

# AUDUBON SUGAR INSTITUTE

## 2022-2024 REPORT

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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 Gillian Eggleston. Research scientist technician Eldwin St. Cyr takes samples at a Louisiana sugarcane factory for research purposes.*

*Back cover photo: Audubon hands-on sugar boiling training for the sugar industry.*




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# LAES DIRECTOR'S FORWARD



*Michael E. Salassi, Ph.D.*

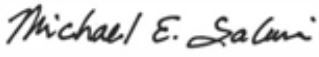
As the director of the Louisiana Agricultural Experiment Station within the LSU AgCenter, it is a pleasure to highlight the achievements and importance of the research and extension activities conducted by the Audubon Sugar Institute (ASI) for this triennial report. ASI continues to play an important role in the mission of the LSU AgCenter in meeting the needs of our state's sugar industry.

Sugarcane remains a very strong part of Louisiana's agricultural economy. In 2025, Louisiana raw sugar factories processed 17.9 million tons of sugarcane from 502,783 acres, with a recovery rate of 247 pounds of raw sugar per ton of cane, producing a final product worth $1.5 billion. The operations of these factories are supported by the research and extension efforts conducted at the Audubon Sugar Institute.

### *The specific mission of the Audubon Sugar Institute includes:*

- Provide technological information and process support to the 11 sugar factories in Louisiana through annual factory operations seminars and factory visits during grinding and off-crop season.
- Improve factory efficiency through continued research projects such as mill extraction tests and bagasse boiler operation studies; optimization of low-grade boiling procedures; production and storage of very-high-purity and very-low-color sugar; and 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 LSU AgCenter along with the American Sugar Cane League and the U.S. Department of Agriculture Agricultural Research Service have enjoyed a decades-long partnership in developing new and improved sugarcane varieties for Louisiana's sugar industry. With the goal of developing newer varieties with higher yield potential and improved stubbling ability, disease and insect resistance and cold tolerance, this three-way crop variety development program yields ever-improved sugarcane varieties released for commercial production by Louisiana producers. Research and extension efforts by the Audubon Sugar Institute greatly support and enhance the efficiency and productivity of Louisiana's raw sugar factory operations in converting these newer varieties of sugarcane into a raw sugar finished product. The LSU AgCenter is proud to be a part of this team in supporting such a major agricultural industry in Louisiana and helping to ensure its economic viability for well into the future.



*Michael E. Salassi, Ph.D.*
*Director, Louisiana Agricultural Experiment Station*

Louisiana's sugar industry operates in an environment that is more complex and data-driven than at any time in its history. Higher cane volumes, extended processing seasons, increased weather variability and the accelerating adoption of digital technologies demand precision at every stage of factory operations.

The Audubon Sugar Institute has responded to these realities with both technical rigor and practical focus. The 2022–2024 period reflects meaningful progress in analytical capability, strategic planning and research output. The acquisition of advanced instrumentation, expanded laboratory services and continued engagement with international technical bodies position Audubon not only as a service provider, but as a center of excellence in sugar processing science.

What distinguishes Audubon's work is its direct relevance to factory performance. Research in areas such as clarification, filtration aids, starch measurement and evaporator scale analysis addresses real operational constraints. The continued evolution of the Round Table Conversation provides a valuable mechanism for peer exchange, allowing factory leaders to share results and refine best practices in real time.

As director of research for the American Sugar Cane League, I view Audubon as an essential extension of our industry's technical capacity. The close collaboration with the LSU AgCenter and support through our partnership with the U.S. Department of Agriculture ensure that research priorities remain aligned with industry needs while maintaining the highest scientific standards.

The progress outlined in this report affirms that Audubon is well positioned to meet the technical challenges ahead. Its work strengthens not only individual factories, but the long-term competitiveness of Louisiana sugar as a whole.

*Atticus Finger*
*American Sugar Cane League*
*Director of Research*



***Atticus Finger***

Research is not an accessory to Louisiana's sugar industry. It is the foundation that secures its future.

For decades, our industry has understood that sustained success requires sustained investment in science. The American Sugar Cane League has worked with the LSU AgCenter to ensure that the Audubon Sugar Institute remains a national leader in applied sugarcane processing research. This collaborative work reflects a simple but powerful principle: When industry stakeholders and research partners align, innovation accelerates and risk is reduced.

This report demonstrates that this model continues to deliver results. In a period marked by production growth, climate variability, longer grinding seasons and rapid technological change, Audubon has remained focused on practical solutions that improve factory efficiency, product quality and operational decision-making. Strategic planning has sharpened that focus, ensuring resources are deployed where they generate measurable returns for growers and processors.

The League's funding of research at Audubon is not merely about supporting projects. It is about protecting a $4 billion economic engine for Louisiana and safeguarding the livelihoods of farm families, factory workers and rural communities. The investments highlighted in this report — from upgraded analytical services to internationally recognized research contributions — are evidence that our commitment is producing value.

On behalf of the industry, I commend Director Gillian Eggleston and the faculty and staff of Audubon for their discipline, responsiveness and excellence. Continued support of research is not optional. It is essential. The work contained in this report reinforces why that commitment must remain strong.

*Jim Simon*
*American Sugar Cane League*
*General Manager*



***Jim Simon***

# DIRECTOR'S REPORT

## *Sugarcane is one of the major crops grown in Louisiana.*

In 2023, during the period of this report, Louisiana produced 2.04 million short tons of raw sugar, accounting for 18% of the domestic U.S. sugar supply. The latest statistics from the American Sugar Cane League showed that in 2022, the state produced sugar from 17 million tons of harvested cane that provided the sugar needs for more than 53 million Americans. Louisiana sugarcane was produced on 473,000 acres of land in 23 parishes from 425 farms. Moreover, the sugarcane industry is vital to the economy of Louisiana, with an annual economic impact of $2 billion to cane growers and raw sugar factories each year, while also generating an overall economic impact of $4 billion.

The profitable and continued production of sugar in Louisiana, however, is challenged by numerous factors including a continuous increase in the volume of the cane supply which has been causing an extension of the processing season at both the beginning and end. Climate changes, including drought or hurricane conditions and freezes late in the season, are also challenging the seasonal quality of Louisiana sugarcane. Additionally, the sugarcane industry, like all other industries, is undergoing a fourth industrial revolution, commonly known as Industry 4.0. This is characterized by the integration of digital technologies with physical processes, the Internet of Things, sensors for real-time data collection, big data analytics, artificial intelligence, cloud computing and automation to create smart factories with improved efficiency, flexibility and real-time decision-making, among others. All of these factors affect the processing and refining at the factory and refinery, respectively. They also represent some of the current major challenges that faculty and staff at the Audubon Sugar Institute (ASI) are trying to address. Ensuring the outputs of ASI, i.e., research, extension, training and service, meet these challenges, it was imperative that strategic planning for ASI was continued.

## Audubon Strategic Plan 2023

When I first started as director of ASI in 2018, one of my first tasks had been to undertake a five-year strategic plan with the help of LSU AgCenter administration, key stakeholders and customers which included personnel from the American Sugar Cane League as well as ASI faculty. This 2018-2023 plan was mostly implemented and due to the success of that plan, another strategic plan was undertaken in July, 2023 with a similar strategic plan committee, to (1) update stakeholders and customers on progress in achieving goals set in the previous five years; (2) ensure the outputs of ASI to external stakeholders and customers are met, including short-term gains as well as long-term returns; (3) create an updated road map to spell out where ASI is going over the next year and next two to 10 years; and (4) to focus the energy, resources and time of ASI.

The new 2023 strategic plan has and continues to allow us to address the challenges and opportunities that face the local and international sugar industries and, therefore, be better able to serve these industries. This has made ASI stronger, more flexible, more service-orientated and a viable force for the future.

### *Improved communications*

Communications have continued to improve inside and outside ASI. For all the faculty and staff of ASI, there are weekly and updated Audubon News. For external customers and stakeholders, selected news articles are shared on an ad hoc basis on the ASI Facebook and web pages. The Audubon Factory Corner series in the Louisiana Sugar Bulletin, has continued and consists of bimonthly articles of practical interest to processors. The annual ASI Round Table Conversation event, for factory fabrication superintendents, chief chemists and control system engineers, has become very popular having evolved into a forum for such factory personnel to present and discuss their own trials and operational experiences from the previous grinding season. This event is led by our temporary extension instructor, JoseManuel Henriquez, who has more than 50 years of experience working for multiple sugarcane factories in Central America and the United States. The event, typically held in March, has not only created a strong foundation for continued collaboration and follow-up between ASI and Louisiana factory personnel, but also allowed for a deeper discussion of topics that matter the most to factories and has provided a real-time measure of operational improvement across the industry. As the conversation has continued to evolve, it has remained a practical, peer-driven platform for learning, improvement and shared progress.

### *Upgraded ASI services*

ASI services to our customers and stakeholders were continually upgraded between 2022 and 2024. For example, a Louisiana Board of Regents (LBR) grant was obtained to purchase a new and up-to-date polarimeter and refractometer to allow uninterrupted operations of the annual molasses survey for all 11 Louisiana factories and beyond. As part of a $1 million LBR grant for the Louisiana Institute for Bioproducts and Bioprocessing (LIBBi), we improved the Audubon Analytical Laboratory Services by purchasing an incubator, high performance liquid chromatography system, and X-ray fluorescence (XRF) instrument. The latter instrument has allowed us to introduce a new service to analyze evaporator scale for factories. This, along with strategic planning for the Analytical Laboratory Services, has allowed it to grow steadily with repeat national and international customers. We continue to find new ways of being of service to our stakeholders.



### *Research and Audubon Center of Excellence*

The research publication rate of ASI staff has grown enormously since 2018 with approximately 83 publications between 2022 and 2024 being presented by ASI faculty and staff at relevant science and industry meetings in the United States and worldwide. Some of the research (e.g., clarification filtration aids and insoluble starch measurement) has had an impact in local and international industries. In particular, the Audubon faculty have excelled on the international level evidenced by garnering seven prestigious international awards from the Sugar Industry Technologists, the International Society of Sugar Cane Technologists and the German sugar industry. Excellence is also reflected by ASI staff receiving five national awards in this time period, as well as increased funding by the American Sugar Cane League. From 2022 to 2024, ASI was the only U.S. laboratory actively involved in the International Commission of Uniform Methods of Sugar Analysis (ICUMSA).

Finally, ASI faculty and staff would like to express their grateful appreciation to LSU AgCenter, American Sugar Cane League and the Louisiana sugar industry for their continued support. The continued changes made to ASI in the past three years have now firmly positioned this historical institute as a springboard for even greater successes in the future.

*Gillian Eggleston*
*Director, Audubon Sugar Institute*

## Audubon Sugar Institute
## 2023 - 2033
## STRATEGIC PLAN

### 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. Structure staffing to include a chemical engineer and an instrument/electrical engineer with preference for sugar experience.
2. Create a succession plan for key personnel.
3. Continue and strengthen analytical and diagnostic services.
4. Identify key processes for advanced automation.
5. Facilitate Industry 4.0 consortium.

### 2-10 Year Goals

#### Objectives

1. Hire or train a data analyst.
2. Set priorities based on information collected during Year 1 process.
3. Offer industry-focused consortium meetings.
4. Build advanced skills for factory/refinery employees.
5. Implement succession plan for key personnel.
6. Support professional development of existing employees.
7. Introduce new service for analyzing evaporator scale.
8. Expand marketing of services.
9. Offer formal coursework for undergraduate and graduate students.

## Factory Services from ASI

### Annual Molasses Survey

*By Chardcie Verret and Tyrenee Foster*

- Since 2001, ASI has analyzed weekly final molasses (seven-day composite) samples from all 11 Louisiana factories and provided weekly molasses survey reports to all participants to inform them of their molasses exhaustion performance. On request, weekly analyses of syrups and juices are also provided to some factories.
- Analyses include refractometric Brix, sucrose, glucose and fructose by high-performance liquid chromatography (HPLC), sucrose by polarimetry, and conductivity ash. In 2024, by gaining a Louisiana Board of Regents grant, a new and up-to-date Rudolph Research polarimeter and refractometer was acquired to analyze apparent sucrose by polarimetry.
- Generated data is used to calculate the target purity (TP) and target purity difference (TPD) for each factory. TP is the arbitrary target concentration of sucrose where, regardless of effort, no further sugar can be crystallized. The formula for TP is below (RS = reducing sugars):

$$TP = 33.9\text{-}13.4 \times \text{Log}_{10}\ RS/Ash$$

- The TP is subtracted from the true purity (calculated using HPLC sucrose) to give the TPD, and the TPD is used by the factories to determine how well they are recovering sugar from their massecuite, which is reflected by residual sugar in the molasses. Generally, a lower TPD value indicates greater efficiency and better molasses exhaustion.
- Results of the molasses survey are distributed weekly to each factory. An example 2023 report is shown below.

**Example ASI molasses survey report sent to the factories each week.**

| Factory | Ref. Brix % mol | True Solids % mol | App. Purity % | True Sucrose % mol | Ratio Pol/ Sucrose | True Purity % | Fru F %TS | Glu G % TS | F+G | F/G Ratio | Cond Ash % TS | F+G/Ash | Target Purity TP % | TPD | TSA@ 80 Ref Brix % mol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | 82.4 | 81.3 | 34.3 | 31.4 | 0.90 | 38.7 | 8.0 | 6.3 | 14.3 | 1.26 | 16.2 | 0.88 | 34.6 | 4.1 | 43.5 |
| **B** | 81.8 | 80.5 | 38.5 | 33.9 | 0.93 | 42.2 | 7.2 | 5.8 | 13.0 | 1.25 | 14.4 | 0.91 | 34.5 | 7.7 | 45.2 |
| **C** | 83.2 | 81.9 | 38.0 | 32.6 | 0.97 | 39.8 | 6.0 | 3.4 | 9.4 | 1.80 | 15.6 | 0.60 | 36.8 | 3.0 | 40.4 |
| **D** | 82.9 | 81.7 | 39.5 | 30.7 | 1.07 | 37.6 | 7.0 | 5.7 | 12.8 | 1.23 | 15.3 | 0.84 | 34.9 | 2.6 | 41.2 |
| **E** | 77.5 | 76.4 | 40.7 | 31.4 | 1.00 | 41.2 | 7.4 | 6.5 | 14.0 | 1.14 | 15.0 | 0.93 | 34.3 | 6.8 | 45.2 |
| **F** | 81.3 | 80.3 | 35.0 | 30.7 | 0.93 | 38.2 | 7.6 | 5.9 | 13.5 | 1.29 | 16.4 | 0.82 | 35.0 | 3.2 | 42.4 |
| **G** | 82.8 | 81.8 | 35.7 | 32.3 | 0.91 | 39.6 | 6.9 | 5.1 | 12.1 | 1.35 | 17.3 | 0.70 | 36.0 | 3.6 | 42.4 |
| **H** | 83.7 | 82.5 | 34.8 | 30.1 | 0.97 | 36.4 | 7.8 | 6.0 | 13.8 | 1.30 | 15.6 | 0.88 | 34.6 | 1.8 | 41.1 |
| **I** | 84.2 | 82.8 | 41.3 | 35.1 | 0.99 | 42.4 | 7.3 | 5.7 | 13.0 | 1.28 | 14.4 | 0.90 | 34.5 | 7.9 | 45.3 |
| **J** | 82.7 | 81.5 | 37.3 | 33.0 | 0.93 | 40.5 | 8.7 | 7.5 | 16.2 | 1.16 | 15.1 | 1.08 | 33.5 | 7.0 | 46.4 |
| **K** | 81.5 | 80.2 | 36.9 | 30.7 | 0.98 | 38.4 | 8.1 | 6.2 | 14.3 | 1.31 | 14.5 | 0.98 | 34.0 | 4.3 | 43.0 |
| **Avg.** | **82.2** | **81.0** | **37.5** | **32.0** | **0.96** | **39.5** | **7.5** | **5.8** | **13.3** | **1.31** | **15.4** | **0.87** | **34.8** | **4.7** | **43.3** |
| **Syrup** | **66.9** | | **84.4** | **52.8** | **1.07** | **78.9** | **4.0** | **4.7** | **8.7** | **0.85** | **3.8** | **2.26** | **29.1** | | |

Note: Using formula TP = 33.9 -13.4log[F+G)/Ash]
Note: Fructose, Glucose and Ash calculated on true solids on molasses and Brix on syrups

**Summary of target purity differences (TPDs) for Louisiana factories (2022-2024).**

| Factory | 2022 | 2023 | 2024 |
|---|---|---|---|
| **A** | 7.0 | 3.2 | 7.0 |
| **B** | 6.9 | 3.9 | 5.9 |
| **C** | 8.4 | 2.8 | 5.6 |
| **D** | 5.5 | 3.2 | 5.9 |
| **E** | 7.8 | 3.2 | 6.0 |
| **F** | 6.2 | 2.1 | 5.4 |
| **G** | 5.1 | 2.9 | 6.3 |

| Factory | 2022 | 2023 | 2024 |
|---|---|---|---|
| **H** | 6.5 | 2.9 | 5.8 |
| **I** | 5.8 | 4.5 | 3.1 |
| **J** | 7.7 | 3.3 | 5.5 |
| **K** | 7.4 | 3.7 | 5.1 |
| **Minimum** | **5.1** | **2.1** | **3.1** |
| **Average** | **6.8** | **3.2** | **5.6** |
| **Maximum** | **8.4** | **4.5** | **7.0** |



*Rudolph Research polarimeter and refractometer acquired in 2024.*



*Research associate Tyrenee Foster performing pol analyses for the annual molasses survey.*

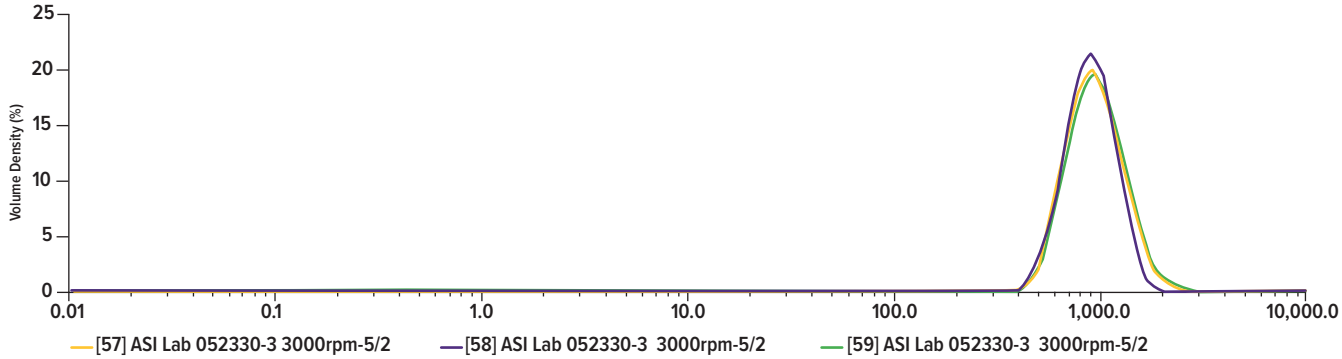
## Particle Size Service

*By Alexa Triplett, Giovanna Aita and Young Hwan Moon*

- ASI offers a particle size measurement service for various types of samples from sugar factories and refineries, on request. Samples are monitored for their particle size distribution using a Malvern Panalytical's Mastersizer 3000 particle size analyzer.
- The Malvern Panalytical's Mastersizer 3000 particle size analyzer is a versatile and compact instrument that uses laser diffraction to measure the particle size and particle size distribution of materials. This takes place by measuring the intensity of light scattered as a laser beam passes through a dispersed particulate sample. The collected data is then analyzed to calculate the size of the particles that created the scattering pattern.
- In the past few years, there has been an emphasis on measuring the particle sizes and distribution of ad hoc samples from Louisiana factories including raw sugars, slurries and C-sugar samples. This service is on request.




*State-of-the-art Malvern Panalytical's Mastersizer 3000 particle size analyzer at the Audubon Sugar Institute.*




| | Record Number | Sample Name | Dx (10) (µm) | Dx (50) (µm) | Dx (90) (µm) |
|---|---|---|---|---|---|
| | 57 | 052330-3 | 640 | 932 | 1,390 |
| | 58 | 052330-3 | 640 | 916 | 1,300 |
| | 59 | 052330-3 | 655 | 955 | 1,400 |
| **Mean** | | | **645.000** | **934.33** | **1,376.7** |
| **1xStd Dev** | | | **8.660** | **19.604** | **70.95** |
| **1xRSD (%)** | | | **1.34** | **2.10** | **5.15** |

*Example raw sugar particle size distribution mean, D50% and coefficient of variation.*

## Enzyme Activity Service

*By Gillian Eggleston*

- Amylase enzymes (both intermediate and high temperature stable amylases) are routinely added in Louisiana sugarcane factories to control starch polysaccharide, which is extracted in sugarcane juice and can cause processing and refining problems. At the same time, dextran polysaccharide is formed when cane microbial deterioration occurs between cutting to crushing and can also form in factory juice areas before juice heating during clarification. Although dextran does not occur every day of processing, when it does it can cause unwanted increases in viscosity, elevated pol readings, elongated sugar crystals, and there is a penalty for high concentrations of dextran in raw sugar. As a consequence, dextranase enzyme is often added when high concentrations of dextran occur in the factory, e.g., after a freeze. It is also now known that fructan (also known as levan) polysaccharide can form on microbial deterioration of sugarcane. Unfortunately, there are no current commercial enzymes that can break down fructan without simultaneously breaking down sucrose.
- Unfortunately, both amylases and dextranases are sold in a range of different units which is confusing to processors and often uneconomical. For this reason, in 2018 the Audubon Sugar Institute offered a new seasonal service to Louisiana factories to measure the activities of up to three commercial amylases and three commercial dextranases for free. Many of the factories have continued to utilize this service.




*Research associate Alexa Triplett performs dextranase activity analysis for a Louisiana sugarcane factory, while Chardcie Verret looks on.*

- ICUMSA GS7-33 (2013) method is used to measure commercial α-amylase activity, and a titration method is used to measure the dextranase activity.
- It was observed that since 2018, the activity of dextranases rose slightly for both non-concentrated (< 25,000 DU/mL) and concentrated dextranases (> 25,000 DU/mL), but there were inconsistent yearly variations especially for nonconcentrated dextranases. The activity of amylases at the low end of the range definitely rose in value from 2018 to 2024, whereas amylases at the higher activity end displayed more variation among the years.

**Range of activities for dextranase and amylase enzymes at Louisiana factories from 2018 to 2024.**

| Year | No. of Factories/Companies | Dextranase Activity (DU/mL) Different Brands | Amylase Activity (KRAU/g) Different Brands |
|---|---|---|---|
| 2018 | 4 | 2,500 to 69,800 | 21 to 215 |
| 2019 | 7 | 1,000 to 62,000 | 14 to 207 |
| 2020 | 6 | 3,000 to 76,900 | 46 to 258 |
| 2021 | 3 | 7,400 to 67,300 | 69 to 238 |
| 2022 | 5 | 1,250 to 92,700 | 47 to 157 |
| 2023 | 5 | 744 to 84,490 | 79 to 392 |
| 2024 | 5 | 4,750 to 88,600 | 91 to 224 |

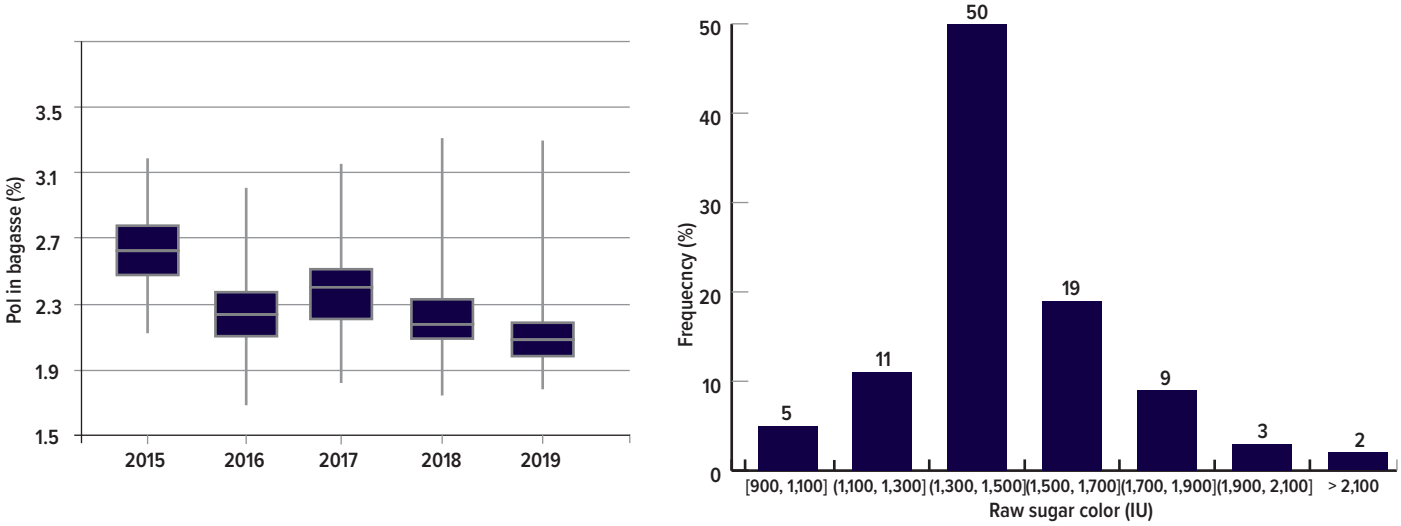
## Service to Analyze Factory Processing Data

*By Stephania Imbachi Ordonez*

- Factory laboratories and operating personnel routinely measure key variables across the process (juice quality, clarification performance, filterability, syrup Brix, massecuites, raw sugar quality and related operating conditions). While these measurements are essential for daily control, the full value of the data is often not captured when results are reviewed only as simple averages or limited trend charts. Variability, outliers and season-to-season shifts and trends can be missed, even though they often explain operational issues and performance changes.
- To support data-driven decision-making, Audubon Sugar Institute continues to offer a factory data analysis service. The goal of this service is to provide clear, practical summaries that help factories evaluate process behavior, identify improvement opportunities and document the impact of operational changes.

- Service deliverables may include:
  - Data organization, quality checks and consistent reporting basis across time periods
  - Visual summaries such as box plots, histograms/frequency charts and time trends
  - Target-range performance metrics (for example, percent of syrup Brix within target)
  - Comparisons across seasons and, when relevant, across units or operating conditions
  - A concise written report with key observations and recommended follow-up checks
- This service is available upon request for individual factories and can be structured as an end-of-season review or as periodic in-season updates. All factory data are treated as confidential.

**(Left) Boxplot of pol in bagasse by season (2015-2019) and (right) frequency diagrams to illustrate the distribution of raw sugar color in Louisiana.**




## New XRF (X-ray Fluorescence) Analysis Service

*By Stephania Imbachi Ordonez*

- The Audubon Sugar Institute is now offering X-ray fluorescence (XRF) analysis to measure the elemental composition of both liquid and solid materials. This service quantifies elements such as calcium, silicon, iron, magnesium, phosphorus, potassium and others, and can support a range of factory applications.
- Common uses include:
  - Evaporator scale (incrustation) analysis to support selection of the most effective cleaning chemical and cleaning program for the evaporator station
  - Quality control of clarification and filtration aids to evaluate variability among batches and suppliers
  - Analysis of molasses to evaluate the concentration of inorganic melassigenic components
  - Additional troubleshooting or characterization needs involving inorganic/elemental content
- For incrustation (scale) samples, collection is recommended at the end of the processing season, ideally before the cleaning step, although samples collected after cleaning can also be analyzed. A minimum of 50 grams per sample is required.




*Rigaku X-ray fluorescence (XRF) instrument at the Audubon Sugar Institute, purchased by a Louisiana Board of Regents grant.*

## Other Services

*By Harold Birkett and Jeanie Stein*

- On request, factory equipment sizing and expansion is provided to Louisiana factories, including tandem mill tests, boiler compliance and efficiency tests, and material and energy balances. These are further discussed in the Research and Development section of this report.

## Analytical Laboratory Services

*By Chardcie Verret*

- The Audubon Analytical Laboratory Services (ALS) was established in 2018 to serve stakeholders and customers better, improve the incoming revenue to the Audubon Sugar Institute (ASI) and realize the commercial impact of research conducted at ASI and by Audubon scientists and collaborators. An example of the realization of commercial impact is the use of a newly developed method to uniquely measure insoluble, soluble and total starch in sugarcane factory and refinery products. Additionally, the ALS has strengthened the extension and service goals of ASI.
- The ALS offers conventional and specialized analytical services for the sugar industry and related industries, including foods and beverages, feeds, biofuels and agricultural commodities.
- Since 2018, the ALS has grown steadily with repeated local, national and international customers. It has been headed by Chardcie Verret, who also leads the ASI Central Laboratory. Two full-time research associates make up the ALS, and for certain methods other research associates at ASI are utilized.
- When a request is made for services, a quotation is created and sent to customers for their approval. Upon approval of the quotation, results are guaranteed 20 business days after receipt of the samples. Sometimes, free interpretation of results is provided by scientists at ASI.
- New methods are continually being added to the roster of analysis offered by ALS
- In 2024, an internal, small strategic plan for the ASI Analytical Laboratory Services was conducted to: (1) increase the revenue and profits, (2) focus the limited energy, resources and time of ALS, and (3) create a road map to address where ALS is going the next year, as well as the next two to five years.
- The 2024-2029 Strategic Plan of ALS has already made improvements to marketing strategies, and an interactive website was created for easy use by customers, which can be accessed at

www.lsuagcenter.com/portals/our_offices/departments/audubon-sugar-institute/analytical-laboratory-services

### Audubon Sugar Institute Analytical Laboratory Services 2024 - 2029 STRATEGIC PLAN

#### 1 Year Goals

**Objectives**

1. Improve financial transactions.
2. Create an interactive website.
3. Undertake a new marketing campaign with new advertising materials.
4. Improve internal and external communications including exploring various software.
5. Continue current methods and strengthen them, and adjust expectations of result turnaround times to within 20 business days.

#### 2-5 Year Goals

**Objectives**

1. Create new targeted advertising materials for local, state, national and international industries.
2. Create ASI Analytical Laboratory Services social media accounts and manage the accounts to increase visibility.
3. Improve presence across LSU AgCenter and LSU websites.
4. Train staff on software, communications, business acumen, customer service, methodologies and new technologies.
5. Increase access to other academic laboratories.
6. Upgrade and enhance current instrumentation, technologies and sample storage.
7. Be active in the International Commission for Uniform Methods of Sugar Analysis (ICUMSA) and other relevant organizations.

## How a Clarification Aid Can Affect the Polarimetric Analysis of Sugarcane Juices

*By Stephania Imbachi Ordonez and Maria del Carmen Perez*

- The use of clarification/filter aids for polarimetry measurements of cane products across the factory is still an acute technical problem in many countries due to the toxicity and environmental concerns of lead acetate, the availability of other nonlead aids and concerns with any metal salts advocated as lead acetate substitutes. Additionally, in various regions including Louisiana, some factory personnel had noted batch-to-batch issues with some clarification aids.
- A systematic study was undertaken comparing various amounts of two commercial clarification aids (Octapol and Clearpol) and diatomaceous earth (DE) on the filtration of Louisiana factory juices through coarse filter paper (27 µm pore size) for their effect on pol at 589 nm accuracy, precision and how they compare to high-performance liquid chromatography (HPLC) true sucrose values.




*Visual differences in Octapol and Clearpol filter aids.*

### Physical and Chemical Differences of Bulk Clarification Aids as Well as Batch-to-Batch Differences (Average Results Shown).

| Characteristic | Bulk Octapol Batch 1 | Bulk Octapol Batch 2 | Bulk Octapol Batch 3 | Bulk Octapol Batch 4 | Mean | CV % |
|---|---|---|---|---|---|---|
| **Bulk Density g/cm³** | 0.609 | 0.618 | 0.627 | 0.675 | **0.632 a[f]** | **4.7** |
| **Moisture %** | 6.4 | 10.6 | 7.0 | 8.4 | **8.1 a** | **23.0** |
| **Calcium %** | 6.97 | 9.22 | 6.18 | 2.51 | **6.2 a** | **44.8** |
| **Magnesium %** | 0.14 | 0.78 | 0.01 | 0.01 | **0.24 a** | **156.8** |
| **Potassium %** | 0.03 | 0.20 | 0.24 | 0.13 | **0.15 a** | **61.3** |
| **Sodium %** | 0.14 | 0.14 | 0.16 | 0.08 | **0.13 b** | **26.7** |
| **Aluminum %** | 13.25 | 10.02 | 10.64 | 14.47 | **12.10 a** | **17.5** |
| **Sulfur %** | 0.02 | 0.04 | 0.01 | 0.03 | **0.03 a** | **51.6** |
| **Iron%** | 0.032 | 0.078 | 0.024 | 0.021 | **0.039 a[∞]** | **68.6** |
| **Boron %** | 0.0032 | 0.0027 | 0.0026 | 0.0037 | **0.003 a** | **16.6** |
| **Manganese %** | 0.0016 | 0.001 | 0.0002 | 0.0001 | **0.0001 b** | **17.8** |
| **Total Soluble Salts %** | **12.23** | **19.67** | **20.72** | **17.79** | **17.60 a** | **21.5** |
| **$CaCO_3$ Equivalent %** | 2.55 | 1.95 | <0.5 | nd[c] | **1.67 a** | **63.2** |

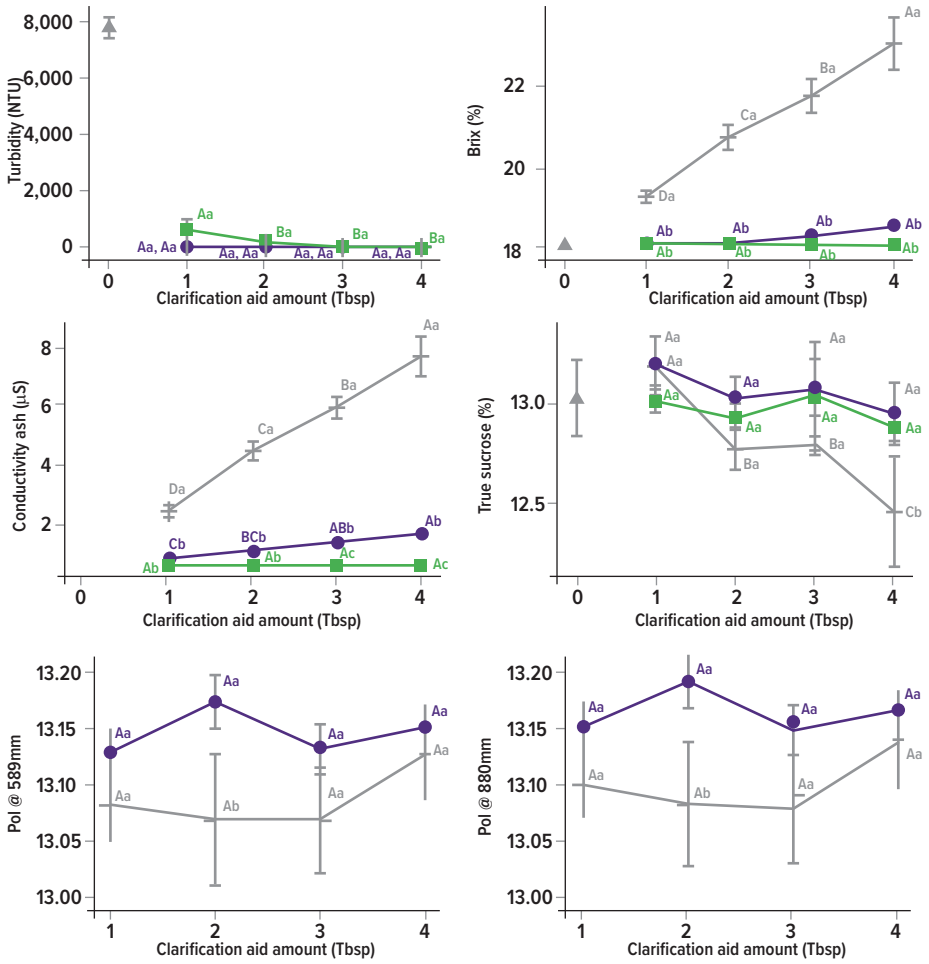
| Characteristic | Bulk Clearpol Batch 1 | Bulk Clearpol Batch 2 | Bulk Clearpol Batch 3 | Mean | CV % |
|---|---|---|---|---|---|
| **Bulk Density g/cm³** | 0.440 | 0.440 | 0.443 | **0.441 b** | **0.4** |
| **Moisture %** | 6.8 | 7.4 | 7.0 | **7.1 a** | **4.3** |
| **Calcium %** | 2.56 | 2.63 | 0.67 | **1.95 a** | **56.9** |
| **Magnesium %** | 0.16 | 0.14 | 0.14 | **0.15 a** | **7.9** |
| **Potassium %** | 0.11 | 0.10 | 0.13 | **0.11 a** | **13.5** |
| **Sodium %** | 0.27 | 0.22 | 0.27 | **0.25 a** | **11.4** |
| **Aluminum %** | 7.65 | 5.77 | 7.35 | **6.92 b** | **14.6** |
| **Sulfur %** | 0.03 | 0.02 | 0.02 | **0.02 a** | **24.7** |
| **Iron %** | 0.088 | 0.078 | 0.184 | **0.117 a** | **50.2** |
| **Boron %** | 0.0022 | 0.0027 | 0.0025 | **0.0025 a** | **10.2** |
| **Manganese %** | 0.012 | 0.0098 | 0.0164 | **0.013 a** | **26.4** |
| **Total Soluble Salts %** | 5.45 | 5.51 | 4.88 | **5.28 b[§]** | **6.6** |
| **$CaCO_3$ Equivalent %** | 0 | 0.77 | <0.5 | **0.42 a** | **92.3** |

*At the time of publication, only three commercial batches of Clearpol were available for analyses.
[f]Means followed by the same lowercase letter are not significantly different between the two aids at the 5% probability level.
[c]nd=not determined
[∞]Significant at the 6% probability level
[§]Significant at the 0.3% probability level

- Octapol had a significantly ($P < 0.05$) higher density (0.615 g/cm³) than Clearpol (0.440 g/cm³); thus for the same volume, slightly less weight of Clearpol is added. The amounts of total salts (av. 17.60%) in Octapol were higher ($P < 0.05$) than in Clearpol (av. 5.28%) with a much greater batch-to-batch variability.
- As the amount of Octapol and Clearpol increased, the Brix of the filtrate juice also increased and at the same time there was a decrease in pol and sucrose values, and this was especially the case for Octapol. This surprising Brix increase was due to soluble mineral salts from the clarification aids dissolving in the filtrate, particularly calcium, magnesium, potassium and sodium salts in Octapol. The dissolved mineral salts may have diluted the sucrose concentration, precipitated out some sucrose, and/

or changed the specific rotation of the pol sucrose complex formation, and studies are ongoing. In contrast to Octapol and Clearpol, the addition of DE did not affect the characteristics of the filtrate, which proved that DE remains inert; however, it did not remove sufficient turbid particles to allow for the measurement of pol.

- Overall, this study highlighted the importance of standardizing clarification aids for pol measurement and the need for batches or lots of such aids to be monitored for critical components that can affect the pol readings, e.g., total salts. A greater risk is being taken when using aids that contain relatively high amounts of salts (> ~6%) because results are more susceptible to inaccuracy when excessively dosed.

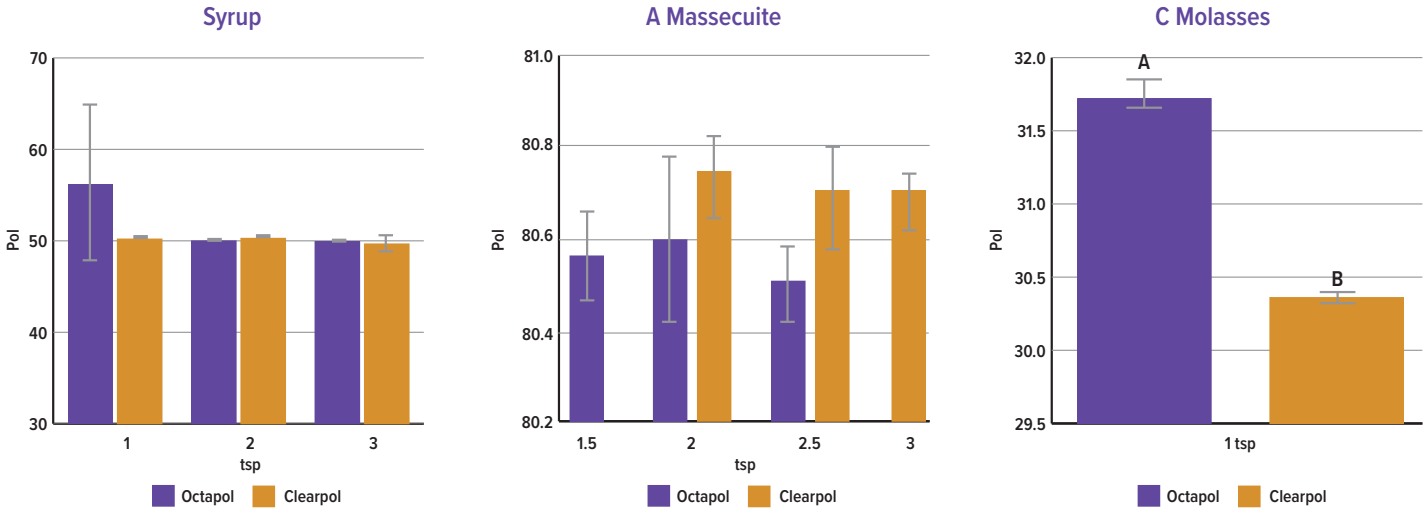



*Composition of the unfiltered press juice and filtrates after various amounts of clarification aids were added. Different letters indicate statistical difference (P value < 0.05): uppercase letters compare tablespoons for the same aid and lowercase letters compare the two aids at the same tablespoons.*

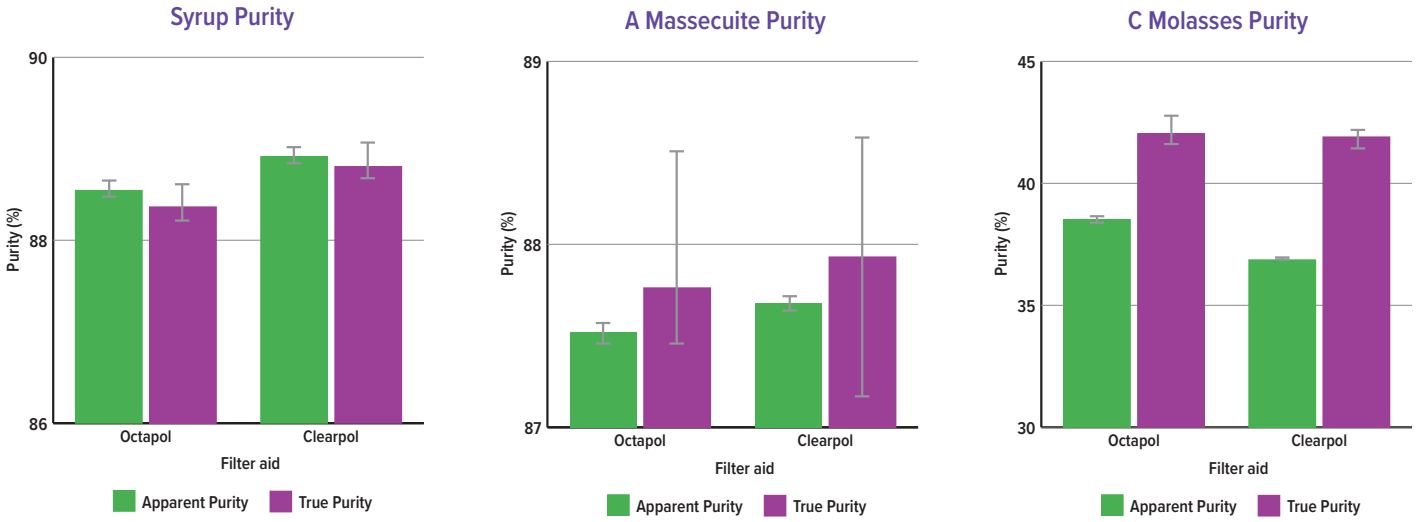
## Differences in Commercial Filter Aids Used to Measure Pol in Intermediate Factory Products

*By Maria del Carmen Perez and Stephana Imbachi Ordonez*

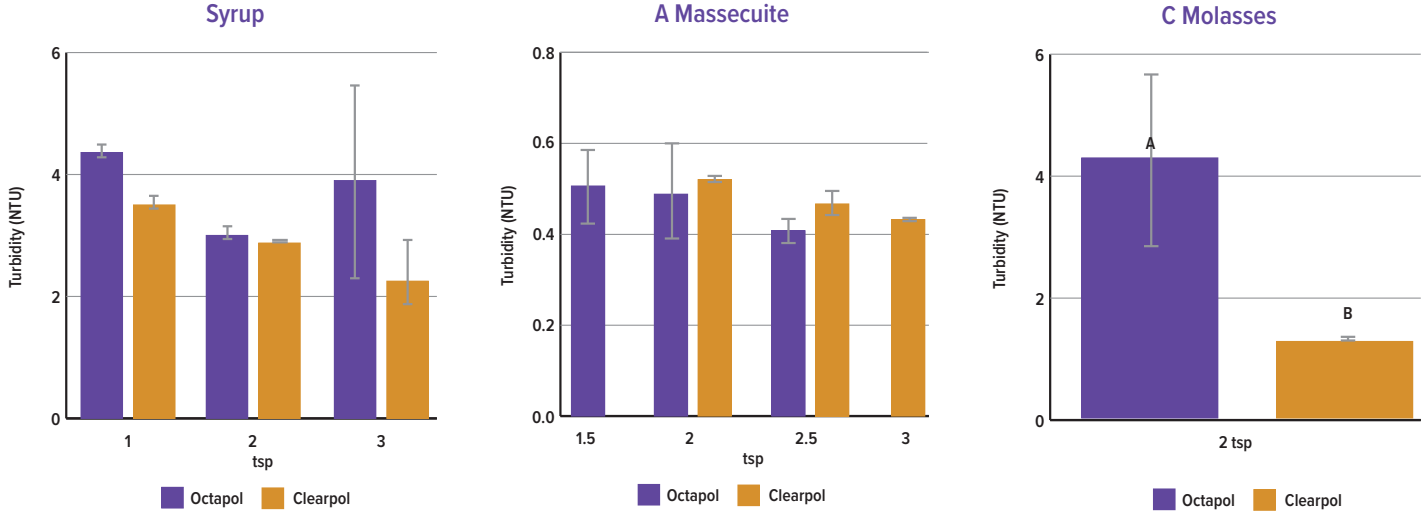
- Previous ASI studies showed that increasing amounts of clarification aids, particularly Octapol, can significantly affect pol and Brix readings in juice. This study was conducted to determine whether similar effects occur in other factory materials such as syrup, molasses and massecuites.
- Factory samples (syrup, molasses, massecuites) were collected at the end of the 2020 and during the 2021 processing season, diluted per factory procedures, and filtered using varying amounts of Octapol and Clearpol. Filtrates were analyzed for pol, Brix, turbidity and HPLC. Experiments were run in duplicate, and results compared statistically using paired t-tests.
- Results showed that increasing amounts of clarification aids had only a slight effect on pol and HPLC sucrose in factory materials. However, Clearpol tended to produce higher apparent and true purities than Octapol.
- Increasing Octapol consistently raised the Brix and turbidity values when compared to Clearpol ($p < 0.05$). This effect is linked to soluble salts in Octapol dissolving into the filtrate, while Clearpol showed greater stability and produced less turbid filtrates. Higher turbidity values can reduce pol accuracy, especially in C molasses.
- These results have provided important information to sugar technologists about the varying performance of commercial filter/clarification aids when measuring pol in factory products.




*Effect of increased amounts of clarification/filter aids on the pol value of different intermediate products.*




*Effect of filter aids on apparent and true purities of syrup, A massecuite, and C molasses. Both apparent and true purities were calculated from the original material Brix.*

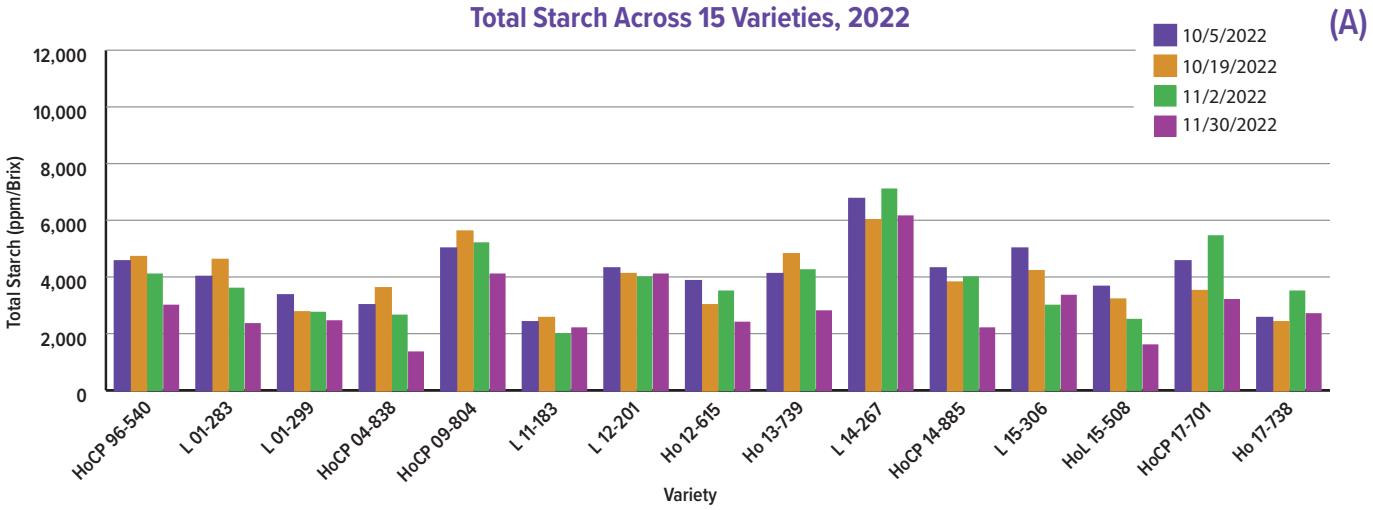


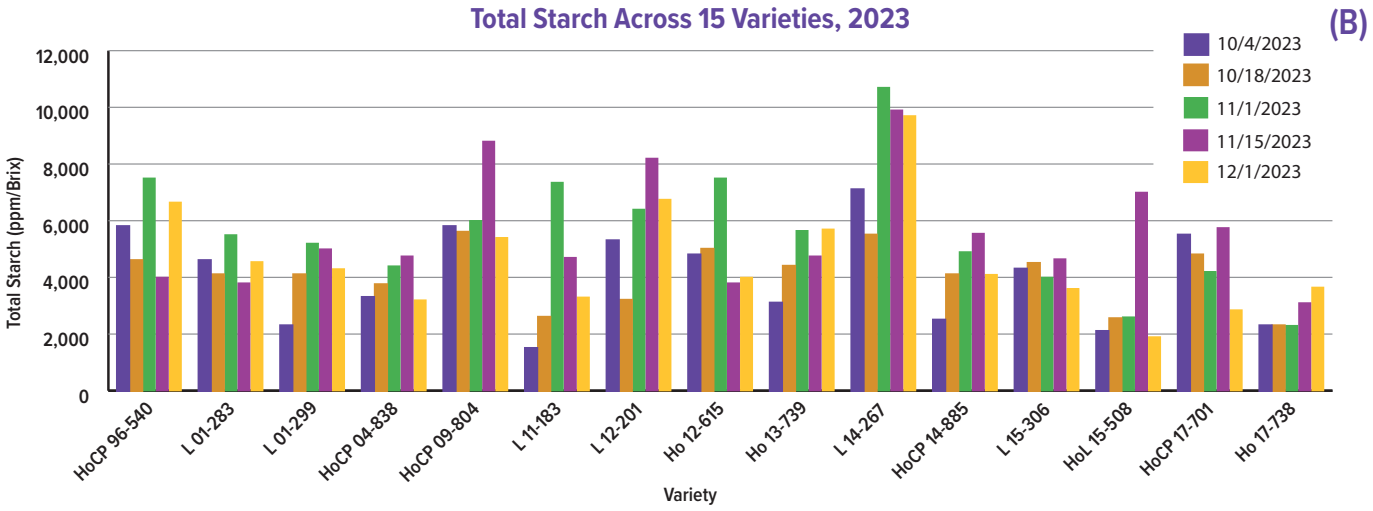

*Effect of increased amounts of filter aids on the filtrate turbidity of different intermediate products.*

## Drought Causes Starch to Increase in Field Sugarcane

*By Gillian Eggleston*

- Sugarcane starch is an impurity which detrimentally affects the manufacture of raw sugar and its subsequent refining. Starch concentrations in field sugarcane have steadily increased over the past two decades in Louisiana and other regions for various reasons. Little was known about how abiotic environmental conditions affect starch concentrations in sugarcane.
- A large two-year field study was conducted in 2022 and 2023 at the LSU AgCenter Sugar Research Station in St. Gabriel, Louisiana. Drought conditions occurred in 2023 with an average rainfall of 61 cm which was much lower than the 164 cm that occurred for the normal 2022 year. Field cane of 15 commercial and precommercial Louisiana varieties was treated with glyphosate ripener (365.4 mL/ha) and harvested four, six, eight, 10 and 12 weeks after treatment. The cane was harvested and stripped of leaves, and the stalks shredded then analyzed with near-infrared spectroscopy for sucrose, moisture, purity, Brix and fiber. Extracted juice was analyzed for total starch content using a microwave-assisted sonication method.
- It was found that although the 2023 drought caused an average decrease of 1.5% moisture for all cane varieties, there was an average increase of 7.8% in sucrose content and 8.4% for theoretical recoverable sugar. In dramatic contrast, the drought caused a marked increase in total starch concentration of 28.5% for all varieties.
- This research has given sugar technologists around the world important information that the maturity profile of the sugarcane played a strong role in the variety's response to the drought stress, with early maturing varieties being more susceptible to the drought than mid-maturing varieties.




*Starch concentrations of 15 sugarcane varieties in (A) 2022 and (B) the 2023 seasons. Percent change from 2022 to 2023 for varieties HoCP 96-540, L 01-283, L 01-299, HoCP 04-838, HoCP 09-804, L 11-183, L 12-201, Ho12-615, Ho 13739, L 14-267, HoCP 14-885, L 15-306, HoL 15-508, HoCP 17-701 and Ho 17-738 were 37.0%, 23.7%, 41.8%, 43.3%, 24.7%, 68.1%, 43.6%, 54.9%, 15.9%, 16.0%, 7.0%, 16.4%, 8.2% and +4.5%, respectively. The overall average (over sampling times and all 15 varieties) increase in starch from 2022 to 2023 for all varieties was 28.5%.*

## Insoluble Form of Starch Contributes to Lower Sugar Exhaustion from Cane Molasses

*By Gillian Eggleston*

- The greatest loss of sucrose in a raw sugar factory is in the final molasses. A two-year (2020 and 2021) study of weekly final molasses from three Louisiana sugarcane factories revealed new information on the effect of starch on molasses exhaustion. During the 2021 season, Louisiana factories experienced markedly higher target purity differences (a lower TPD indicates greater recovery of sugar), and thus lower exhaustion compared to the 2020 normal season. Differences in molasses exhaustion among the factories could not all be explained by conventional reducing sugar/ash ratios, particularly in 2021.
- With the advent of new methods for the sugar industry, developed by Audubon scientists, to measure the amounts of soluble and insoluble starch as well as total starch, these three forms of starch were analyzed in all the samples.
- For the first time, the starch form was shown to impact molasses exhaustion. The greater the amount of insoluble starch in the molasses the higher the TPD value (R2=0.886). This is most likely because the insoluble swollen starch increases the viscosity of the molasses which, in turn, impedes sucrose exhaustion.
- The factory that added high-temperature (HT) stable amylase to the clarification settling tank consistently had the lowest TPD values in both years. The risk of carry-over amylase activity in raw sugar, however, increases with the addition of HT amylase, but this problem could be solved at the refinery with the use of activated carbon. This study is ongoing.

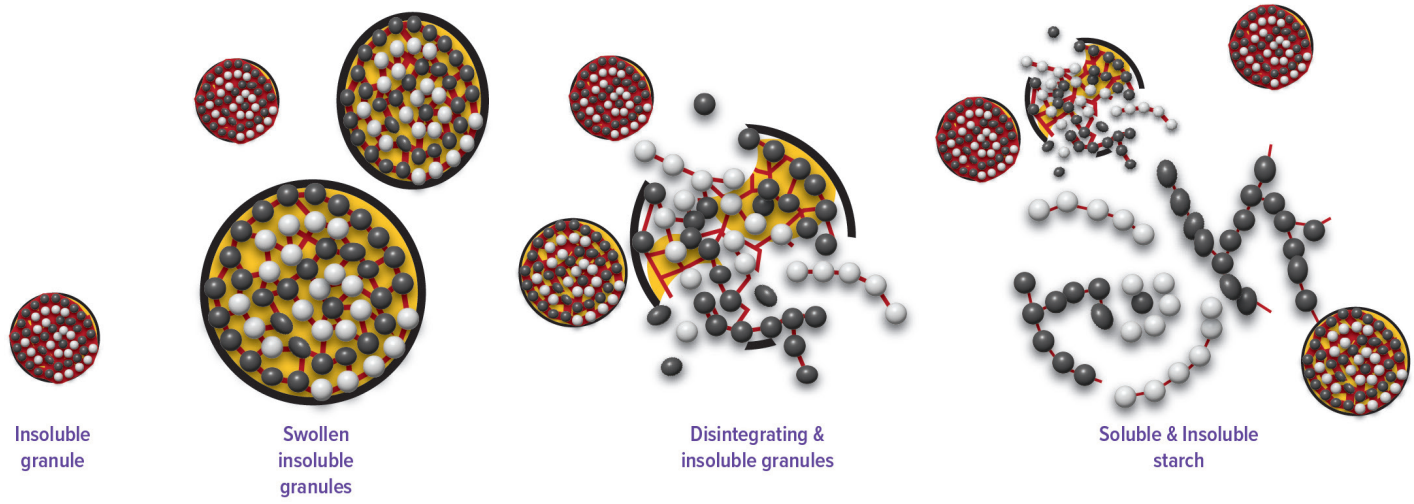
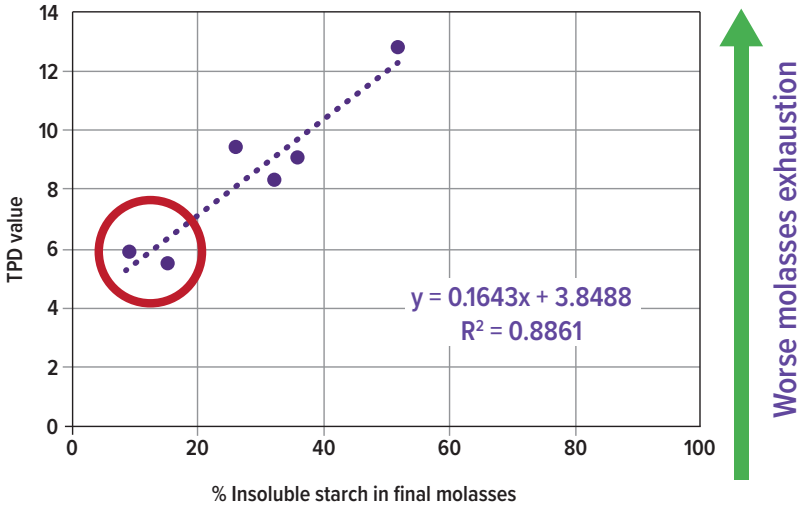



*Illustration of how sugarcane starch behaves in the factory after being extracted as granules (1 to 5 µm) during extraction by roller milling.*




*Effect of percent insoluble starch on the mean TPD values for three Louisiana factories for both 2020 and 2021 processing seasons. The data inside the circle is from Factory I.*

## Statistical data of total, soluble and insoluble starch concentrations in final molasses from three Louisiana sugarcane factories across the 2020 and 2021 seasons, as well as the percentage of each starch form.

| Factory | Season Statistical Parameter | Concentration (ppm/Brix) Total Starch | Concentration (ppm/Brix) Soluble Starch | Concentration (ppm/Brix) Insoluble Starch | Soluble Starch % | Insoluble Starch % | Soluble: Insoluble Starch Ratio |
|---|---|---|---|---|---|---|---|
| **E** | **Mean ± SD** | 2,952bB[§] ± 961 | 2,273aA ± 1,035 | 740aB ± 674 | 74 ± 19 | 26 ± 19 | **2.85** |
| **E** | **CV %** | 33 | 46 | 91 | 26 | 73 | |
| **E** | **Median** | 2,932 | 2,065 | 578 | 73 | 27 | **2.70** |
| **E** | **Maximum** | 4,418 | 4,268 | 2,036 | 98 | 53 | |
| **E** | **Minimum** | 1,281 | 921 | 53 | 47 | 2 | |
| **H** | **Mean ± SD** | 2,762bB ± 702 | 2,086aB ± 841 | 863aB ± 413 | 68 ± 14 | 32 ± 14 | **2.13** |
| **H** | **CV %** | 25 | 40 | 48 | 21 | 44 | |
| **H** | **Median** | 2,581 | 1,953 | 680 | 64 | 36 | **1.78** |
| **H** | **Maximum** | 4,099 | 4,099 | 1,625 | 90 | 49 | |
| **H** | **Minimum** | 1,894 | 1,214 | 349 | 51 | 10 | |
| **I** | **Mean ± SD** | 4,130aA ± 1,524 | 3,514aA ± 1,417 | 616aA ± 570 | 85 ± 15 | 15 ± 15 | **5.67** |
| **I** | **CV %** | 37 | 40 | 93 | 17 | 96 | |
| **I** | **Median** | 4,467 | 3,386 | 368 | 89 | 11 | **8.09** |
| **I** | **Maximum** | 6,538 | 5,635 | 2,041 | 99 | 55 | |
| **I** | **Minimum** | 1,861 | 1,088 | 32 | 45 | 2 | |
| **E** | **Mean ± SD** | 5,343aA ± 796 | 2,534bA ± 963 | 2,808aA ± 1,173 | 48 ± 19 | 52 ± 19 | **0.92** |
| **E** | **CV %** | 15 | 38 | 42 | 40 | 37 | |
| **E** | **Median** | 5,342 | 2,342 | 3,141 | 39 | 61 | **0.64** |
| **E** | **Maximum** | 6,442 | 5,105 | 4,392 | 85 | 74 | |
| **E** | **Minimum** | 3,697 | 1,213 | 792 | 26 | 15 | |
| **H** | **Mean ± SD** | 5,326aA ± 1,693 | 4,056aA ± 1,923 | 1,905bA ± 1,145 | 64 ± 22 | 36 ± 22 | **1.78** |
| **H** | **CV %** | 32 | 47 | 60 | 34 | 61 | |
| **H** | **Median** | 5,445 | 3,009 | 1,793 | 54 | 46 | **1.17** |
| **H** | **Maximum** | 7,746 | 7,045 | 3,672 | 95 | 60 | |
| **H** | **Minimum** | 2,407 | 1,519 | 361 | 40 | 5 | |
| **I** | **Mean ± SD** | 3,824bA ± 1,750 | 3,526aA ± 1,614 | 353cB ± 222 | 91 ± 6 | 9 ± 6 | **10.11** |
| **I** | **CV %** | 46 | 46 | 63 | 6 | 62 | |
| **I** | **Median** | 3,109 | 2,992 | 302 | 93 | 7 | **13.29** |
| **I** | **Maximum** | 8,466 | 7,887 | 748 | 96 | 25 | |
| **I** | **Minimum** | 2,109 | 2,011 | 98 | 75 | 4 | |

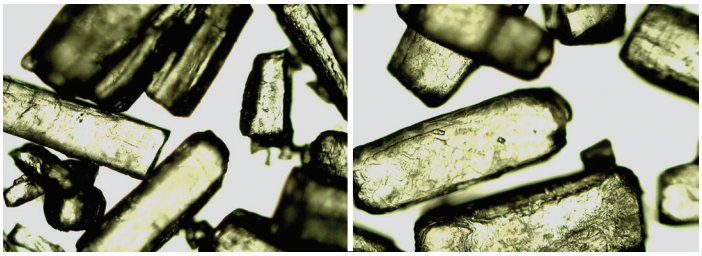
White = 2020.

Purple = 2021.

## Fructans Causing Severe Elongation of Raw Sugar Crystals

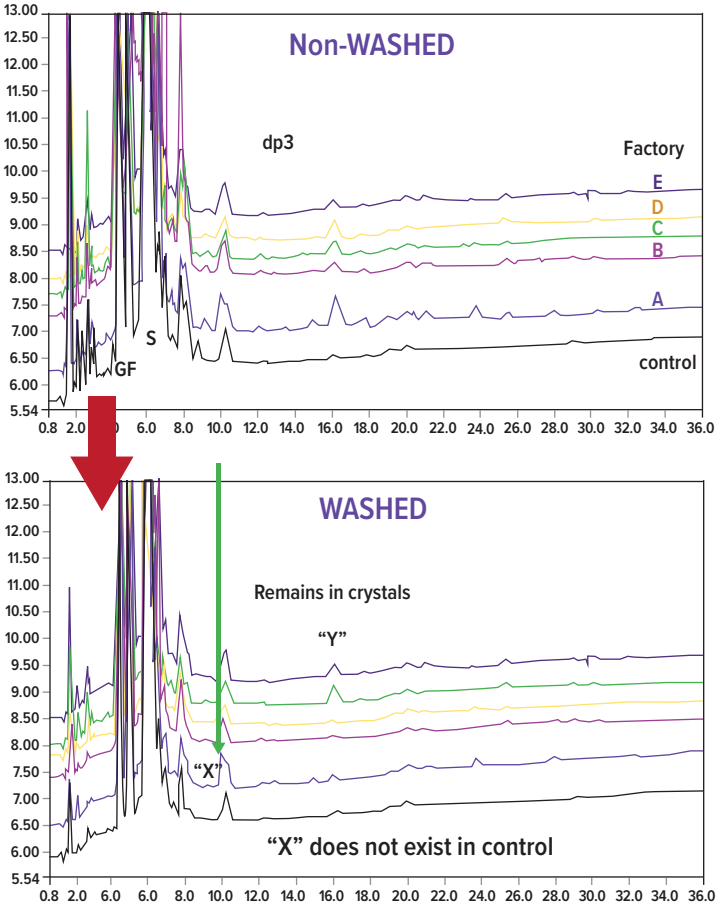
*By Stephania Imbachi Ordonez*

- Crystal elongation is unwanted since it reduces crystallization rates and leads to higher molasses production with higher purities, centrifugation problems and higher sucrose losses. It has previously been reported that some polysaccharides, e.g., dextran, and shorter chain oligosaccharides, e.g., kestoses, can cause elongation. Since sugarcane processing seasons in Louisiana have been lengthened in recent years because of increased sugarcane tonnage, sugarcane has been crushed both earlier and later in the season. In the early 2022 season, many of the Louisiana cane factories had unusual crystal elongation even though the contents of Haze dextran were not high and dextranase did not alleviate the problem. Additionally, the weather was dry and relatively warm.
- Crystal elongation was very severe (up to 7.9-fold elongation) and associated with microbial deterioration indicated by lower fructose/glucose ratios and much higher-than-normal fructan (short and/or long chains of fructose) contents in molasses, plus low juice pH.



*Crystal elongation digital photographs from Louisiana factories in the early sugarcane processing season in 2022. Elongation factors ranged from 1.8 to 7.9 fold.*

- Raw sugar crystals are normally surrounded by a molasses layer but whatever component(s) that were causing the elongation had to be inside the crystal, therefore, the crystals were washed. Negligible dextran was found in the washed crystals which confirmed that dextran was not responsible for the elongation. On the other hand, 73%-92% of fructans concentrations remained in the washed elongated crystals compared to the control (no elongation) which only contained 51% fructan. Moreover, there were significant correlations between the elongation factor and the fructans content of unwashed and washed raw sugar crystal samples with an R2 of 78.8% and 64.9%.
- A few oligosaccharides (trisaccharides) were found in elongated crystals that were strongly related to the elongation and fructan values of the crystal, and one was tentatively identified as levan triose. Further research is ongoing to identify and confirm if they cause elongation, and if other molecules also contribute.




*Ion chromatograms of unwashed and washed crystals. DP3 = three degrees of polymerization (trisaccharide). S = sucrose, G = glucose, and F = fructose. Peak "Y" has tentatively been identified as levan triose.*

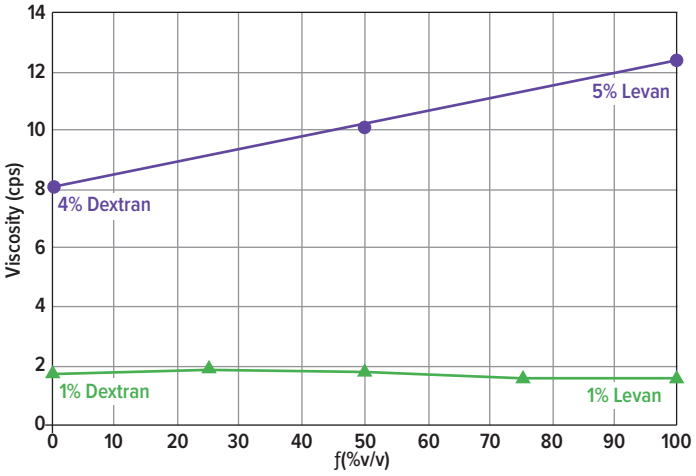
### The fructan and dextran contents of washed and non-washed raw sugar crystals.

| Factory | Non-Washed Raw Sugar Av. Fructan (ppm/Brix) | Washed Raw Sugar Av. Fructan (ppm/Brix) | % Fructan in crystals (%) Av. Fructan (ppm/Brix) | Non-Washed Raw Sugar Av. Dextran (ppm/Brix) | Washed Raw Sugar Av. Dextran (ppm/Brix) | % Dextran in crystals (%) Av. Dextran (ppm/Brix) |
|---|---|---|---|---|---|---|
| **Control** | 1,596 | 808 | 50.6 | 0 | 0 | - |
| **A** | 1,455 | 1,269 | 87.2 | 0 | 0 | - |
| **B** | 1,448 | 1,325 | 91.5 | 6.5 | 6 | 92.3 |
| **C** | 1,891 | 1,685 | 89.1 | 0 | 0 | - |
| **D** | 1,603 | 1,189 | 74.2 | 0 | 0 | - |
| **E** | 1,793 | 1,303 | 72.7 | 22.1 | 7.5 | 33.9 |

## Preliminary Study on Viscosity Enhancing Interactions Between Major Sugarcane Polysaccharides

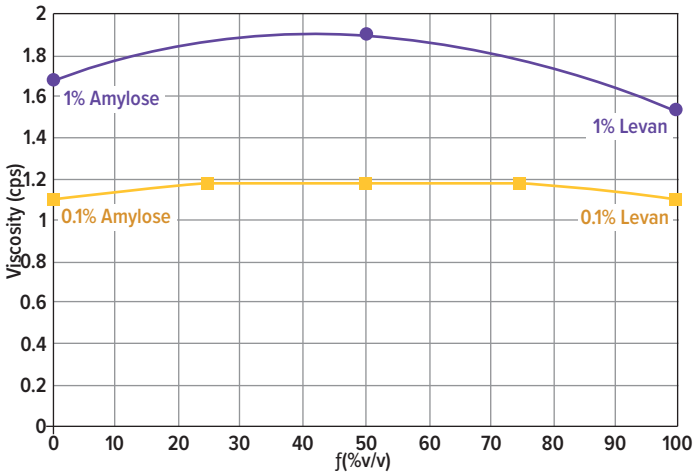
*By Gillian Eggleston*

- For decades dextran and starch polysaccharides have been considered the major polysaccharides in sugarcane processing but in recent years, scientists from the Audubon Sugar Institute have shown that fructans have been greatly underestimated, particularly those formed from microbial deterioration of sugarcane (levans). A great technical concern for the factory is the effect of polysaccharides on the viscosity of sugar streams and the associated detrimental effect on the exhaustion of sucrose from molasses.
- It is well known that certain polysaccharides can interact strongly to give synergistic increases in viscosity. Furthermore, levan is known to have strong cohesive strength and be "sticky." Therefore, interactions were investigated between starch (specifically amylose and amylopectin), dextran and levan polysaccharides, which could be involved in high C-massecuite viscosities,
- Solutions of bacterial levan were mixed in various ratios with a solution of either dextran (high molecular weight HMW) or amylose or amylopectin at approximately the same viscosity. In the absence of any interaction between the two polysaccharides, the viscosity would be expected to remain close to the common value for the individual starting solutions and vice versa. At 1% starting concentrations of levan and dextran there was a slight but significant ($P < 0.05$) increase in viscosity of the 75% levan:25% dextran mixture, suggesting when enough levan is present there may be some interaction. At much higher starting concentrations of levan (5%) and dextran (4%) there was no interaction but no suppression of viscosity either.




*Viscosity changes (25 C; 12 rpm) in mixed solutions of levan and dextran (HMW weight); ʃ denotes the proportion of dextran solution in each mixed system with ʃ=0 and ʃ=100% (v/v) corresponding to the starting solutions of levan and HMW dextran. Viscosity was measured using a Brookfield rotational viscometer.*

- When various starter concentrations of levan and amylose were mixed there was consistently a repeated increase in viscosity, suggesting levan interacts with amylose to elevate the viscosity. Moreover, this occurred even at a low concentrations (0.1% equivalent to 1,000 mg/kg which is found in downstream cane products at the factory). In strong contrast, dextran suppressed amylose viscosity. Amylose and amylopectin only slightly interacted when the amylopectin was greater than the amylose concentration.
- These initial results suggest polysaccharide interactions are occurring in sugarcane molasses and further understanding of such interactions will underpin technical solutions to weakening them in the industrial setting.

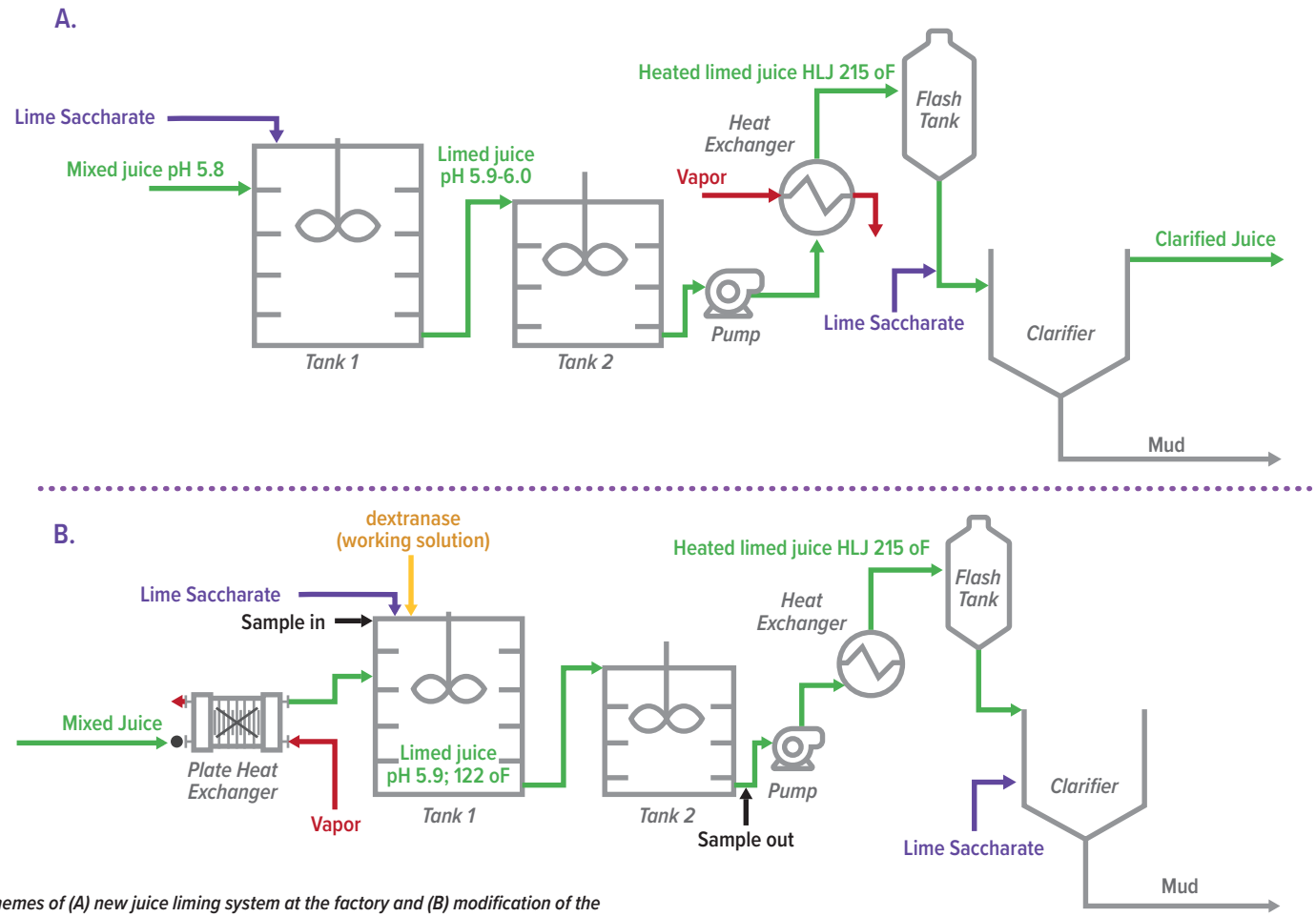



*Viscosity changes (25 C; 12 rpm) in mixed solutions of levan and amylose; ʃ denotes the proportion of amylose solution in each mixed system with ʃ=0 and ʃ=100% (v/v) corresponding to the starting solutions of levan and amylose.*

## Optimized Dextranase Application to Continue Processing Sugarcane After a Severe Freeze

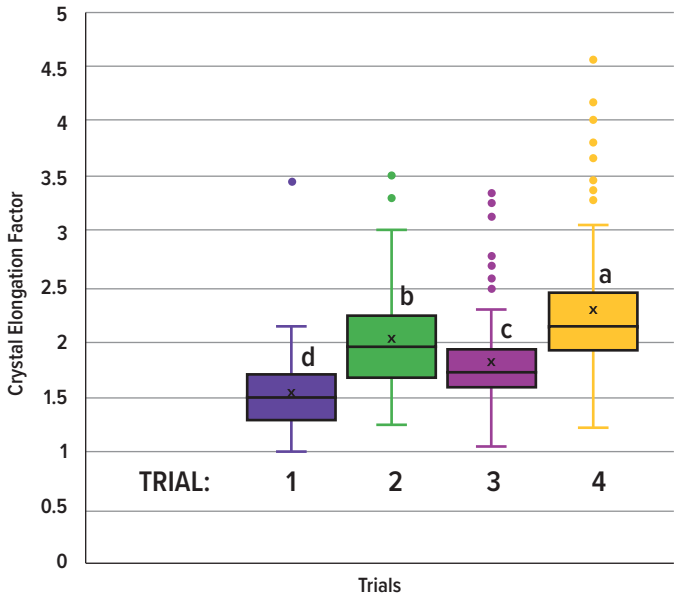
*By Gillian Eggleston*

- A Louisiana statewide severe freeze occurred Dec. 23-26, 2022, which was followed by warm weather and occasional fog causing severe deterioration of all sugarcane varieties in the fields. Dextranase was applied to break down dextran (glucose polysaccharide) into smaller, more manageable molecules to improve processing.
- Heating juice to a temperature of 50 C and preliming to pH 5.9 is optimal for dextranase application, but after 50 C the activity falls off quickly. One factory built a new juice liming system that was quickly modified for optimal dextranase application after the freeze. Optimum conditions for concentrated dextranase (92,700 DU/mL) applied were: Brix < 25%, temperature 50 C, juice pH = 5.90, 1:10 working solution of concentrated dextranase up to 5 mg/L (ppm) dosage; retention time = 10 minutes; 0.624 $s^{-1}$ agitation.




*Schemes of (A) new juice liming system at the factory and (B) modification of the liming system for dextranase application post-freeze.*

- The optimum conditions showed that dextranase applied to sugarcane juice can work very successfully, i.e., break down > 80% Haze dextran, and minimize/overcome processing problems associated with a severe sugarcane freeze. Retention time was not as important as temperature and the pH of the juice. This was positive news for other factories who do not have a lot of retention time available, but mixing (agitation) must be optimal.
- Overall, the optimal use of dextranase allowed the factory to:
  - Process all the field sugarcane from the growers even when sucrose concentrations were very low (down to ~56% juice purities on the last day of cane delivery)
  - Continue to crystallize sugar at acceptable crystallization rates
  - Keep crystal elongation factors to only 2.3 and largely prevent needle formation
  - Allow the production of raw sugar with no dextran penalties from the refinery

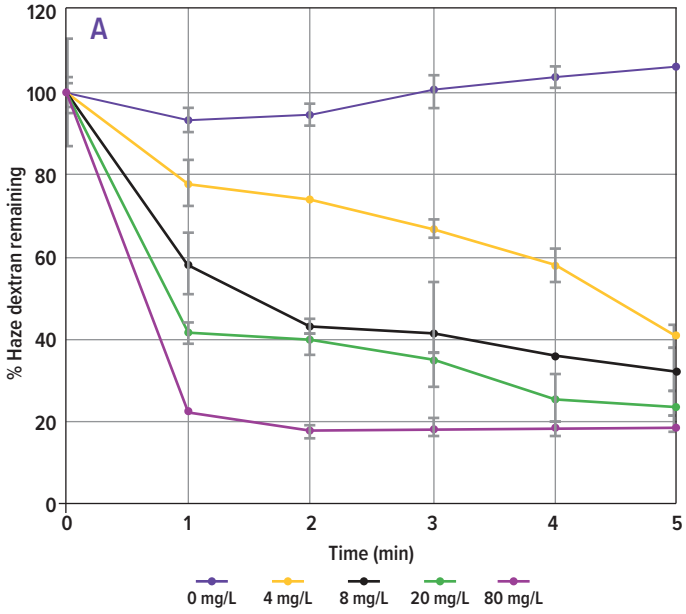



*Box plots of crystal sizes in A-massecuites from the dates of each dextranase trial. The line cutting across the box is the median crystal value and x marks the average crystal value. The upper and lower lines of the boxes represent the 75th and 25th percentile of the data. Whiskers represent the furthest points of the data (maximum and minimum) and the separate dots are outliers. Different lowercase letters above each box are significant at the 5% probability level.*

## Dextranase Application at Low Deses and Retention Times

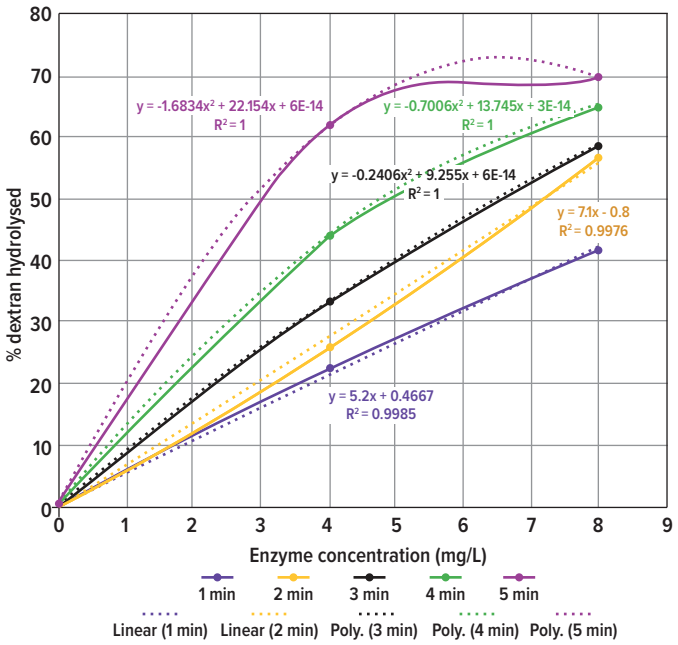
*By Gillian Eggleston*

- Dextranase enzyme is applied in sugarcane factories to hydrolyze dextran into smaller, more manageable molecules. After we reported the optimum conditions for the factory application of concentrated dextranase were: Brix < 25%, temperature 50 C, prelimed juice pH 5.90, 1:10 working solution of concentrated dextranase up to 5 mg/mL dosage, retention time 10 minutes and 39 rpm agitation, we studied adding lower doses of the enzyme at lower retention times. This was because (1) some factories have < 10-minute juice retention time available and (2) the relatively high cost of adding dextranase.
- For dextranase concentrations of 4 to 80 mg/L (ppm), most of the dextran hydrolysis occurred in the first minute, after which there were diminishing techno-economic returns with an increase in retention time and dextranase concentration.




*Effect of 0 to 80 mg/L doses of dextranase under optimum conditions on the remaining amount of Haze dextran in the sugarcane juice (initial Haze dextran content was 3950 mg/kg). Vertical lines represent standard deviations from the average values.*

- A study evaluated and predicted dextran hydrolysis in sugarcane juice (3,950 mg/kg Haze dextran content) following the optimum conditions with ≤ 5 mg/mL of concentrated dextranase (92,330 DU/mL) and retention times ≤ 5 minutes.
- Up to 51% Haze dextran hydrolysis or 62% true dextran hydrolysis can occur within these conditions, which is promising for those factories with low retention times available for juice.




*Effect of low doses of enzyme concentration on percent dextran hydrolyzed from 0 to 5 minutes of reaction time. Linear or polynomial equations for each reaction time curve are stated directly on the graph.*

*Calculated percent of Haze dextran and true dextran hydrolysis at 0.5 to 5 mg/L (ppm) doses of dextranase for 1, 2, 3 and 4 minutes of reaction time. Calculations were undertaken using the equations generated in the previous figure. True dextran hydrolysis was calculated based on 17.5% dextran remaining.*

| Concentration of dextranase (mg/L or ppm) | 1 min** | 2 min** | 3 min** | 4 min** |
|---|---|---|---|---|
| **0.5** | 3.1 (3.7) | 2.8 (3.3) | 4.6 (5.5) | 6.7 (8.1) |
| **1** | 5.7 (6.9) | 6.3 (7.6) | 9.0 (10.9) | 13.0 (15.8) |
| **1.5** | 8.3 (10.0) | 9.9 (11.9) | 13.3 (16.2) | 19.0 (23.1) |
| **2** | 10.9 (13.2 | 13.4 (16.2) | 17.6 (21.3) | 24.7 (29.9) |
| **3** | 16.1 (19.5) | 20.5 (24.8) | 25.6 (31.0) | 34.9 (42.3) |
| **4** | 21.3 (25.8)* | 27.6 (33.5)* | 33.2 (40.2)* | 43.8 (53.0)* |
| **5** | 26.5 (32.1) | 34.7 (42.1) | 40.3 (48.8) | 51.2 (62.1) |

*Experimental data was 22.2%, 26.0%, 33.2% and 43.8% Haze dextran hydrolysis at 1, 2, 3 and 4 minutes, respectively, which was very close to the calculated values
**% Calculated haze dextran hydrolysis (true dextran hydrolysis in parenthesis)

## An Update on the Four Boiling Double Magma Scheme at the Factory

*By Harold S. Birkett*

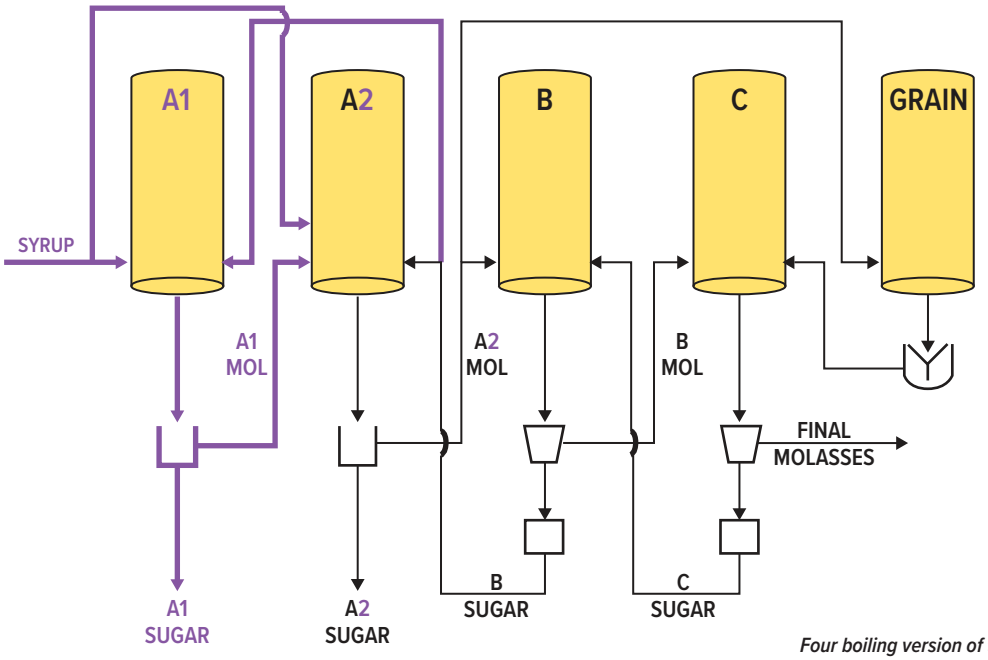
- In recent years the Louisiana sugarcane industry has developed sugar cane varieties with high sugar content and high purities of final evaporator syrups. The table below tabulates the crop average syrup purities for the 2022 to 2024 processing seasons.

### Crop average syrup purities for 2022, 2023 and 2024 processing seasons.

| Factory | Final Evaporator Syrup Purities (%) Season 2022* | Final Evaporator Syrup Purities (%) Season 2023 | Final Evaporator Syrup Purities (%) Season 2024 |
|---|---|---|---|
| **A** | 87.36 | 88.09 | 89.52 |
| **B** | 85.43 | 86.57 | 87.71 |
| **C** | 85.80 | 87.99 | 88.37 |
| **D** | 86.31 | 88.58 | 88.49 |
| **E** | 84.39 | 86.40 | 87.12 |
| **F** | 87.71 | 87.11 | 86.68 |
| **G** | 84.35 | 85.46 | 85.64 |
| **H** | 86.36 | 87.28 | 86.51 |
| **I** | 87.20 | 86.50 | 87.12 |
| **J** | 87.32 | 86.39 | 86.29 |
| **K** | 87.38 | 86.69 | 86.33 |
| **Average** | 86.33 | 87.01 | 87.25 |

*Syrup purities for 2022 season were depressed by a severe freeze at the end of the season.

- During the last 10 years, the syrup purity has averaged 88%-89% for two of the years, 87%-88% purity for five of the years, and 86%–87% for two years. These high syrup purities have made it difficult to achieve low purity final molasses with the three boiling schemes which are utilized in Louisiana (both the double magma and the conventional three boiling schemes).
- About 10 years ago we proposed a four boiling version of the three boiling double magma scheme to produce very high purity (VHP) sugar and low purity final molasses. One Louisiana factory has been using the four boiling double magma system for the last 10 years. Another factory started to implement the four boiling scheme for the last two seasons. Three additional factories are considering implementing the four boiling double magma scheme in the future.
- The four boiling double magma scheme requires the same number of pans and centrifugals as the three boiling double magma scheme and also requires the same quantity of exhaust steam. The additional equipment required for the four boiling double magma boiling scheme above that required for the three boiling double magma scheme are:
  - Additional molasses storage for the molasses from the additional A strike
  - Separate mixers for the two A massecuites (A1 and A2)
- The most difficult problem in implementing the conversion from the three boiling to four boiling double magma scheme is configuring the A1 and A2 centrifugal batteries. Although the number of A centrifugals required is unchanged, the number of centrifugals required in each battery depends on the syrup purity.
- For those factories considering implementing the four boiling double magma boiling scheme, ASI is available to assist in evaluating alternatives.

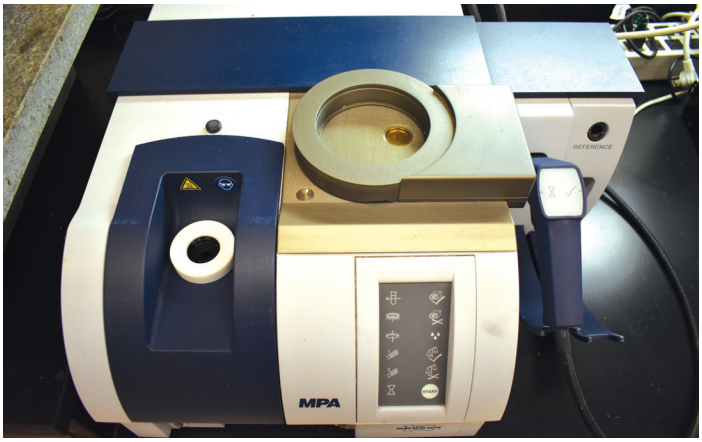



*Four boiling version of the double magma system.*

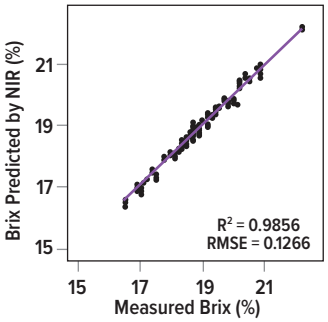
## Developing a New Louisiana Cane Payment System Based on NIR Technology

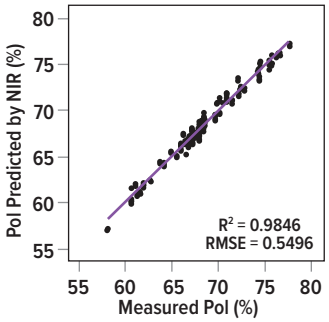
*By Stephania Imbachi Ordonez*

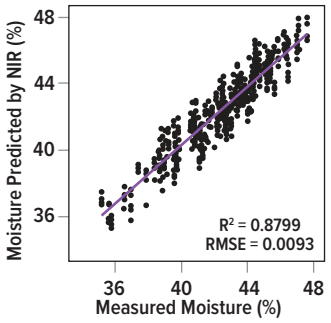
- The Louisiana cane payment system determines the value of cane based on its quality parameters (pol, Brix and fiber). These parameters are currently measured using wet chemistry methods that are time-consuming, costly, and generate chemical waste. The project aimed to evaluate near-infrared (NIR) spectroscopy as a rapid, nondestructive and environmentally friendly alternative to replace conventional methods.
- NIR calibrations were developed using data collected from shredded cane, press juice and press cake samples. During the 2021 to 2023 processing seasons, over 1,000 samples were analyzed using Bruker MPA I and II instruments installed at two Louisiana sugar factories. Reference analyses were conducted using standard core laboratory procedures for Brix, pol and moisture.
- Press juice analysis was the most reliable for pol and Brix calibrations, offering accurate results with minimal sample prep. Moisture model accuracy improved after standardizing the oven drying procedure (105 C for 25 hours) per ICUMSA recommendations.
- Results showed excellent calibration performance for juice samples with $R^2$ = 0.99 (Brix) and $R^2$ = 0.98 (pol). The moisture model ($R^2$ = 0.88) was less accurate due to sample heterogeneity and moisture variability.
- This project demonstrated the feasibility of incorporating NIR technology into the Louisiana cane payment system, promoting modernization, reducing analytical costs and enhancing consistency across the industry. One Louisiana sugarcane factory and a commercial grower purchased Bruker TANGO NIR (portable) spectrometers and began implementing the developed calibrations to adopt the technology for core lab analysis and preharvest studies, respectively.




*Bruker NIR instruments used in the study.*




*Comparison of NIR predictions and measured values on the test set for Brix and pol in press juice, and moisture in press cane.*

## Bagasse Boiler Tests

*By Harold S. Birkett*

- Louisiana sugarcane factories often require bagasse boiler tests for efficiency and permit compliance.
- Sixty-five tests were conducted at Louisiana sugar factories over the past 2022 to 2024 period. Operating conditions were recorded while temperatures and oxygen were measured. Bagasse samples were collected for moisture and ash analyses.

**Results of bagasse boiler testing.**

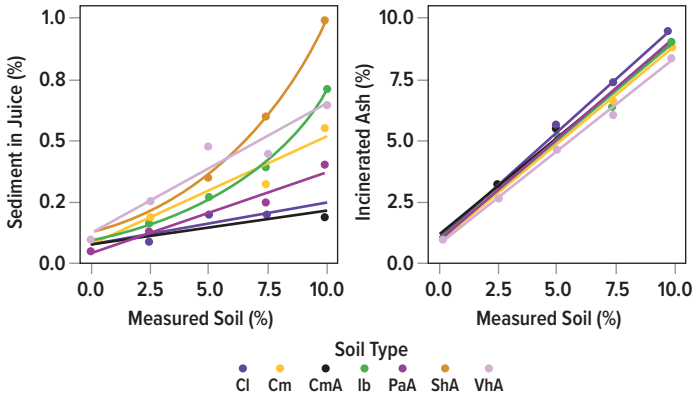
| Parameter | Average | High | Low |
|---|---|---|---|
| **Steam flow, lbs/hr** | 142,606 | 257,000 | 67,200 |
| **Steam pressure, psig** | 248 | 653 | 181 |
| **Preheated air, degrees F** | 441 | 585 | 268 |
| **Flue gas, degrees F** | 376 | 497 | 275 |
| **Bagasse moisture, %** | 50.65 | 55.07 | 46.58 |
| **Bagasse ash, %** | 4.31 | 12.37 | 1.86 |
| **Oxygen, %** | 9.36 | 14.84 | 4.43 |
| **Excess air, %** | 88.70 | 241.36 | 31.14 |
| **Efficiency, %** | 63.10 | 66.50 | 57.20 |
| **Lbs steam/lb bagasse** | 2.32 | 2.65 | 1.90 |

- Improving boiler performance allows for more efficient steam production and better compliance with government permit regulations.

## Quantifying Extraneous Matter in Shredded Sugarcane Using Near-Infrared Spectroscopy

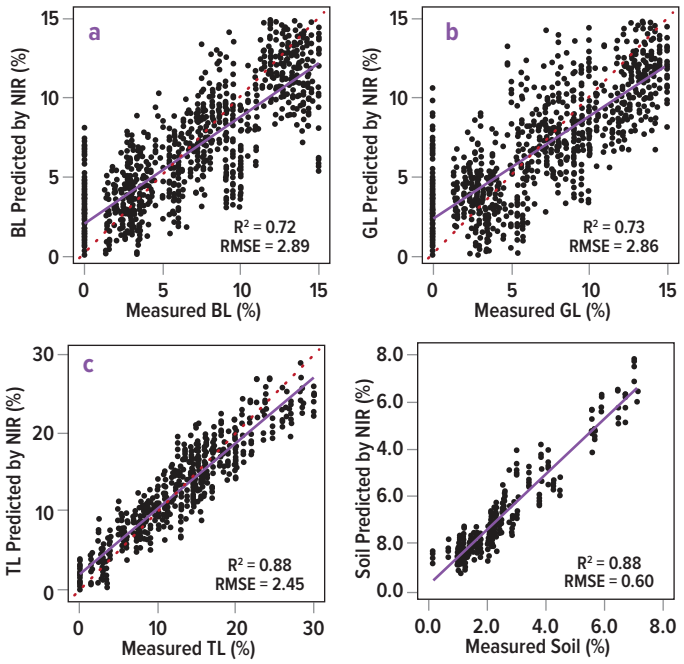
*By Stephania Imbachi Ordonez*

- Extraneous matter (EM) is also commonly known as sugarcane trash in Louisiana and is composed of leaves, tops, soil and roots. Despite its significant impact, it cannot be regularly quantified in cane loads delivered to sugar factories due to the lack of practical measurement methods and is, therefore, still excluded from cane payment systems. We investigated the use of NIR spectroscopy as a rapid, nondestructive method to measure EM and solve this important technical challenge.
- NIR calibration models for leaf (green or brown) content in shredded cane were developed using mixtures of clean cane, soil and leaves with known EM concentrations. Soil content calibrations were built using incinerated ash (a measure of minerals) as the reference method.
- Under the Louisiana payment system, sediment in juice is currently used as an indication of soil content in cane. However, this method showed poor correlation with actual soil content ($R^2$ = 0.12), making it unreliable. In contrast, incinerated ash content demonstrated a strong and consistent correlation ($R^2$ ≈ 0.99), confirming its suitability as the primary basis for NIR calibration.




*Relationship of soil content with sediment (right) and incinerated ash (left) from prepared cane-soil mixtures across different soil types.*

- Results showed that soil content based on ash analysis yielded strong calibration results ($R^2$ = 0.88), markedly outperforming sediment analysis ($R^2$ = 0.12). For the first time, NIR successfully predicted brown leaves ($R^2$ = 0.72), green leaves ($R^2$ = 0.73), as well as total leaves ($R^2$ = 0.88) in shredded cane samples.
- Machine learning models (support vector machines, neural networks and random forest) were tested to improve prediction accuracy. The $R^2$ for soil increased to 0.91 and total leaves to 0.94.

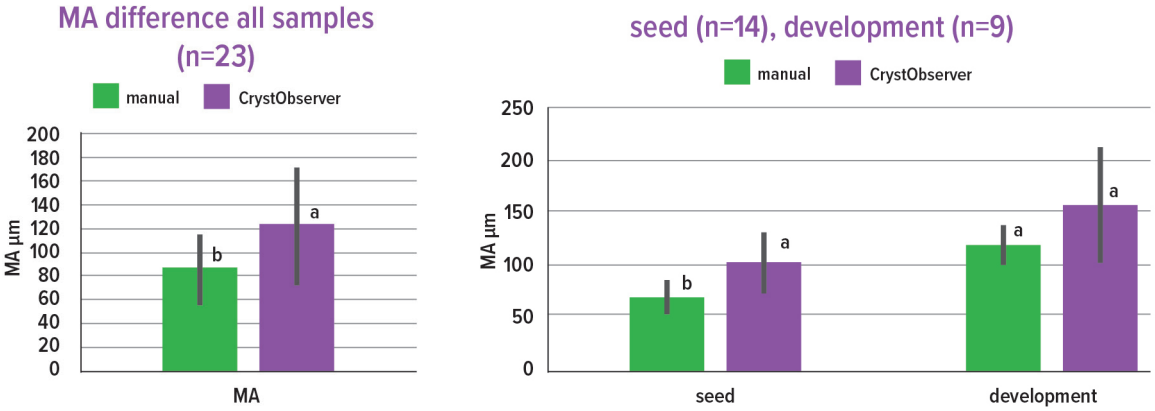



*Comparison of NIR predictions and measured values on the test set for brown leaves (BL), green leaves (GL), total leaves (TL) and soil in shredded cane.*

## Real-Time Monitoring of Crystal Size and Shape in Batch Vacuum Pans in Louisiana

*By Stephania Imbachi Ordonez and Peter Gaston*

- Monitoring and control of sucrose crystal size, shape and distribution are essential for optimizing raw sugar production in Louisiana factories. Traditional visual methods using handheld microscopes are time-consuming and imprecise, especially during periods of crystal elongation. The ITECA CrystObserver, an online video microscope, offers real-time monitoring capabilities and was installed in a Louisiana factory to evaluate its performance and accuracy.
- The CrystObserver system includes a sensor mounted on the vacuum pan, a control enclosure and a dedicated computer for image analysis. It captures high-resolution images of crystals and calculates metrics like crystal mean aperture (MA), coefficient of variation (CV) and fines percentage. A portable Q-scope microscope was also used to manually measure crystal size for comparison. Samples were prepared and analyzed using calibrated software, and paired t-tests were conducted to compare the two methods.
- The CrystObserver provided real-time visualizations and downloadable data but showed consistent discrepancies when compared to manual microscope (Q-scope) measurements. It tended to report higher MA values, especially during the seed stage of crystallization, likely due to calibration differences.




*MA values of CrystObserver versus Q-scope for all samples (left) and seed and development (right). Differences in lower case letters for each pan stage only were significantly different at the 5% probability level. (*n=number of samples)*



*CrystObserver mounted on the side of the pan in a Louisiana factory.*

CV values were generally lower than those from the Q-scope, although not statistically significant. The system includes two particle size calculation modes but manual switching between modes was required, and this may have affected the accuracy of the measurements.

- A second Louisiana factory using the CrystObserver reported operational improvements, including better control of the crystal CV and reduced molasses purity. The ability to digitally archive strike data also helped identify issues like false grain formation, previously undetected.
- The study concluded that the CrystObserver is a promising tool for enhancing crystallization monitoring and control in raw sugar factories. While it offers valuable real-time data and operational insights, further automation and calibration improvements are needed to fully realize its potential.

## Mill Performance Tests

*By Harold S. Birkett*

- Mill performance tests are requested each year by Louisiana factories interested in improving their mill extraction.
- At each factory, 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 from 11 mill tests over the past three sugarcane crops (2022-2024) are given in the table below.

### Summary of mill test results.

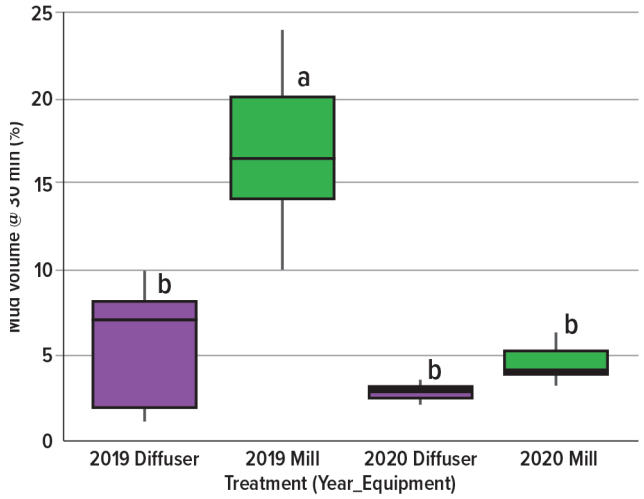
| Sample | Average | High | Low |
|---|---|---|---|
| **Open cells % prepared cane** | 79.35 | 82.96 | 73.07 |
| **Moisture % cane** | 72.56 | 75.83 | 71.06 |
| **Pol % cane** | 12.97 | 14.39 | 11.97 |
| **Fiber % cane** | 12.81 | 14.61 | 11.70 |
| | | | |
| **First mill moisture % bagasse** | 61.22 | 66.59 | 55.78 |
| **First mill pol extraction, %** | 60.77 | 72.22 | 48.45 |
| | | | |
| **Last mill moisture % bagasse** | 52.63 | 60.08 | 47.65 |
| **Last mill pol % bagasse** | 2.26 | 3.16 | 1.57 |
| **Last mill fiber % bagasse** | 41.39 | 46.25 | 36.47 |
| **Tandem pol extraction, %** | 94.67 | 96.06 | 92.97 |

- 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 of 1% in the tandem pol extraction can mean an extra 2.5 pounds sugar produced per ton cane.

## Differences in Juice Clarification from a Cane Diffuser, Bagasse Diffuser and Tandem Mill

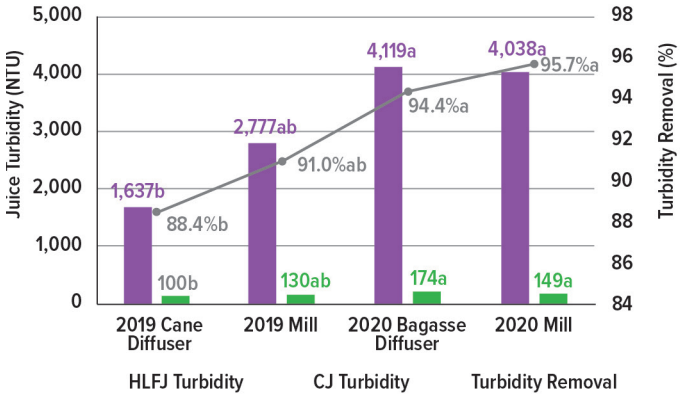
*By Maria del Carmen Perez*

- Roller mills and diffusers are the two juice extraction methods used in the sugarcane industry, with the tandem mills most popular in Louisiana. Diffuser technology has two variants: (1) cane diffusers whereby prepared cane passes through the diffuser, and (2) bagasse diffusers whereby the diffuser processes bagasse from one preextraction mill and then the diffusion process is followed by a dewatering mill. The aim of this study was to compare the effect of the two diffuser types and the mill on the performance of juice clarification at one single Louisiana factory across two processing seasons (2019 and 2020; the bagasse diffuser was only installed in 2020).
- Mud volumes were always higher during the clarification of mill juice compared to cane diffuser juice. This was confirmed by the filter cake production at the factory with 199.1 and 182.4 pounds per ton of cane, respectively. Differences between the two seasons were due to variations in cane quality.




*Mud volumes for the mill and cane diffuser om 2019 and mill and bagasse diffuser in 2020 at the factory.*

- During the 2019 season, the turbidity of the flash heated limed juice (HLFJ) was higher for mill juice than the cane diffusion juice but there was no statistical difference due to the high variability. This was expected since the bagasse mat in a diffuser acts as a filter for the juice. This trend, however, changed during the 2020 season with similar HLFJ turbidities for mill and bagasse diffuser juices. The same behavior was observed for the turbidity of the clarified juice (CJ). The increase in juice turbidity from the cane diffuser could be due to: (1) the transition from cane diffuser to bagasse diffuser, and (2) the cane quality variability.
- The average turbidity removal (from FHLJ to CJ) was statistically ($P < 0.05$) lower for the cane diffuser during the 2019 season at 88.4% compared to the bagasse diffuser in 2020 at 94.4%, as well as the mill in 2020 (95.7%). All the turbidity removal values were lower than the typical values observed in Louisiana factories at about 96.5%.



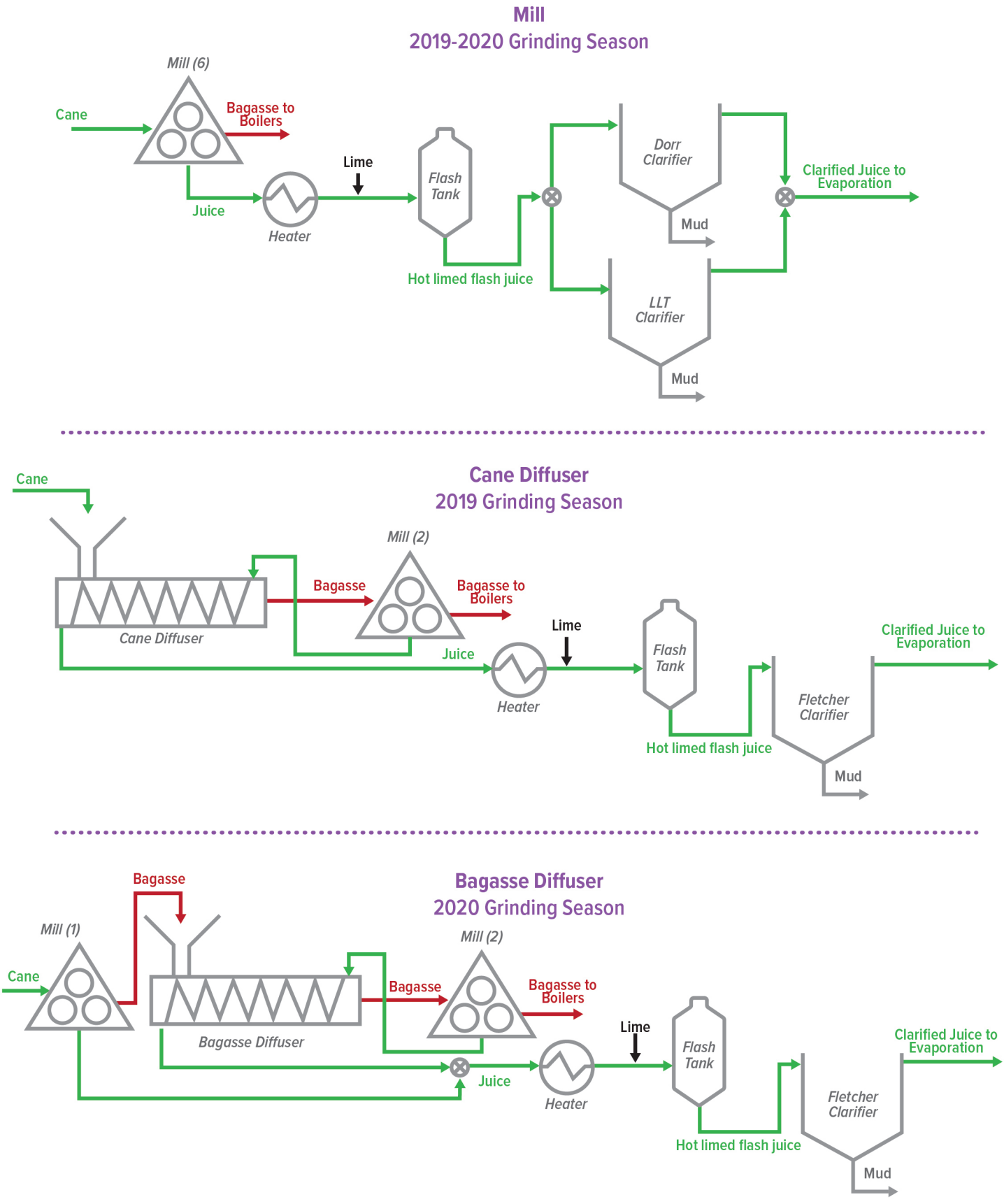

*Juice turbidity and percent turbidity removal for mill and cane diffuser during the 2019 season, and mill and bagasse diffuser during the 2020 season.*

- No statistical differences were found for juice Brix values from the mill or diffuser. During the 2019 season, there was no statistical difference between the HLFJ pH values of the cane diffuser (7.77) and mill (7.59). In 2020, the mean pH value of the HLFJ for the bagasse diffuser and mill increased. The drop in pH from HLFJ to CJ, for the mill juice was greater than for the diffusion juices during both seasons, but without any statistical difference. There was no statistical difference for the pH drop value between the diffuser in 2019 and 2020, which indicated that the conversion from the cane diffuser to the bagasse diffuser did not affect the pH drop during juice clarification.

**Juice pH and pH drop for mill and cane diffuser during the 2019 season, and mill and bagasse diffuser during the 2020 season.**

| Year/Equipment | HLFJ pH | CJ pH | pH Drop |
|---|---|---|---|
| **2019 Cane Diffuser** | 7.77±0.43 b | 7.53±0.23 b | 0.26±0.43 a |
| **2019 Mill** | 7.59±0.77 b | 7.26±0.13 c | 0.56±0.15 a |
| **2020 Bagasse Diffuser** | 8.36±0.43 a | 8.00±0.15 a | 0.36±0.46 a |
| **2020 Mill** | 8.01±0.32 b | 7.50±0.29 b | 0.50±0.37 a |

- Overall, this new information will be helpful to those regions of the world who are considering new juice extraction systems.

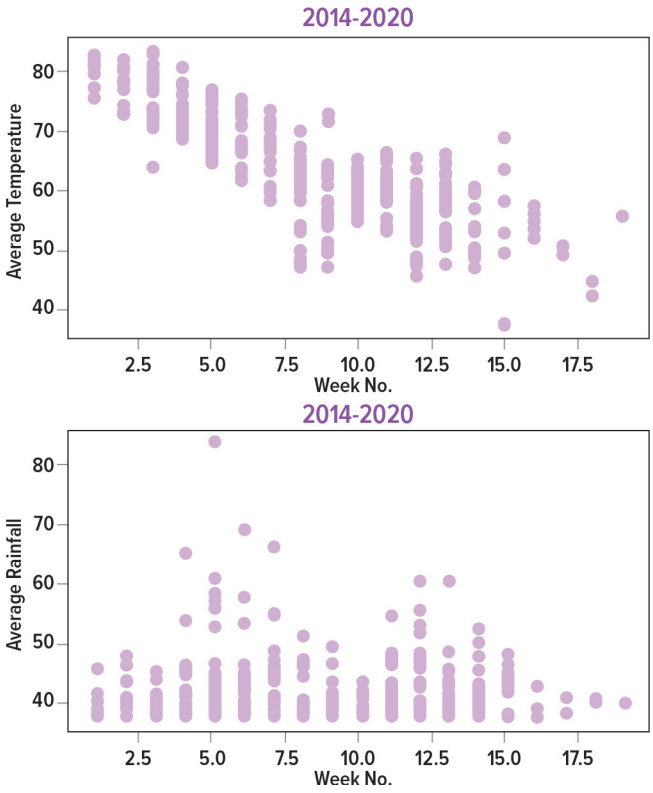



*Flow diagram of the extraction and clarification processes at the factory.*

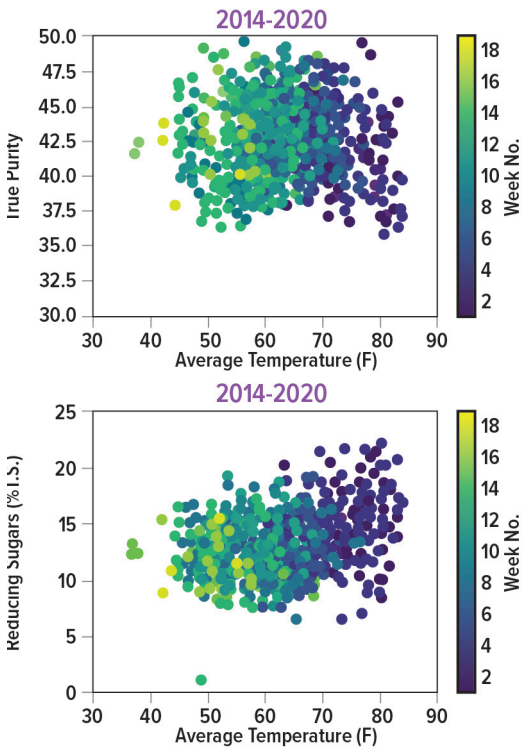
## Effects of Harvest Temperature and Rainfall on Molasses Quality

*By Evan Terrell and Chardcie Verret*

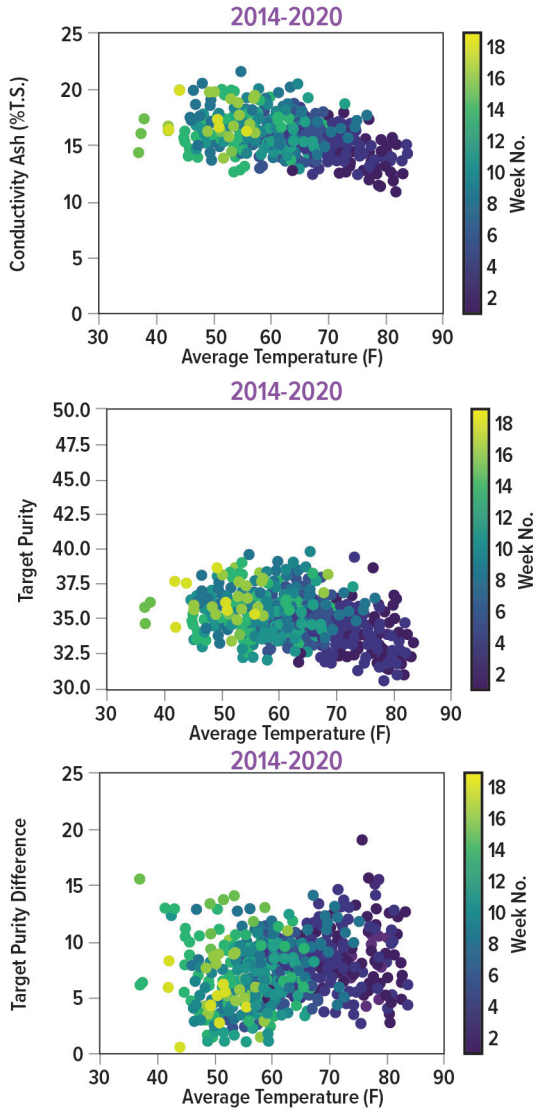
- Since final molasses represents the greatest loss in raw sugar factories, there was a compelling need for closer molasses analyses aimed at minimizing the content of unrecovered raw sugar. In this project, undertaken with Evan Terrell a scientist at U.S. Department of Agriculture Agricultural Research Service (USDA-ARS), associations of harvest weather conditions (temperature and rainfall) on molasses quality characteristics were investigated using data from the Audubon molasses survey covering the 2014 to 2020 timeframe of raw sugar production in Louisiana.
- Specific quality characteristics of molasses studied were true purity (HPLC measurement), reducing sugars (glucose and fructose, HPLC measurement) and conductivity ash. Reducing sugars and ash were reported as a percent of total soluble solids (%TS). From these measured quantities, target purity and TPD (target purity difference) were calculated. Weather data from the National Oceanic and Atmospheric Administration (NOAA), corresponding to the weekly molasses survey data, were collected for four locations in Louisiana: Baton Rouge, New Iberia, Jeanerette and Thibodaux. Raw sugar factories were allocated to a specific weather location based on approximate geographic proximity. Weekly weather data were collected such that they temporally match weekly molasses survey data. Data analysis and visualization were done using tools in Microsoft Excel and Python in the Jupyter Notebook environment.
- Based on these analyses, there were limited apparent effects from average weekly rainfall on measurable characteristics of molasses and TPD. However, over the course of the processing season there was a decreasing trend of reducing sugars and target purity with temperature, and an increasing trend of conductivity ash and TPD with temperature. Target purity difference is an important metric for factory performance to estimate the final molasses exhaustion. This parameter is derived from the content of reducing sugars and conductivity ash present in the molasses, which govern overall sucrose solubility.
- Further analysis of paired harvest weeks exhibiting anomalous temperature behavior (“cold” early-season week followed by “hot” late-season week) was explored to attempt to decouple potential effects of time in season from temperature. This analysis suggested that there may be some evidence of increased microbial activity, sucrose losses and increased contents of reducing sugars at higher ambient environmental temperature, independent of the time in season. These apparent results offer ample opportunities for closer study, particularly to look for evidence of microbial activity on a daily basis. Continued analysis can highlight implications on molasses characteristics, overall sucrose degradation, reducing sugar content and the presence of polysaccharides.




*Average weekly temperature (F), left; and average weekly rainfall (inches), right for all locations and years.*




*Charts continued on next page.*




*Molasses survey data for all locations and weeks plotted against average weekly temperature (F). Specific molasses data labels are given in the vertical axis of each subplot. Time in season (week) is represented on the color bar(s).*

## Development of a Secure Online Application for Visualizing Manufacturing Reports

*By Anurag Mandalika and Evan Terrell*

- Louisiana raw sugar factories generate extensive daily manufacturing data, traditionally compiled in PDF reports and printed. While informative, these formats limit the ability to analyze trends, correlations and process inefficiencies, especially as factories move toward automation.
- With USDA-ARS scientist Evan Terrell, Audubon scientists developed a prototype application using the Shiny package in R software to visualize manufacturing data from multiple factories. The app reads compiled datasets (e.g., Excel spreadsheets) and allows users to select variables from dropdown menus to generate plots and trends across processing seasons.
- Several factories participated in the development of this app during the 2023 processing season, sharing reports to build yearly datasets. The app currently includes variables such as crop days, grind time, cane pol, sugar pounds made, molasses purity and more. Users can compare variables across seasons and locations, with future plans to integrate weather data for more in-depth analyses.
- Preliminary visualizations demonstrated the app's capability to reveal correlations (e.g., CanePol versus LbsSugarTonCaneRV). While the goal was not to highlight specific trends, the tool shows promise for enabling factory personnel and researchers to identify inefficiencies and optimize processes.
- This visualization tool enhances data accessibility and interpretation. Continued development, including secure hosting, automated data transcription and factory-specific customization, are needed to fully integrate the app into factory operations and research workflows. This project is ongoing.

## EPS Producing Microorganisms from Louisiana's Crusher Juice

*By Giovanna M. Aita*

- During the microbial deterioration of sugarcane, a variety of extracellular polysaccharides EPS, (e.g., dextran, fructan or levan), oligosaccharides (e.g., kestoses, isomaltotriose, isomaltotetraose, leucrose), sugar alcohol (mannitol), alcohols (e.g., ethanol) and organic acids (e.g., lactic, acetic) can be produced.
- The microbial-derived EPS dextran has generally been considered the main problem in sugarcane processing, with the genus *Leuconostoc* (in particular the bacterium *Leuconostoc mesenteroides*) being the main source of dextran in the sugar industry.
- Technical problems associated with the presence of dextran at the sugar factory can affect every step of sugar processing. Dextran contributes to the clogging of filters, pipelines and tanks and may interfere with the removal of suspended matter during clarification. Their presence can cause scale accumulation that results in heat losses in the cane juice evaporators, affect viscosities of juices and syrups with undesirable effects on the filtration, clarification, boiling, and affination processes, and also elongate sugar crystals.
- This study aimed to identify the predominant microbial populations in crusher (first extracted) juice from a Louisiana sugarcane factory using universal primers for 16S rRNA (bacteria) and 18S rRNA (fungi), and PCR amplification, as well as to determine whether these isolates could produce EPS other than dextran.
- Several microbial isolates belonging to the genera *Lactobacillus, Lactococcus, Leuconostoc, Pantoea, Pseudomonas* and *Saccharomyces* were identified in high cell numbers in Louisiana's crusher juice, with all isolates capable of producing dextran and/or fructans (table below).
- Among these genera, *Leuconostoc* had the most diverse number of species and were identified as *Leuconostoc mesenteroides, Leuconostoc citreum, Leuconostoc pseudomesenteroides* and *Leuconostoc suionicum*. Some of these microbial strains were surprisingly able to produce both dextran and fructans, highlighting the diversity of EPS among these isolates.

**Identified EPS-producing microorganisms from Louisiana's crusher juice.**

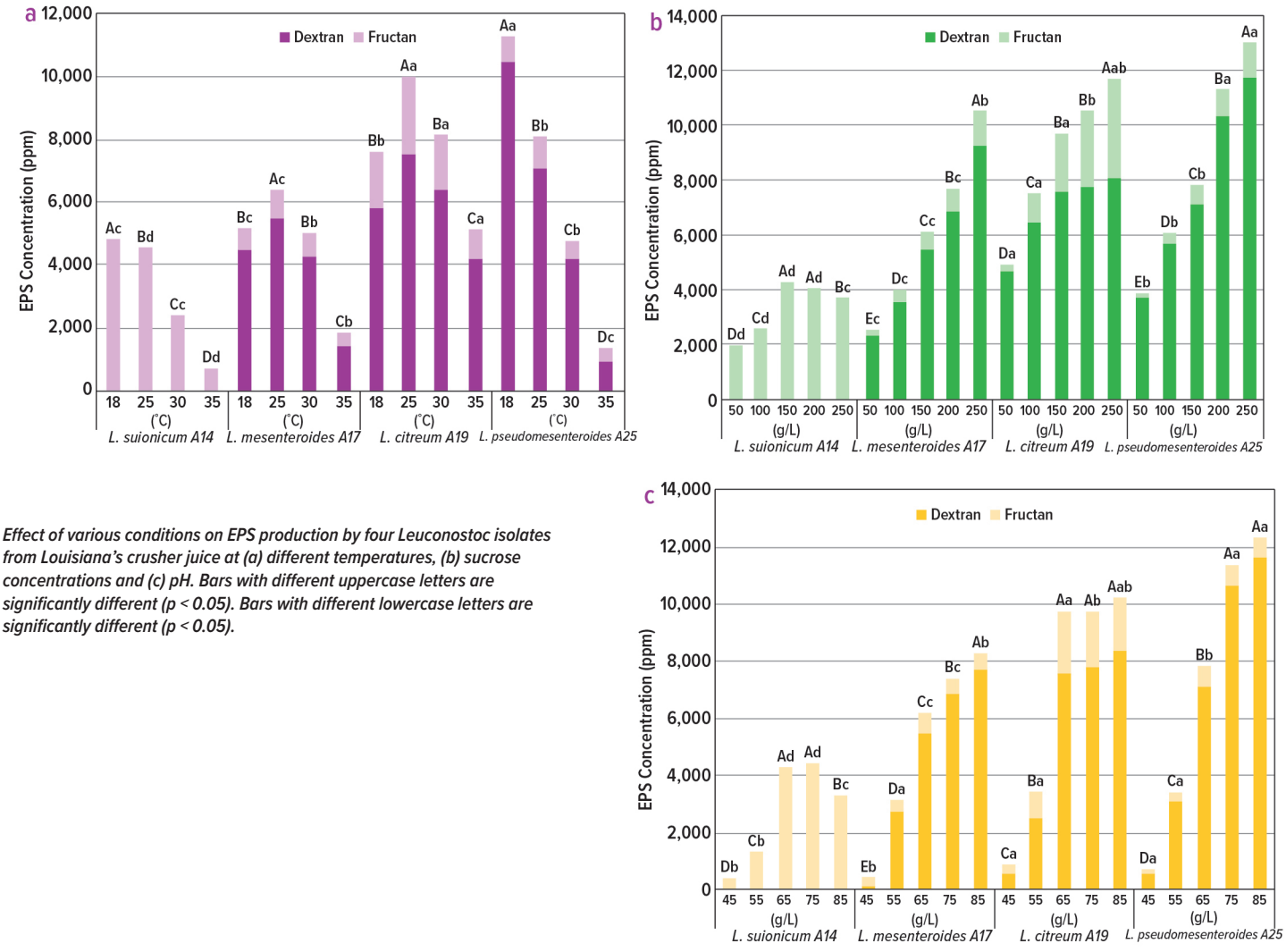
| Genus | Species | Identified Isolates | Identification Match (%) | Dextran | Fructan |
|---|---|---|---|---|---|
| *Lactobacillus* | *fermentum* | 13 | > 97 | +/- | + |
| *Lactobacillus* | *plantarum* | 1 | 99 | + | + |
| *Lactococcus* | *lactis* | 1 | 99.9 | + | + |
| *Leuconostoc* | *citreum* | 2 | > 99.4 | + | + |
| *Leuconostoc* | *mesenteroides* | 5 | > 99 | + | + |
| *Leuconostoc* | *pseudomesenteroides* | 1 | 99.8 | + | + |
| *Leuconostoc* | *suionicum* | 7 | > 99.3 | +/- | + |
| *Pantoea* | *ananatis* | 2 | > 99.2 | + | + |
| *Pseudomonas* | *lactis* | 1 | 99.9 | + | + |
| *Pseudomonas* | *abietaniphila* | 1 | 99.4 | + | + |
| *Pseudomonas* | *moravienis* | 1 | 99.8 | + | + |
| *Pseudomonas* | *rhodesiae* | 1 | 99.4 | + | + |
| *Pseudomonas* | *vancouverensis* | 1 | 99.7 | - | + |
| *Saccharomyces* | *cerevisiae* | 7 | 99 | + | + |

+ = EPS produced; - = no EPS produced.

## Effect of Processing Conditions on the Production of Extracellular Polysaccharides

*By Giovanna M. Aita*

- Biosynthesis and secretion of extracellular polysaccharides (EPS) such as dextran and fructan (levan) from *Leuconostoc* spp. occur during different growth phases, and both the amount and type of polymer can be influenced by growth/processing conditions and medium compositions.
- Four microbial isolates belonging to the genus *Leuconostoc* (*L. suionicum* A14, *L. mesenteroides* A17, *L. citreum* A19 and *L. pseudomesenteroides* A25, previously isolated and identified from a Louisiana crusher juice) were selected for their population numbers, diverse number of species and ability to produce dextran and/or fructan; and the effect of processing conditions, i.e., pH, temperature and sucrose concentration, on EPS production was evaluated.
- Contrary to reports on sugarcane deterioration about *Leuconostoc* spp. being producers of mostly dextran, we identified a single isolate of *L. suionicum* A14 that produced only fructans from sucrose.
- This is the first study to report on a fructan-only producing *Leuconostoc* isolate from sugarcane.
- EPS production by the identified *Leuconostoc* spp. was affected by temperature, sucrose concentration and medium pH.
- Maximum EPS production was observed when temperatures were between 18 C and 30 C, with increasing sucrose concentrations (≤ 250 g/L) and over a wide range of pH 5.5-8.5.
- Results from this project will help sugar technologists understand the conditions that cause the formation of dextran and levan outside and inside the factory.




*Effect of various conditions on EPS production by four Leuconostoc isolates from Louisiana's crusher juice at (a) different temperatures, (b) sucrose concentrations and (c) pH. Bars with different uppercase letters are significantly different ($p < 0.05$). Bars with different lowercase letters are significantly different ($p < 0.05$).*

## Testing an In-line Brix Meter in a Louisiana Factory

*By Stephania Imbachi Ordonez and Peter Gaston*

- Modern sugarcane factories are increasingly adopting Industry 4.0 technologies, including automation and real-time data monitoring. One key parameter in sugar processing is Brix, which measures the percentage of refractometric dissolved solids in a solution. This study focused on evaluating the performance and calibration stability of an Inmec in-line microwave Brix meter installed in a Louisiana factory during the 2023 processing season.
- The Inmec IL Brix sensor was installed in a factory vacuum pan and calibrated using massecuite samples analyzed with a high-accuracy Bellingham and Stanley laboratory refractometer. Samples were collected twice weekly from October 2023 to January 2024 during seed and development strikes. Each sample was diluted, shaken and measured three times using a temperature-controlled Bellingham and Stanley RFM340+ refractometer. Statistical paired t-tests were used to compare Brix values from the in-line sensor and the lab reference.




*Inmec IL in-line microwave Brix sensor (left) and Bellingham and Stanley RFM340+ refractometer (right).[*

- Results showed a statistically significant difference between the two instruments, but the average discrepancy was only 0.15% Brix. This small difference is considered operationally insignificant. The in-line sensor tended to report slightly higher Brix values, especially during development strikes and late-season samples. However, molasses measurements showed no significant differences. The minor variation may be due to the physical distance between the sampling point and the sensor location on the pan.
- The study concluded that the Inmec in-line Brix meter maintained its calibration and provided reliable measurements throughout the season. Despite minor statistical differences, the sensor proved robust for commercial use and is a viable option for real-time Brix monitoring in sugarcane factories.

### Comparison of Brix between in-line Brix sensor reading and reference refractometer.

| Sample/Parameter | In-line Brix Sensor Av. % | Reference Refractometer Av. % | Av. Difference (In-line – Ref.) | N | P Value |
|---|---|---|---|---|---|
| **Overall** | 88.23 | 88.08 | 0.15 | n=79 | 0.002 |
| **Molasses** | 81.49 | 81.73 | -0.24 | n=15 | 0.099 |
| **Massecuite** | 89.81 | 89.57 | 0.24 | n=64 | 0.000 |
| **Seed strike** | 86.55 | 86.52 | 0.04 | n=41 | 0.603 |
| **Development strike** | 90.01 | 89.74 | 0.27 | n=36 | 0.000 |
| **Mid-season** | 88.37 | 88.36 | 0.02 | n=42 | 0.807 |
| **Late-season** | 88.07 | 87.78 | 0.30 | n=37 | 0.000 |

## Evaluation of Technologies for Rapid Analysis of Moisture Content of Press Cane and Bagasse

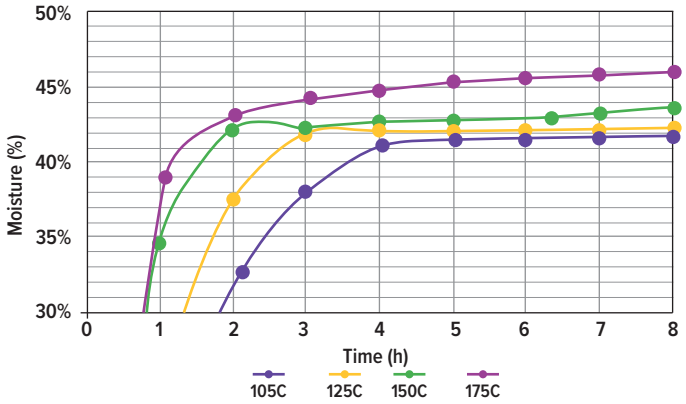
*By Stephania Imbachi Ordonez*

- Accurate moisture measurement of press cane is essential for the Louisiana cane-payment system, but conventional oven methods are slow (up to 180 minutes), labor-intensive and vary across factories. Prior studies (Imbachi Ordonez, 2021-2022) revealed inconsistencies and inaccuracies in factory oven moisture results, likely due to sampling errors, human error and methodological differences.
- This project aimed to evaluate CSC Digital Moisture Balance and BMA Moisture Analyser as faster, more efficient alternatives to conventional oven drying.



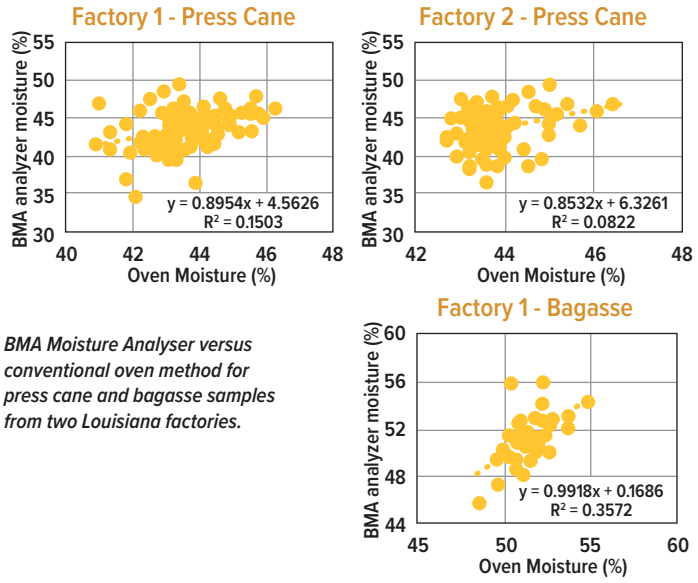

*CSC Digital Moisture Balance.*

- Louisiana factory laboratories use different drying times (70 minutes to three hours) and temperatures (150 C to 170 C). To standardize the oven moisture methodology, seven press cane samples were dried at 105 C, 125 C, 150 C and 175 C for 24 hours with hourly weights recorded. Drying at 175 C caused browning and unstable weights, likely from the breakdown of organic materials, not moisture loss. Constant weight was reached at 105 C to 125 C after four hours and at 150 C after three hours. For practicality, 150 C for three hours was selected as the standard.

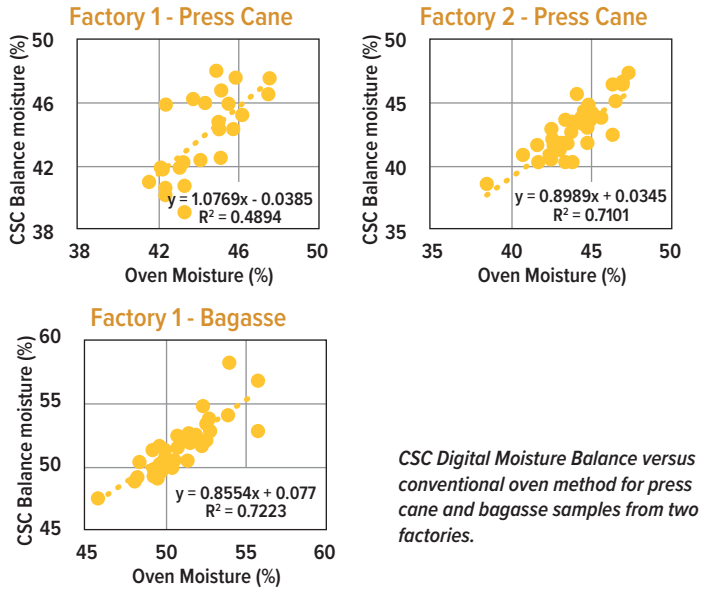



*Moisture content of press cane samples dried at different temperatures (105 C to 175 C) for 23 hours.*

- Moisture content was measured using standardized oven drying at various temperatures and compared against the CSC Digital Moisture Balance and BMA Moisture Analyser, with calibration models developed using press cane and bagasse samples from multiple factories.
- Initial results showed promising correlations between BMA moisture readings and oven methods ($R^2$ up to 94.2%), but final calibrations revealed very low accuracy ($R^2$ up to 35.72%), and the CSC Digital Moisture Balance showed moderate correlation ($R^2$ up to 72.23%).
- Neither the CSC Digital Moisture Balance nor the BMA Moisture Analyser produced results comparable to the oven method, with significant variability depending on sample type and factory origin.
- The study concluded that while these technologies offer speed and convenience, they currently lack the precision required for integration into the Louisiana cane-payment system, highlighting the need for further development before adoption.




*BMA Moisture Analyser versus conventional oven method for press cane and bagasse samples from two Louisiana factories.*




*CSC Digital Moisture Balance versus conventional oven method for press cane and bagasse samples from two factories.*

## Evaluation of Auto Filtration Equipment for Polarimetric Analysis

*By Stephania Imbachi Ordonez*

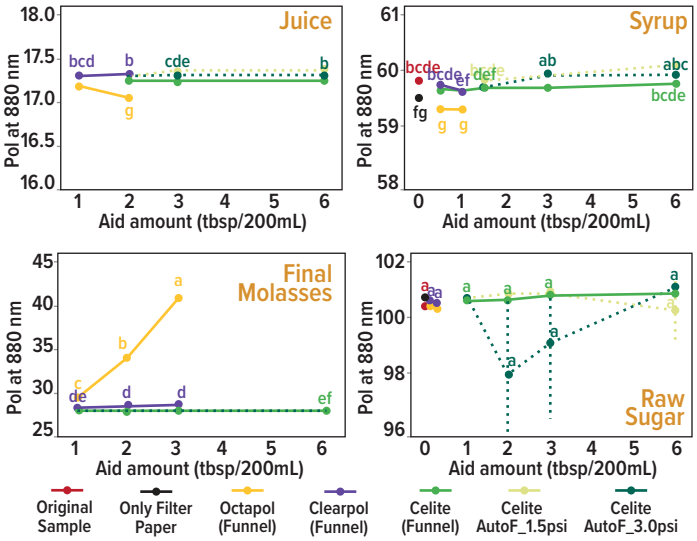
- Polarimetry remains a key method in the sugar industry for estimating apparent sucrose content, but accurate measurements require clarification steps that are time consuming and affected by inconsistent clarification aid quality which can lead to unreliable pol readings.

- This study evaluated the Autofilt Z automatic pressure filtration unit manufactured by Schmidt + Haensch, as a modern alternative to conventional clarification methods using Octapol and Clearpol clarification aids for polarimetric analysis of sugarcane factory products. The aim of the project was to improve accuracy, reduce analysis time and lower operational costs.
- Core lab juices, syrup, final molasses and raw sugar samples from Louisiana factories were analyzed using funnel filtration with filter/clarification aids and automatic filtration with Celite, comparing pol, Brix, turbidity, filtration time and cost across methods.



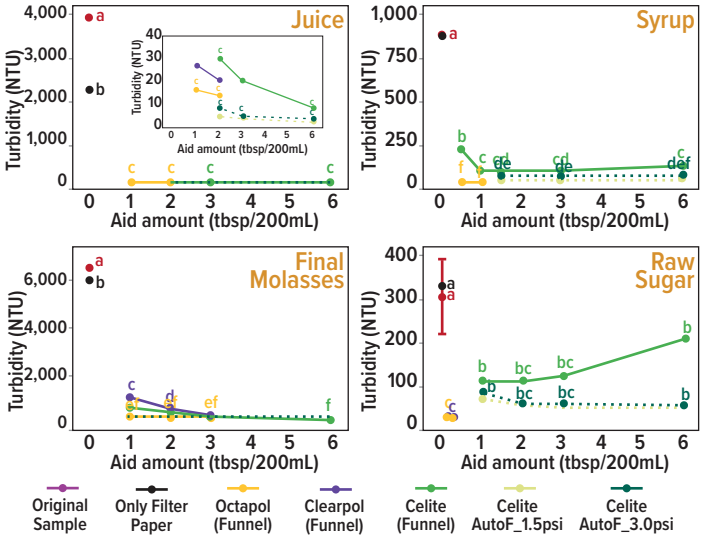

*Autofilt Z automatic pressure filtration unit (Schmidt + Haensch, Berlin, Germany).*

- Octapol and Clearpol increased the Brix values of the filtrate due to dissolved salts, while Celite had no significant effect. In contrast, the Autofilt Z method provided consistent Brix readings of the filtrate and allowed direct purity estimation without any centrifugation. Octapol and Clearpol also decreased pol readings at 880 nm, especially in juice and syrup, while Celite with Autofilt Z showed minimal impact.




*Effect of increasing amounts of clarification/filtration aid during funnel and automatic filtration on pol measured at 880 nm.*

- Autofilt Z significantly reduced the turbidity of the filtrate and the filtration time, cutting daily filtration time for 250 samples from eight to four hours. It also reduced the consumption of filter/clarification aid and required only one operator, resulting in seasonal cost savings of at least $15,331 compared to manual funnel filtration.




*Effect of increasing amounts of clarification/filtration aid during funnel and automatic filtration on turbidity.*

## Annual cost of funnel filtration and automatic filtration (including aids and labor)*.

| Filtration method | Filtration aid | Amount (kg/ season) | Aid cost (U.S. $/ season) | Number of analysts | Staff cost (U.S. $/ season) | Extra cost versus AutoFilt Z (U.S. $/ season) |
|---|---|---|---|---|---|---|
| Funnel | Octapol (2 tbsp) | 570 | 13,300 | 2 | 19,200 | 15,331 |
| Funnel | Clearpol (2 tbsp) | 380 | 9,880 | 2 | 19,200 | 11,911 |
| Automatic | Celite (5% w/v) | 312 | 7,569 | 1 | 9,600 | - |

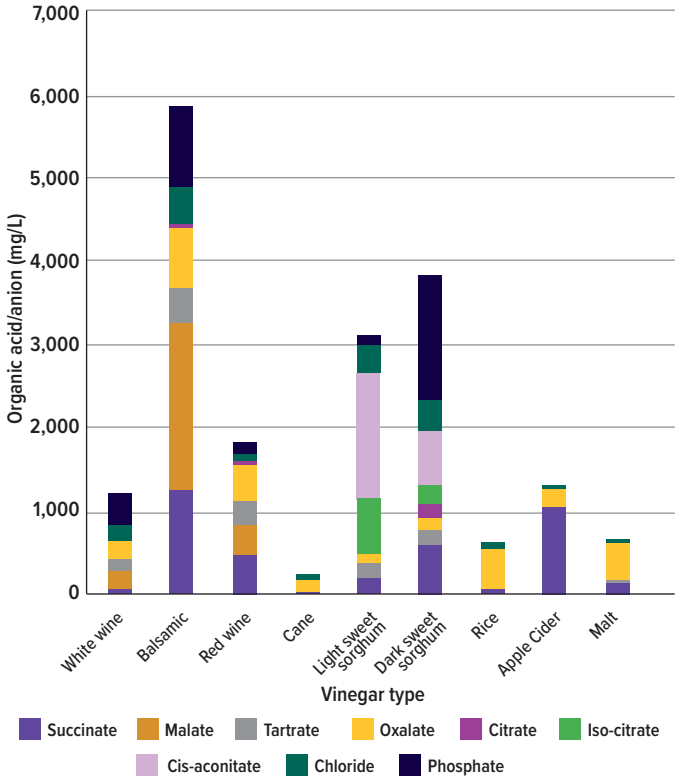
*Calculations based on 100 days/processing season, U.S. $8/hour/employee, 12 hours/day

- The study concluded that Autofilt Z, when used with Celite, is an efficient, reliable, and cost-effective solution for improving the accuracy, speed, and affordability of polarimetric analysis in sugar factories, particularly for dark samples analyzed at 880 nm.

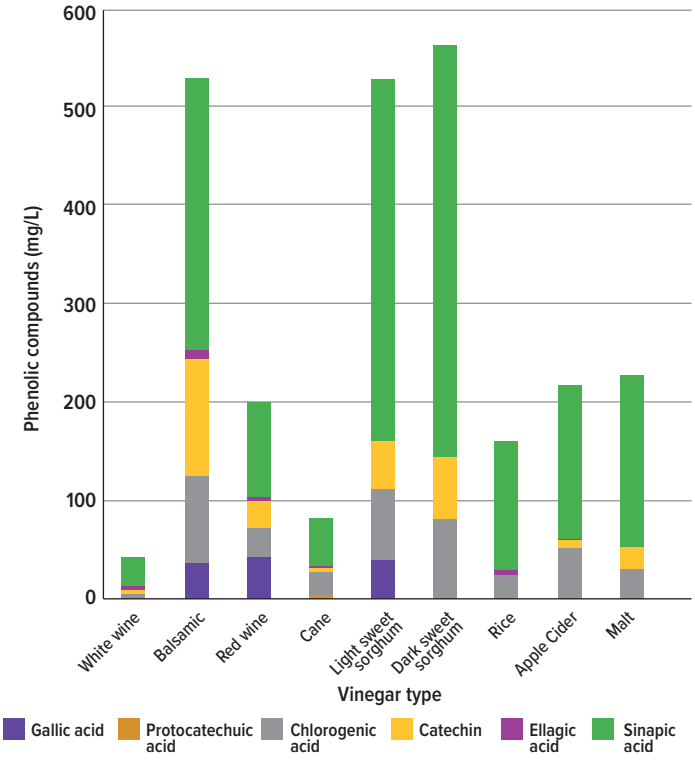
## Composition and Health Benefits of Vinegars from Sugar Crops

*By Gillian Eggleston*

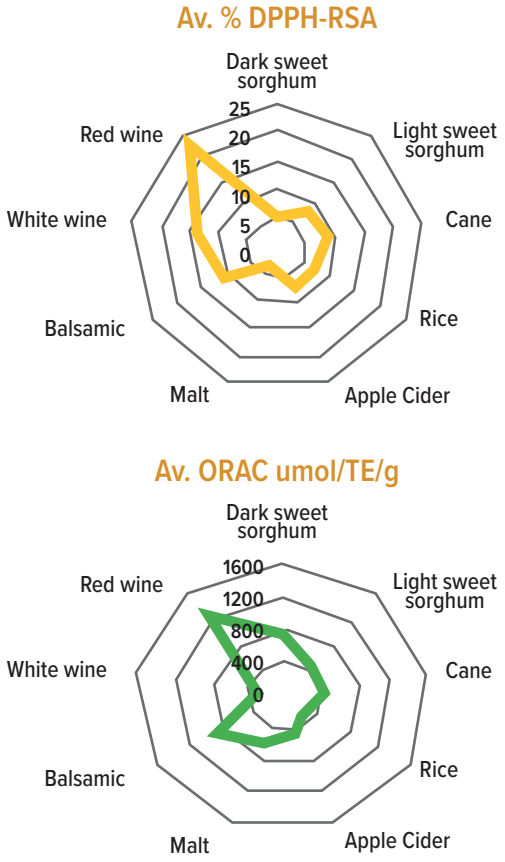
- Many types of commercial vinegars are now available, including food, specialty (gourmet), cleaning (produced in large volume) vinegars and even flavored drinking vinegars that are growing fast in popularity. This has set the stage for the greater production and marketing of sugar crop vinegars manufactured from sugarcane juice or diluted syrups and even sugarcane rejects and by-products including bagasse and molasses. How commercial sugarcane and sweet sorghum (a grass sugar crop similar to sugarcane) vinegars compare in composition and nutritional benefits to other popular vinegars will facilitate their utilization and marketing.
- Eighteen commercial sugarcane, red wine, white wine, apple cider, balsamic, rice, malt and sweet sorghum vinegars were analyzed for phenolic compounds, total phenolic and acid contents, antioxidant activity, organic acid and anion contents, color, Brix, density and turbidity. There was a large variation in Brix (3.3% to 28.6%) among all the vinegars and cane vinegars (four) ranged from 2.2% to 11.6%. Color indicator values (color at pH 9.0/color at pH 4.0) were not an indication of phenolic colorants in the vinegars. The cane vinegars exhibited the lowest pH values (2.49 to 2.83), which may impart greater preservation ability. Vinegars manufactured from particulate juices had higher turbidity values compared to those from diluted syrups.
- Only the sweet sorghum vinegars contained aconitic acid (cis form) and relatively high levels of citric and isocitric acids.
- Dark sweet sorghum vinegar contained significantly the greatest amount of total phenolic content (2,617 mg/L). The predominant phenolic components in the vinegars were phenolic acids with only one flavonoid (catechin) detected. Sinapic acid was the major phenolic acid in many vinegars.
- The antioxidant capacity of the vinegars was measured with two complementary methods: DPPH radical scavenging activities and ORAC oxygen radical absorbance capacity, with acceptable values for sweet sorghum and vinegars, but red wine vinegars exhibited the highest values.
- Overall, vinegars from cane juice had higher nutritional value than vinegars from syrups and white wine and were in the same range as red wine and cider vinegars. Sweet sorghum vinegar produced from diluted syrup had higher nutritional value than vinegar from juice and were, generally, in the same range as balsamic and red wine vinegars.
- This research has given sugar and food technologists, as well as consumers, around the world important information on the nutritional benefits of vinegars manufactured from sugar crop feedstocks.




*Average contents of organic acids and anions in the vinegars.*




*Average contents of phenolic compounds in the vinegars.*

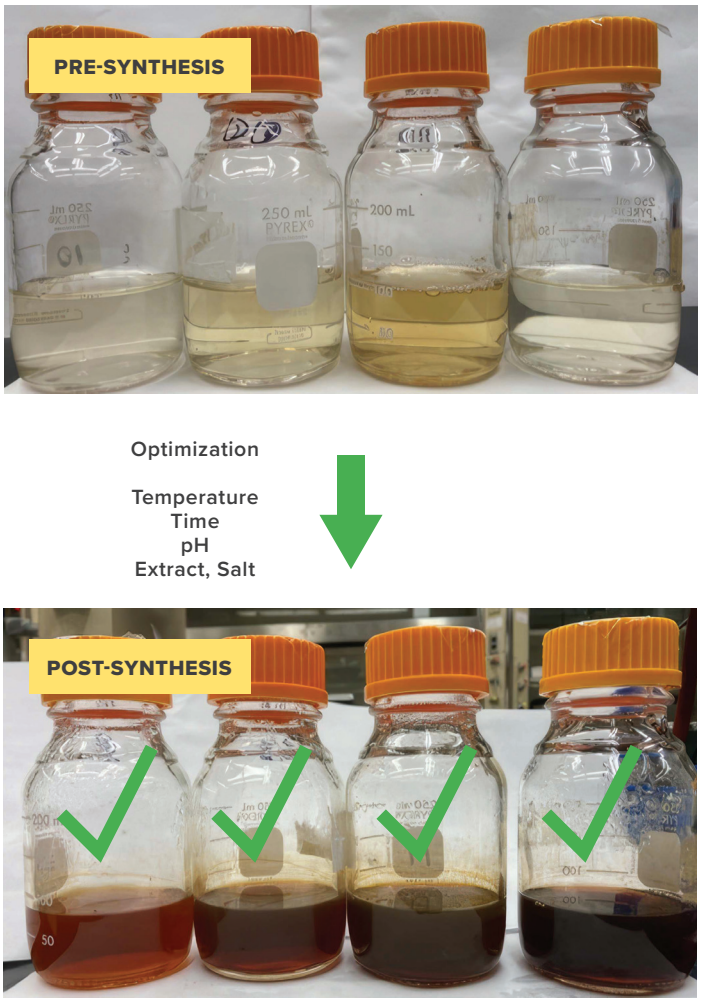



*Spider plots of antioxidant capacity (average values) of sugarcane, sweet sorghum and other commercial vinegars measured in (top) and (bottom) ORAC units (µmol/TE/g).*

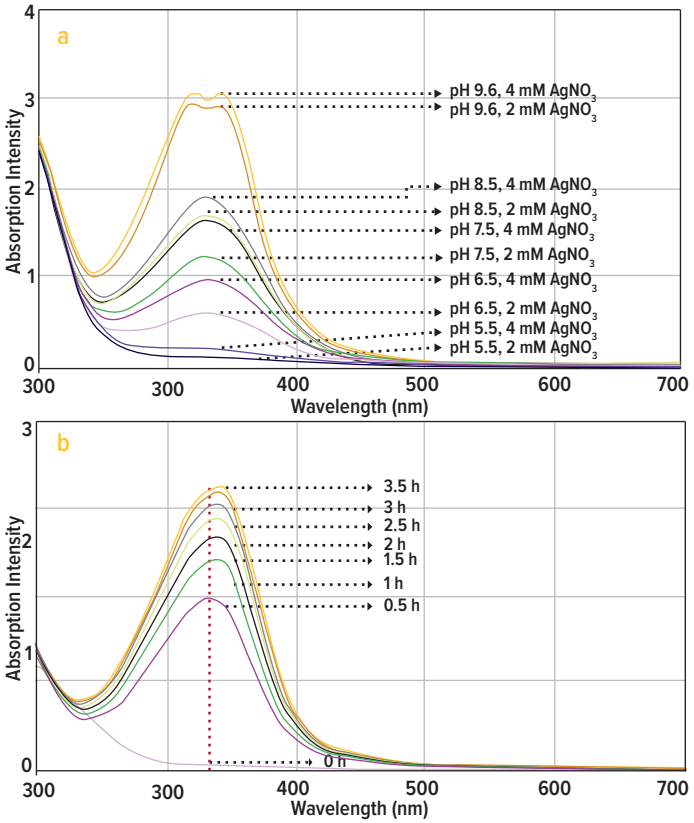
## Sugarcane-Derived Nanoparticles: Synthesis

*By Giovanna M. Aita*

- Nanotechnology is a novel area of science that combines biology, chemistry and physics, and plays a vital role in diverse fields like medicine, food and agriculture. Metal nanoparticles are less than 100 nm in size and have distinctive physicochemical characteristics which can help enhance the antimicrobial, antioxidant, anti-inflammatory, catalytic and optical properties of many biomolecules.
- Eco-friendly and biological approaches, where microorganisms, enzymes, polysaccharides, oligosaccharides, fungi, yeast, intact plants and plant extracts (green method) are used in the synthesis of metal nanoparticles, have received vast attention in the last decade.
- The most robust and popular approach is the green synthesis of metal nanoparticles from plant extracts.
- A new green method was developed for the synthesis of silver nanoparticles from the polyphenols extracted from blackstrap molasses or bagasse (e.g., gallic acid, vanillic acid, p-coumaric acid, ferulic acid, sinapic acid, caffeic acid, 4-hydroxybenzoic acid, syringic acid, protocatechuic acid, ellagic acid, chlorogenic acid, catechin, syringaldehyde, 4-hydroxy-3-methoxyphenyl and 2-methoxy-4-vinylphenol).
- Optimization of reaction parameters, i.e., temperature, pH, time, silver nitrate ($AgNO_3$) and extract concentrations, for the synthesis of nanoparticles is crucial and a prerequisite for achieving stability, maximum yield and control over nanoparticles size and shape to prevent aggregation.
- Polyphenols act as reducing agents of the silver ions and as capping agents of the newly synthesized nanoparticles.
- The reduction of silver ions and synthesis of nanoparticles from molasses or bagasse extract were visually confirmed by the color change as the reaction mixture turned from light yellow to dark red brown and by the appearance of a distinct peak at 430 nm observed by UV-Vis analysis.




*Synthesis optimization of silver nanoparticles from polyphenols extracted from sugarcane by-products.*



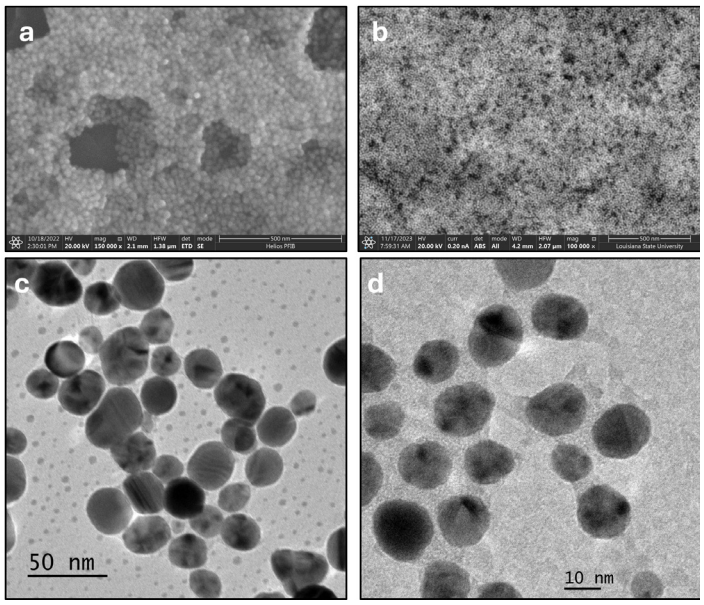

*UV-Vis spectra of the synthesized silver nanoparticles from bagasse extract at (a) increasing pH (5.5-9.6) and final silver nitrate concentrations (2-4 mM $AgNO_3$) for 30 minutes, and at (b) increasing reaction times of zero to three and a half hours with 4 mM $AgNO_3$ at pH 9.6. The dashed line indicates the slight red shift taking place after one hour at 430 nm. Optimum synthesis conditions were mixing bagasse extract and silver nitrate solution (9:1 ratio) to a final concentration of 4 mM $AgNO_3$, pH 9.6, at 85 C for one hour.*

- Optimum conditions for the synthesis of nanoparticles from (1) molasses were observed when mixing extract and $AgNO_3$ solution (9:1 ratio), 1 mM $AgNO_3$, pH 7, at 90 C for one hour, and (2) bagasse were observed when mixing extract and $AgNO_3$ solution (9:1 ratio), 4 mM $AgNO_3$, pH 9.6, at 85 C for one hour.

## Sugarcane-Derived Nanoparticles: Characterization

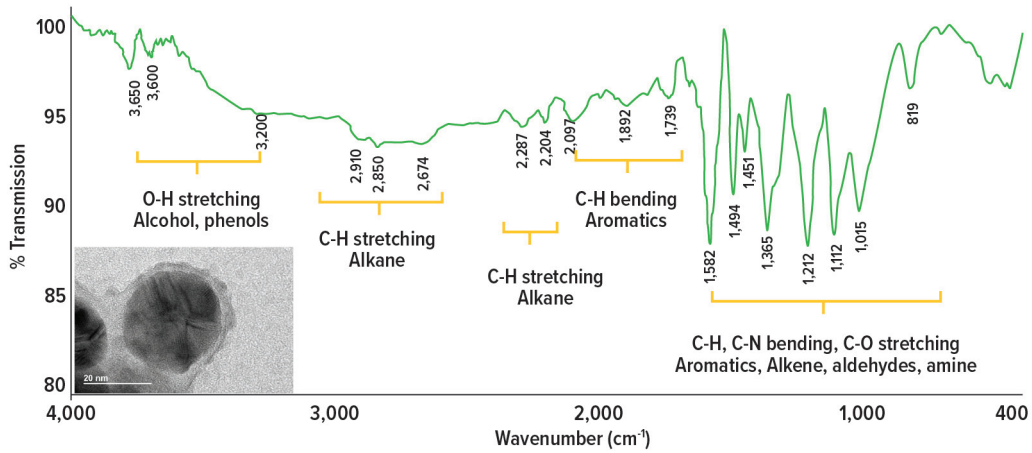
*By Giovanna M. Aita*

- Methods for characterizing nanoparticles involve microscopy, e.g., SEM, TEM and spectroscopy (e.g., EDS, FTIR, XRD) techniques. They play an important role in the analysis of various features, including morphology, chemical composition, compound structure, topology, interfacial properties, etc.
- Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) images of sugarcane-derived nanoparticles showed spherical shapes with uniform size distribution and with nanoparticles ranging in size from 40-65 nm for those derived from molasses extracts and ~15 nm in size for those derived from bagasse extracts.

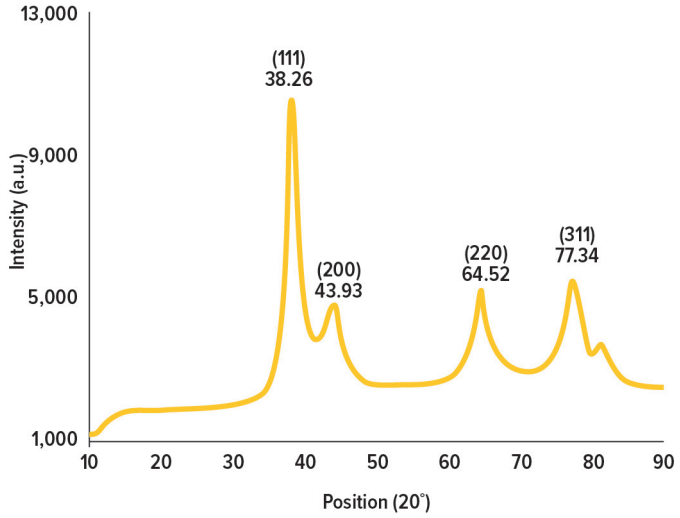



*SEM and TEM images of synthesized silver nanoparticles from polyphenols extracted from molasses (a, c) and bagasse (b, d).*

- The synthesized nanoparticles had an average negative zeta potential of -15.6 mV (molasses) and -24.8 mV (bagasse). This was an indication of their strong stability in solution.
- Energy-dispersive X-ray spectroscopy (EDS) analysis showed the strong elemental silver (Ag) signal or peak at 3 keV indicating that the synthesized nanoparticles were of high purity and confirmed their formation.
- Fourier transform infrared (FTIR) spectroscopy was employed to characterize the biomolecules that participated in the reduction of silver ions to nanoparticles by identifying the possible functional groups capping them. Peaks observed illustrated the various active groups such as hydroxyl, carboxylic acids, alkanes, alkynes and alkyls, which are characteristic of the identified polyphenols present in the extracts (e.g., gallic acid, vanillic acid, p-coumaric acid, ferulic acid, sinapic acid, caffeic acid, 4-hydroxybenzoic acid, syringic acid, protocatechuic acid, ellagic acid, chlorogenic acid, catechin, syringaldehyde, 4-hydroxy-3-methoxyphenyl and 2-methoxy-4- vinylphenol).
- The phase purity and crystallinity of the prepared nanoparticles were studied using X-ray diffraction (XRD) analysis. Sharp and well-defined diffraction peaks were observed characteristics of the metal face-centered cube, indicating that the nanoparticles formed were essentially crystalline.




*FTIR spectra for synthesized nanoparticles from sugarcane by-products.*

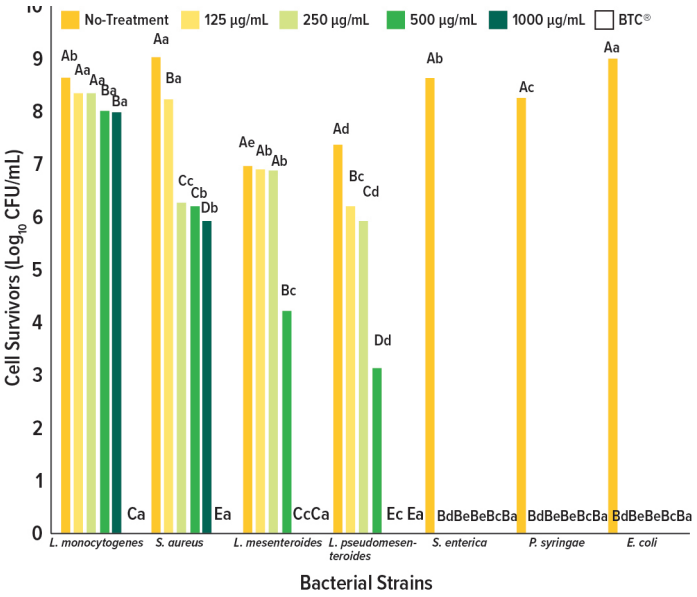



*XRD spectra for synthesized nanoparticles from sugarcane by-products.*

## Sugarcane-Derived Nanoparticles: Antimicrobial Properties

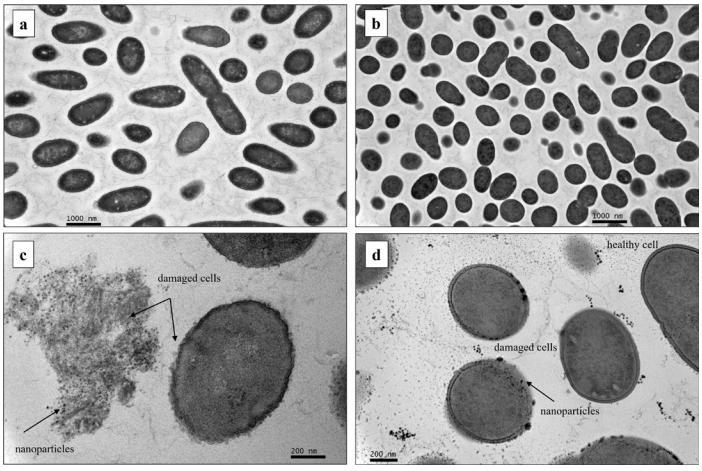
*By Giovanna M. Aita*

- Metal-based nanoparticles are widely used as biocides across multiple industries due to their strong antimicrobial activity against bacteria, fungi and some viruses. In healthcare, they are incorporated into wound dressings, medical device coatings and hospital textiles to reduce infections. In food and agriculture, they are applied in antimicrobial packaging, surface disinfectants and crop protection. Water treatment systems use nanoparticle-coated filters to eliminate pathogens, while consumer goods such as cosmetics, soaps, textiles and household appliances benefit from their antimicrobial properties. Industrial uses include paints, coatings, plastics and construction materials.
- The diversity of synthesized nanoparticles (e.g., shape, size, charge) allows them to interact with different microorganisms. The synthesized sugarcane-derived nanoparticles were more biocidal against the Gram-negative bacteria *Salmonella enterica* ATCC 13312, a foodborne pathogen that causes salmonellosis (a bacterial disease that affects the intestinal tract); *Pseudomonas syringae* ATCC BAA 871, a plant pathogen that causes fruit spot and foliage blight; and Escherichia coli ATCC 35218, a foodborne pathogen that causes dysentery, than the Gram-positive Listeria monocytogenes ATCC 19115, a foodborne pathogen that causes listeriosis; Staphylococcus aureus ATCC 12600, a human pathogen associated with nosocomial infections; and two previously identified food spoilage isolates from crusher juice *Leuconostoc mesenteroides* (A17) and *Leuconostoc pseudomesenteroides* (A25), microbes that cause operational challenges during raw sugar production.




*Antimicrobial activity of sugarcane-derived nanoparticles (125-1,000 µg/mL). BTC, a broad-spectrum disinfectant, at a final concentration of 500 µg/mL was used as positive control. Bacterial cells grown in media with no antimicrobial treatment were considered negative controls. Bars with different uppercase letters are significantly different ($p < 0.05$) within each bacterial isolate at various nanoparticles concentrations. Bars with different lowercase letters are significantly different ($p < 0.05$) among bacterial strains at various nanoparticles concentrations.*

- Gram-positive bacteria were more resistant to the sugarcane-derived nanoparticles than the Gram-negative bacteria due in part to their cell wall composition. Gram-positive bacteria have a thick (~20 nm) peptidoglycan layer in their cell walls, consisting of short peptide cross-linked linear polysaccharide chains, which results in a more rigid and less penetrable structure for nanoparticles, whereas the Gram-negative bacteria have a thinner (5-7 nm) peptidoglycan layer surrounded by an outer membrane. Furthermore, the positive charged silver in the nanoparticles attach to the lipopolysaccharides core component of the bacterial cell wall of the Gram-negative bacteria, making them more susceptible to the nanoparticles.
- The exact mechanisms by which these sugarcane-derived nanoparticles affect bacteria are yet to be understood. However, based on published information and our results it can be suggested that these nanoparticles interact with the cell surfaces of bacteria, cause disruption of intracellular organelles, and produce reactive oxygen species (ROS) and free radicals causing oxidative stress, which can be deadly to bacterial cells.
- TEM images of the Gram-negative *E. coli* ATCC 35218 and the Gram-positive *Leuconostoc mesenteroides* (A17) exposed to 125 µg/mL nanoparticles for 30 minutes and 500 µg/mL nanoparticles for three hours, respectively, showed significant damage to the cell wall and outer membrane compared to control. TEM images also showed the attachment of the nanoparticles to the cell surfaces, which led to their disruption and disintegration, followed by cell leakage and death.




***TEM images of (a) Escherichia coli ATCC 35218 cells (control), (b) Leuconostoc mesenteroides (A17) cells (control), (c) E. coli cells exposed to 125 µg/mL nanoparticles for 30 minutes, and (d) L. mesenteroides cells exposed to 500 µg/mL nanoparticles for three hours.***

- Despite their versatility, concerns remain about potential environmental accumulation, regulatory restrictions, and the risk of microbial tolerance. Thus, their use requires a balance between effectiveness and safety.

## Harold Birkett

- **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.
- **Core laboratory** visits were made to several factories to review procedures and methods and to provide factory personnel and growers with an understanding of both core lab and factory reports. The core lab provides information for cane payment and predicted factory yield.
- **Cold tolerance tests** were conducted in Shriever, Louisiana, following freezes in 2022, 2023 and 2024 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 and breeders as it gives an indication of varietal cold tolerance. It can also provide an indication of the degree of cane deterioration that may be expected at the factories. More about these tests can be found in the Louisiana Sugarcane Research Annual Progress 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, polysaccharides, phosphate, color, titratable acidity, etc.). There were several requests for literature searches regarding continuous pans, boilers, scrubbers, viscosity, molasses exhaustion, crystallization, 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.
- **Sugar losses** were an issue at some of the factories over the 2022 to 2024 period. Assistance was given with sampling and analyses of bagasse, final molasses, filter cake and entrainment losses.

## JoseManuel Henriquez

- The 2022 grinding season in Louisiana presented two unique problems particularly early in the season: (1) **high pol content in the cane at the beginning of the grinding season compared with the previous seasons** and (2) **the immediate appearance of elongated and needle grain, while the presence of dextran was not detected**. Some factories had to deal with the latter problem intermittently throughout the whole season. Helped multiple Louisiana factories with multiple visits to coordinate responses by increasing the cleaning and sanitation protocols, as well as addition of enzymes to cope with the increasingly difficult operations in vacuum pans and to obtain adequate molasses exhaustion.
- During the 2023 Louisiana grinding season, drought-affected cane was processed. The main problem from this, observed during the whole grinding, was the increasing levels of starch. Helped numerous mills with visits to discuss this situation and provide information on the point of application of amylases (enzymes that break down starch), temperatures, dosages, to control high levels of starch.
- A new C massecuite continuous vacuum pan (CVP) was installed at one Louisiana factory and there were associated problems including the determination of the amount of C massecuite produced. It was advised that they utilize the capacity of C massecuite pumps to obtain an estimate of the amount. This estimate then allowed them to calculate the amount of molasses fed into the pan and determine crystal yield.



*JoseManuel Henriquez, left, discusses factory problems with processors at the factory.*

- Advised one factory with the replacement of their clarifier for a new one of higher capacity. Discussed with them the alternatives between rebuilding with the same design or rebuilding changing design to one LLT type clarifier. Put them in contact to another factory out of the country that did the latter and the company that builds them.
- Aided one factory that had to process cane of extreme dehydration which forced them to add water before the crusher, so they could get some juice in the first mill.
- Advised factory during the 2023 grinding season on the operations of their continuous vacuum pans for all massecuites (A, B and C) with good results.
- Helped multiple factories, during the 2024 Louisiana grinding season that had faced heavy rains causing them to deal with unusual amounts of mud and high levels of dextran.

- Advised a Louisiana factory in 2024 on the appropriate pan operations. This included optimized dilution of the molasses before feeding the vacuum pans and the use of a reheater to raise C massecuites to optimum temperatures.

## *Roundtable Conversation Events*

In 2021, Henriquez started one-day conversation events for key professionals involved in raw sugar manufacturing, specifically targeting fabrication superintendents, chief chemists and control system engineers. These extension events are roundtable-style gatherings that create a relaxed, open environment where peers from different factories can connect, put faces to names and exchange real-world experiences from day-to-day operations — both the successes and challenges. From the start it quickly became apparent how valuable these events were, and an important gap was highlighted: Many operational decisions depend heavily on laboratory data. The latter explains why in 2022 the group was expanded to include chief chemists. This addition broadened the scope and depth of discussions, but it also revealed one more missing gap. While process management and chemical analysis work hand-in-hand, real-time automation is critical to turning ideas into action. To complete that loop, control systems engineers were later included, allowing discussions to move seamlessly from concept to implementation.

## *Topics and Discussions*

From 2022 to 2024, the conversation topics covered a wide range of practical, factory-driven subjects, including:

- Early versus late season start-ups
- Sanitation strategies and enzyme treatments for dextran and starch control
- The role and importance of demister separators in evaporators and pans
- Documentation of grinding results to capture actionable insights

## *Growth and Engagement*

The events are typically held in mid-March and have shown steady growth in attendance. Participation increased from approximately 25 factory representatives plus 10 ASI staff in the first year to about 45 factory representatives plus 15 ASI staff by 2024. This consistent growth reflects the strong interest and value that participants place on these conversations.

Informal feedback from attendees has reinforced this impact. Participants frequently describe the events as “an important forum to discuss pressing, practical situations faced in daily factory operations” and note that they “look forward to each conversation as an opportunity to openly share and learn from both positive and challenging experiences from the previous grinding season.”

## *Shift Toward Factory-Led Contributions*

During the first three years, the events followed a facilitator-led format, with data presented, topics introduced and discussions guided to encourage participation and documentation of observations. In 2024, the format evolved again — this time placing factories at the center of the conversation.

Factories were invited to prepare and present papers based on their own trials and operational experiences. The response exceeded expectations: **10 of the 11 Louisiana factories** presented papers addressing topics such as:

- Mud pump performance
- Filter cake calculations
- Operational results and improvements across the previous three grinding seasons
- Color removal and clarifier comparisons
- Advantages of split CVPs
- Final molasses exhaustion
- Future fabrication department projects
- Five-year equipment addition plans aligned with grinding rate goals

## *Ongoing Value*

This shift has created a strong foundation for continued collaboration and follow-up. It allows not only for deeper discussion of topics that matter most to the factories but also provides a real-time measure of operational improvement across the industry. As these conversations continue to evolve, they remain a practical, peer-driven platform for learning, improvement and shared progress.



*Cody Eaves of St. Mary factory gives a presentation at the 2024 Roundtable Conversation Event.*

## Stephania Imbachi Ordonez

- Conducted belt filter comparisons at two Louisiana factories; Crompion filters showed lower pol in filter cake and higher mud retention.
- Assisted one factory in resolving excessive C molasses foaming; recommended surfactant use to control foam formation.
- Supported John Deere in calibrating NIR technology to quantify leaf content in shredded cane.
- Guided A. Wilbert's Sons in setting up Tango NIR for preharvest cane analysis and training personnel on calibration model development.
- Provided assistance to one Louisiana factory in decision-making for processing sugarcane affected by lightning (~55 acres); site visit, sample collection and juice analysis led to recommendation to process cane immediately and blend with fresh cane.
- Conducted a clarifier performance trial at a factory; analyzed flash-heated limed juice and clarified juice samples for turbidity, pH and sugar content by high performance liquid chromatography.
- Performed clarification aid testing at Cora, Texas, factory; initial Clearpol batch failed, prompting further testing with a new batch and Octapol. Factory ultimately reverted to Octapol after comparative evaluation.
- Supported Westfield pan floor operations by training operators on microscope use for crystal size monitoring and evaluating C-stage crystal size impact on slurry quantity.



*Stephania Imbachi Ordonez looks at sugar factory crystals at a Louisiana factory.*

# Training by Audubon from 2022-2024

During the previous ASI strategic plan timeline (2018 to 2023), we expanded training to include updating and modernizing the training facilities at Audubon. Specifically, this included (1) virtual transmission of courses, (2) incorporating smartboard technology, (3) training in English and Spanish (upon request), (4) course content enhancement by visits to the Audubon pilot plant and (5) optional factory visits available on request. Training courses and workshops from 2022 to 2024 were undertaken at the Audubon Sugar Institute and at outside venues.

## Introduction to the Technology of Raw Sugar Production (one and a half days)

*By Stephania Imbachi Ordonez and Lenn Goudeau*

- This course was introduced in 2020 and has become popular with factory personnel, sugar researchers and even people outside of the sugar industry. It 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, general mass balances across sugar factories, sucrose losses, environmental issues related to sugar production and utilities (water, steam, and energy).



*Stephania Imbachi Ordonez, center, gathers with 2023 course participants.*

## Color and Decolorization Processes (one day)

*By Gillian Eggleston*

- This course was designed for technical staff working in raw sugar factories and cane refineries.
- This course was given at LSR Refinery in Louisiana in April 2023 and in Morocco in 2025.
- The training course includes information on the analysis of color and color balances across the factory, natural colorants extracted in sugarcane juice, process derived colorants, color control and removal at the factory and refinery, as well as a summary of refinery decolorization processes on different colorant types and process combinations.

## Sugar Boiling for the Sugar Industry (two courses of three to four days)

*By Harold Birkett and Lenn Goudeau*

- This popular hands-on course was separated into two complementary courses in 2023. The first course was "Introduction to Sugar Boiling for the Sugar Industry" designed for people with no or limited sugar boiling experience or those who want to learn how to boil (crystallize) sugar and gain an understanding of the principles involved. During the course, participants learn background information on sugar crystallization and how a vacuum pan works. They also learn how to concentrate syrup to reach supersaturation, seed and grow a sugar grain strike, and gain a practical grasp of sugar boiling using unique hands-on, pilot plant equipment.



*Students from Leighton Sugars receive their sugar boiling short course certificates of completion from instructors Harold Birkett and Lenn Goudeau on March 24, 2022.*

- The second, more advanced course was "Intermediate Sugar Boiling for the Sugar Industry" for people who (1) already have a basic understanding of the sugar crystallization process, (2) have worked on the vacuum pan floor and want to learn more, (3) want a refresher, and/or (4) have previously taken the "Introduction to

Sugar Boiling for the Sugar Industry" course. Not only do trainees learn theoretical and practical information on sugar crystallization, including effects of steam, vacuum and purity on sugar boiling, and how a vacuum pan works, they also seed and grow a sugar grain strike and make magma to grow A, B and C strikes from syrup, A molasses and B molasses (in the pilot plant).

## Chief Chemist Short Course (two 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 (three days)

*By Jeanie Stein*

- This 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 a bench chemist 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.

## Sweeteners: Choices, Production and Functionalities in Products (two 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

# New Courses in Development

In the new ASI strategic plan (2023 to 2028) training has expanded to build advanced skills for factory and refinery employees, particularly focusing on data analyses, interpretation and advanced automation.

## Introduction to Crystallography and its Applications in the Sugar Industry Course (one day)

*By Ricardo Carcamo*

- The course is designed for laboratory and factory technicians and processors with a basic understanding of the crystallization process.
- The course will introduce the basic concepts of the crystalline structure of sucrose, microscopic and macroscopic features, introduction of crystal size population metrics and distributions, crystal size characterization techniques, morphology features, good practices in crystal size analysis, interpretation of crystal size analysis results, introduction to the mass-count relationship for crystallization, crystal size as guidance for seeding and crystal population balance.

## Intermediate Course in the Technology of Raw Sugar Production

*By Stephania Imbachi Ordonez, Ricardo Carcamo, and Gillian Eggleston*

- Following the existing one-and-a-half-day "Introduction to the Technology of Raw Sugar Production" course, we will expand on this and create a new three-day advanced "Intermediate Course in the Technology of Raw Sugar Production."
- This course is being designed for participants who already have some experience in the sugar industry and want to deepen their technical and practical understanding. The course will refresh essential concepts for all factory operations (milling, clarification, evaporation, crystallization, centrifugation and refining) but also will expand into more advanced topics. These include detailed mass and energy balances, process control strategies and instrumentation, new technologies in the industry, the behavior and impact of factory impurities (such as starch, dextran, and fructan), the up-to-date use of enzymes, sucrose losses and ways to minimize them, and color development and control across the factory, among others. This intermediate version is intended to bridge foundational knowledge with practical, higher-level tools needed for process optimization.

## Apprenticeship in Factory Sugar Operations (approximately one year)

*By Ricardo Carcamo*

On the recommendation of the ASI Training Advisory Committee, particularly Frank Jamieson, a new type of course based on past industrial apprenticeships is being developed. What is proposed is a credit-based sugar technologist diploma, with optional and mandatory courses either already taught or in development at the ASI. Once a certain number of credits is fulfilled, a diploma will be awarded. These courses will include introductory courses in the sugar industry, specific process areas, factory performance indicators, data analysis, statistics, laboratory practices, pilot plant trials and practical work at the factories. Courses will be covered by (1) factory instructors, (2) Audubon personnel and (3) guests at ASI.

## Workshops Available

**A number of workshops are also available from ASI upon request (one to two days).**

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

In addition to providing courses and workshops, ASI scientists sometimes give ad hoc symposiums. Giovanna Aita gave an ad hoc symposium on “Microorganisms in Sugarcane and Raw Sugar Processing: Impact and Preventative Action” in the fall 2023 at ASI. Giovanna Aita and Gillian Eggleston were also co-organizers of a symposium at the American Chemical Society national meeting (CARB Division) in Denver 2024. The title of the symposium was “Circular Sustainability of Sugar Crops.”

# Updates on the Audubon Pilot Plants

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 with a loading and unloading yard. The pilot plant equipment can be used for many types of crop feedstocks.

## *List of ASI Pilot Plant Capabilities*

- Continuous operation cane/biomass preparation equipment including conveyor load cell, two knives, shredder, mill tandem and juice clarification system
- Batch pilot plant equipment including cane chipper, cane splitter, cane de-pither, shredder, three-roll mill and French oil press
- Batch juice processing equipment including evaporators and vacuum pans
- Two 16 L fermenters (portable)
- Steam explosion bioreactor
- 120 psi steam supply and two vacuum pumps
- Walk-in cooler at 35 F and a walk-in freezer at -8 F
- Welding shop and machine shop capabilities
- Trained personnel to operate the pilot plant safely
- Various size trailers including a dump trailer

The Audubon pilot plant equipment and operators are available for rent, collaborative projects and training. The pilot plant equipment is taken care of by facility manager Stuart Goudeau.



*The clarification system in the Audubon pilot plant.*

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# AWARDS

## International Awards

### *2024 Sugar Industry Technologists (SIT) Crystal Award for Outstanding Achievement in Sugar Technology*

**Gillian Eggleston**, 2024 SIT Annual Meeting, Vancouver, Canada. Eggleston is only the third woman to win this prestigious award.



### *2022 SIT George and Eleanor Meade Best Paper Award*

**Stephania Imbachi Ordonez** and **Gillian Eggleston** (co-authors), "Implementing predictive dynamic process simulation technology to optimize sugar refinery vacuum pan operation." Presented at 2023 SIT Annual Meeting, New Orleans, Louisiana, USA.

### *2022 SIT Frank M. Chapman Memorial Best Poster Award*




**Stephania Imbachi Ordonez**, "Comparative study of evaporator cleaning practices at Louisiana factories." Presented at 2023 SIT Annual Meeting, New Orleans, Louisiana, USA.

### *2023 August John Vitos Award for Best Poster, ISSCT Co-Products Commission*




**Giovanna Aita** and **Young Hawn Moon**, "Unlocking the real potential of black soldier fly larvae protein and lipid derivatives from cane by-products as animal feed." 31st Congress of the International Society for Sugar Cane Technologists, Hyderabad, India.

### *2023 John Clayton Award for Best Poster, ISSCT Factory Commission*




**Giovanna Aita** and **Young Hawn Moon**, "Effect of cultivation conditions on extracellular polymeric substances production by microbial isolates from Louisiana's crusher juice." 31st Congress of the International Society for Sugar Cane Technologists, Hyderabad, India.

### *2023 German Association of Sugar Technologists (VDZ) Prize Paper*

**Stephania Imbachi Ordonez**, "Benchmark study of evaporator cleaning practices in Louisiana cane sugar factories." Sugar Industry International.

### *2023 German Association of Sugar Technologists (VDZ) Best Paper Award*

**Gillian Eggleston**, **Alexa Triplett** and **Peter Gaston**, "Fructan (levan) is a more pervasive polysaccharide in the sugar industry than previously thought." Sugar Industry International.

## National Awards

### *Charle E. Coates Memorial Award*

**Gillian Eggleston**, from the Baton Rouge Section of the American Chemical Society for contributions to profession, community and society of Louisiana. 2022 Charles E. Coates Memorial Award Banquet, Baton Rouge, Louisiana.



## *2022 Sugar Notable Researcher*



**Harold Birkett**, Sugar Journal

## *2022 Denver T. Loupe Outstanding Paper Award, Manufacturing Section*

**Gillian Eggleston**, **Alexa Triplett**, E. Petrie, **Eldwin St. Cyr**, K. Didier, **Collins Kimbeng** and H. Waguespack, "How glyphosate and moddus ripeners affect starch concentrations in Louisiana sugarcane varieties." Annual Joint Meeting 2022 of the American Association of Sugar Cane Technologists, Florida.

## *LSU AgCenter Tipton Team Research Award for LIBBI (Louisiana Institute of Bioproducts and Bioprocessing), 2024*




**Gillian Eggleston** and **Giovanna Aita**, LSU AgCenter Awards Ceremony, Baton Rouge, Louisiana.

## *Lifetime Achievement Award for work in the Louisiana Sugarcane Industry by St. James Agricultural Tour*

**Jeanie Stein**, 62nd St. James Appreciation Supper, Vacherie, Louisiana.



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

- Applied Biochemistry and Biotechnology
- BioEnergy Research
- Bioresource Technology
- Industrial Crops and Products
- Journal of Applied Microbiology
- Journal of Industrial Microbiology and Biotechnology
- Journal of Chemical Technology and Biotechnology
- Journal of Biomass and Bioenergy
- Sugar Industry Technologists
- Sugar Tech
- American Chemical Society
- American Society for Microbiologists

# INTERNATIONAL ACTIVITIES

## International Commission for Uniform Methods of Sugar Analysis (ICUMSA)

- **ICUMSA General Subject 7 Cane Processing General Referee:** Gillian Eggleston
- **ICUMSA General Subject 7 Associate Referee:** Alexa Triplett
- **ICUMSA General Subject 1 Associate Referee:** Chardcie Verret

## 33rd ICUMSA Session, June 2023

### *The following international method was accepted:*

ICUMSA GS7 (2023) Method "Total, Soluble and Insoluble Starch in Raw Cane Sugar by Microwave-Assisted Neutralization – Tentative" following acceptable single laboratory validation results.

## International Society of Sugar Cane Technologists (ISSCT)

- **ISSCT Chair Processing Section of Factory Commission 2019-2024:** Gillian Eggleston
- **ISSCT Chair of Factory Commission 2023-2024:** Gillian Eggleston
- **ISSCT Member of Co-Products Commission 2019-2024:** Giovanna Aita
- **ISSCT Member Engineering Section of Factory Commission 2023-2024:** Stephania Imbachi Ordonez



## Sugar Industry Technologists (SIT)

The International SIT annual meeting was held in New Orleans, Louisiana, May 7-10, 2023, and delegates visited ASI on May 10.

## World Sugar Yearbook 2022

One Audubon paper titled "Energy cane bagasse as a source of prebiotics" was selected for the World Sugar Yearbook 2022.



## Faculty of the Audubon Sugar Institute 2022-2024



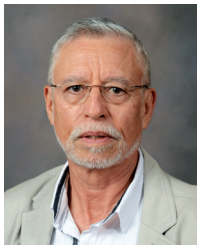
*Dr. Gillian Eggleston*
*Director and Professor*
*Chemistry*



*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)*



*Dr. Anurag Mandalika*
*Assistant Professor*
*Process Engineering*
*2021-2023*

## Staff at the Audubon Sugar Institute 2022-2024



*Tyrenee Foster*
*Research Associate*



*Peter Gaston*
*Research Associate*



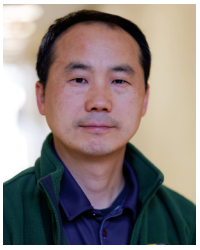
*Lenn Goudeau*
*Research Associate*



*Chardcie Verret*
*Supervisory Research*
*Associate*



*Jason Frazier*
*Maintenance Repair*
*Master*



*Dr. Young Hwan Moon*
*Senior Scientist*
*Specialist*



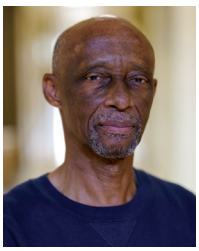
*Alexa Triplett*
*Research Associate*



*Angela Alarcon-Rodriguez*
*Research Associate*



*Faye Muse*
*Admin. Coordinator IV*



*Eldwin St. Cyr*
*Research Scientist*
*Technician*



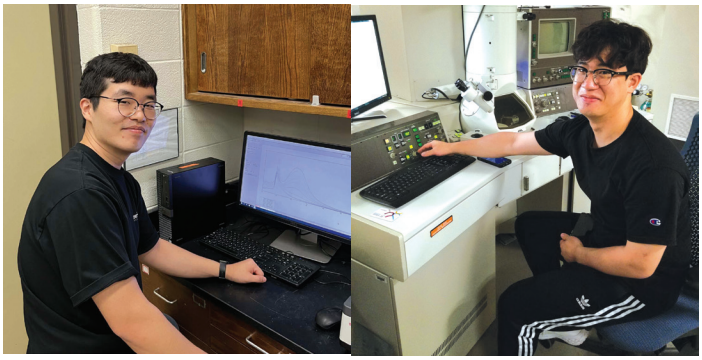
*Tiago Beaulieu*
*Research Associate*
*(Temporary)*

*Not pictured: Jeanie Stein*
*Research Associate*

## Students, Interns and Visiting Scientists at the Audubon Sugar Institute 2022-2024

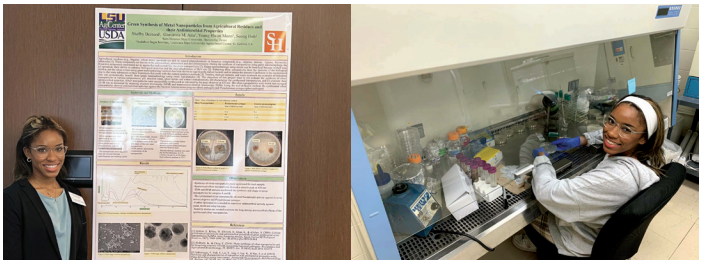


**Seong Huh**, a graduate student of Dr. Doman Kim from Seoul National University, South Korea, spent six months conducting research in Dr. Giovanna Aita's laboratory. Seong optimized a method for the synthesis of metal nanoparticles from wood residues.

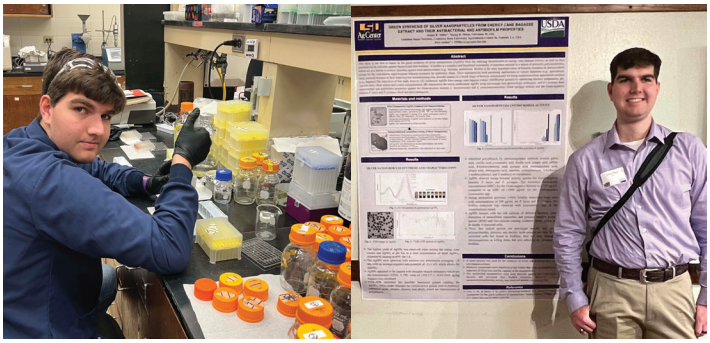


**Kiboem Jin**, left and **Dong Sun Yoo**, graduate students of Dr. Doman Kim from Seoul National University, spent six months conducting research in Dr. Giovanna Aita's laboratory. They evaluated the antimicrobial activities of metal-based nanoparticles.

**Eleanor McFeaters**, an intern at Louisiana Sugar Refining and an undergraduate student at LSU, worked on her thesis proposal called "Implementing SysCAD Dynamic Process Simulation Technology to optimize Sugar Refinery Vacuum Pan Boiling Sequences." She was mentored by a professor from the Biological and Agricultural Engineering Department at LSU and Stephania Imbachi Ordonez and Dr. Gillian Eggleston from ASI.



**Shelby Bernard**, a junior from Sam Houston University, joined Dr. Giovanna Aita's research team as an ASPIRE intern. Her project title and poster presentation were on the green synthesis of metal nanoparticles from agricultural residues and their antimicrobial properties. ASPIRE is a research internship program where students are paired with an expert faculty member who has an available well-defined research project. The faculty member mentors the student in the techniques that are needed to do the research, as well as presentation skills and the writing of technical/scientific reports.



**Julian Miller**, a junior from Louisiana State University, joined Dr. Giovanna Aita's research team as an ASPIRE intern. His research project focused on the synthesis optimization and recovery of bagasse-derived nanoparticles.



**Dr. Giovanna Aita**, from left, with some members of her research team including **Kiboem Jin**, **Dong Sun Yoo**, **Shelby Bernard** and **Dr. Young Hwan Moon**.

**Stephania Imbachi Ordonez**, a research instructor at ASI, in the period 2022-2024 was working on her Ph.D. degree in chemical engineering with the Chemical Engineering Department of LSU in Baton Rouge. She was mentored by chemical engineering professor Dr. Kevin McPeak and Dr. Gillian Eggleston from ASI. The focus of her Ph.D. research was on the use of near-infrared spectroscopy for the Louisiana Cane Payment System.



**Dr. Ahmed Ibrahim Said**, a visiting scientist from the Department of Sugar and Integrated Industries Technologies, Assiut University, Egypt, arrived in 2024 and worked at ASI for nine months as a Fulbright Scholar. The focus of his research was on sustainable building construction materials using renewable cane bagasse a major by-product of raw sugar factories. He worked with Dr. Gillian Eggleston and Dr. Qinglin Wu of the Renewable Natural Resources Department of LSU AgCenter in Baton Rouge.

## Audubon on Facebook




- The Audubon Facebook page was started in 2019, and it continues to be a great way to keep up with notable activities at Audubon.
- The Facebook page is regularly monitored and updated with notable Audubon news, and instant messaging is available through the page. In addition, we have strived to make sure that all Facebook posts are accessible and compliant with the Americans with Disabilities Act.

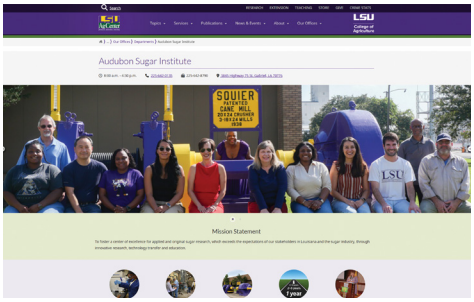
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## New Audubon Analytical Laboratory Services Website

- Via the 2024-2029 Strategic Plan of the Audubon Laboratory Services, the website was completely redesigned and made interactive to make it more accessible for customers as well as user friendly. It can be found on the ASI website homepage or accessed at: https://www.lsuagcenter.com/portals/our_offices/departments/audubon-sugar-institute/analytical-laboratory-services
- The page contains a listing of all the services that are performed: conventional sugar analyses, enzymatic assays, specialized sugar analyses, and other analyses including viscosity, density, total phenolic content, and two types of antioxidant assays.
- Under each type of analyses is the detailed list of the analyses that can be performed on that type of sample.
- It contains background information about the Audubon Analytical Laboratory Services as well as important contact information, the availability of price discounts for multiple samples and how to order laboratory analyses.

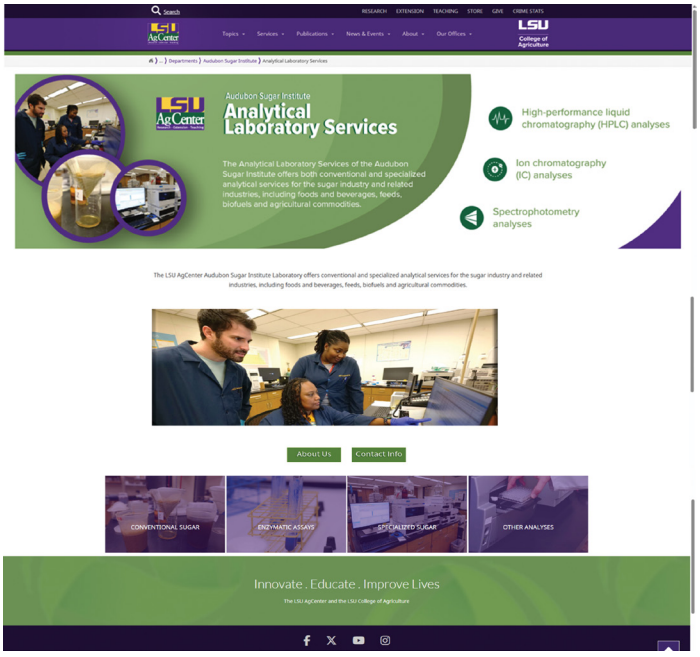
**SCAN FOR EASY ACCESS**
www.lsuagcenter.com/portals/our_offices/departments/audubon-sugar-institute/analytical-laboratory-services

## Audubon Sugar Institute Website




- The ASI website continues to serve as a central platform for sharing information with industry stakeholders, collaborators and the public.
- The **News** section is regularly updated and highlights recent ASI activities, including technical presentations, awards, industry and academic visits, and other notable events involving ASI faculty and staff.
- The **Training and Extension** section was updated to reflect current and accurate information on ASI courses, seminars, and training opportunities available to the sugar industry.
- In the **Publications** section, a direct link to ASI Factory Operations Seminar booklets was added, allowing users to easily access the most recent seminar materials.
- Images and visual elements across the site were updated as needed to improve consistency and presentation.

**THE AUDUBON SUGAR INSTITUTE (ASI) WEBSITE**
website can be found at: www.lsuagcenter.com/portals/our_offices/departments/audubon-sugar-institute




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