemical Losses in Upstream and Downstream Products at a Sugarcane Factory.”

49th American Association of Sugar Cane Technologists annual joint meeting, Point Clear, Alabama.

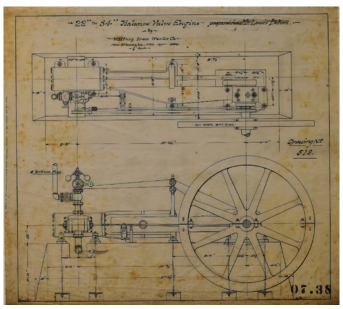
Audubon scientists serve as invited reviewers for numerous scientific journals, including:

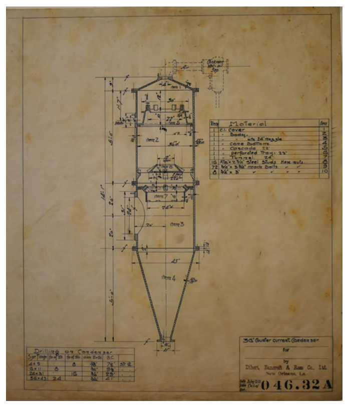
- Advances in Sugar Crop Processing and Conversion (Proceedings)
- Applied Biochemistry and Biotechnology
- BioEnergy Research
- Bioresource Technology
- Industrial Crops and Products
- International Sugar Journal
- Journal of Applied Microbiology
- Journal of Industrial Microbiology and Biotechnology
- Journal of Chemical Technology and Biotechnology
- Journal of Biomass and Bioenergy
- Sugar Tech

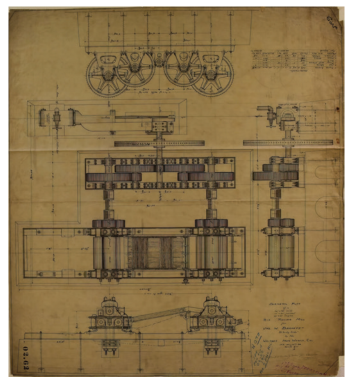
Donation of Important Sugar Industry Archives to ASI in 2018

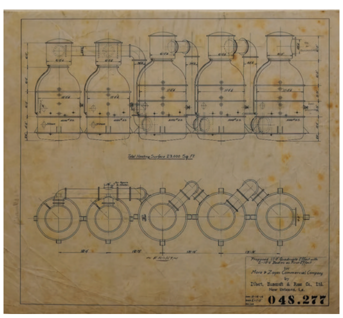
In August 2018, the Audubon Sugar Institute received an extraordinary donation of a large collection of old technical drawings, ledgers and photographs from Bradken Inc. in Amite, Louisiana. The collection originated from the famous Whitney Iron Works Company in New Orleans and their successors, the Dibert, Bancroft, and Ross foundry located in Mid-City New Orleans. These archives depict designs and blueprints of sugarcane processing equipment and buildings built for companies in for North, Central and South America from the 1880s to the 1970s.

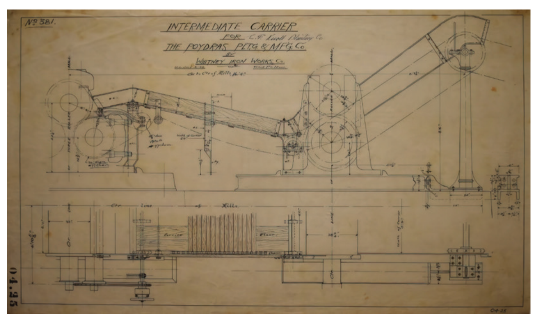
This outstanding collection of approximately 10,000 archival documents represents an important historical microcosm of the sugarcane industry in the Americas and how it developed. The Audubon Sugar Institute is honored to have received this impressive collection and has already made strides to share it with the public by exhibiting it at the meeting of the American Society of Sugar Cane Technologists in Alabama in the summer of 2019. The collection is currently housed in an archives room at the Audubon building with a dehumidifier to protect the documents. In the next years, the plan is to digitalize the documents and put them on the Audubon website.











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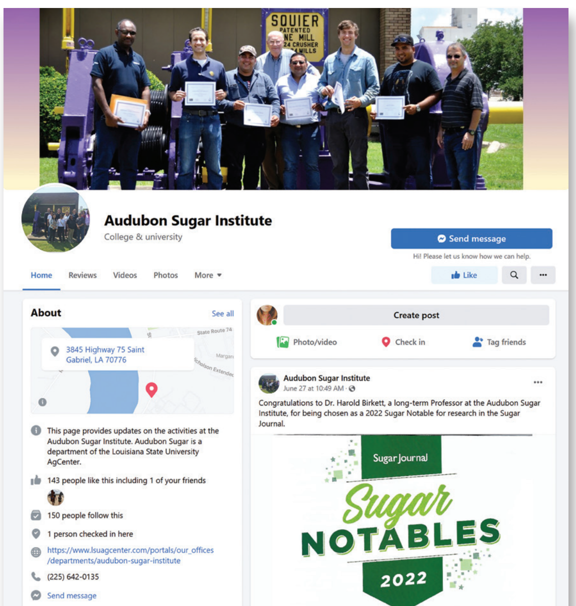
ONLINE

Audubon Is Now on Facebook

- The Audubon Facebook page was started in 2019, and it is a great way to keep up with the weekly news and activities at Audubon.
- The page is located at www.facebook.com/Audubon-Sugar-Institute-2248168232163000.
- The Facebook page is regularly monitored and updated each week with Audubon news, and instant messaging is available through the page. In addition, we have strived to make sure that all Facebook posts are ADA (Americans with Disabilities Act) accessible.
- Visit the Facebook page and give us a like to start receiving Audubon Facebook posts directly in your news feed.

The Audubon Facebook Page



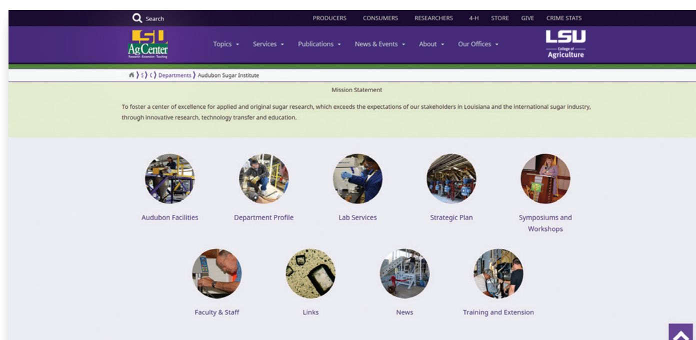
Improved Audubon Website

The Audubon website was given a major update in 2018 to make it more user friendly and to introduce some new areas of pursuit within the Institute. The page can be found at:

https://www.lsuagcenter.com/portals/our_offices/departments/audubon-sugar-institute.

- The website is being made more accessible to persons with visual and hearing impairments. Since the 2018 update, all new postings must pass an accessibility test before being published on the website, and older material is either being made accessible or it is being removed from the site.
- One new addition on the website is the Lab Services page. This page contains a listing of all the ASI Laboratory Services that can be done at Audubon along with pricing information
- The ASI Strategic Plan is a new feature that outlines the goals of the institute over the next decade.
- The Symposiums and Workshops page is another new area of pursuit that has been added to the website. Each year a different symposium has been planned, and although the COVID-19 pandemic has put these on hold for the time being, we are hopeful that the symposiums and workshops will be able to resume very soon.

The Audubon Website Homepage



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