
SUMMARY STATUS OF THE 2008 RESEARCH PROGRAM AT CENTRE ACER

October 2008

STUDY OF THE IMPACT OF AIR INJECTION ON MAPLE SYRUP PROPERTIES (PROJECT 330)

This study seeks to understand the mechanism by which air injectors may influence the development of color and taste characteristics as well as its impact on shelf life of maple syrup under various packaging and storage conditions.

A preliminary study (Project 329) evaluated syrups from 17 producers using air injectors and 18 without. It was found that this new technology produced lighter-colored syrups for early and mid-season sap and that off-flavors were more prevalent. As a sequel, the current study produced syrups from 4 producers using early, mid and late season sap, in extremely well controlled lab conditions. The study was designed to evaluate the effect of oxygen on the changes observed while controlling the impact of the mechanical action and the lowering of temperature due to gas injection. The experimental design included:

- Control (no injection)
- 0% oxygen/100% nitrogen injection
- 10% oxygen/90% nitrogen injection
- 21% oxygen/78% nitrogen injection (air)

There were 2 parts to this study:

- Study of the product chemistry: What effect do air injectors have on the product attributes, such as color, taste, pH, Brix, dissolved oxygen, oxido-reduction potential, chemical composition profiles and flavor characteristics? Does air injection contravene Quebec's provincial regulation forbidding the use of decoloring, bleaching and refining processes in maple syrup?
- Impact on conservation: What is the stability of air injected syrup in different packaging materials and with regards to long term storage?

Findings:

- The changes observed cannot be attributed only to mechanical action or delayed caramelisation and Maillard reactions.
- Injection of air in maple syrup enhances a number of complex chemical reactions.
- It appears that the oxygen introduced in sap through air injection, produces a higher concentration of hydrogen peroxides in-situ which in turn may act to oxidize color producing compounds and colored polymers (lighter color maple syrup): bleaching effect? This effect is observed for early and mid season syrups while it seems to be blurred in late season syrups. A much higher rate of production of caramelisation and Maillard reaction by-products (highly colored) may explain this observation.

- A number of different sensory evaluation tests conducted, all point to higher prevalence of off-flavors in air injected samples and a diminution of the characteristic maple flavors.
- No effect on conservation was detected amongst air-injected and control maple syrup samples, except for the original difference obtained upon their production. Subsequent trend in stability followed the same pattern as the control syrup.

Status: All the experimental work is completed. A presentation to the industry and regulatory officials at the provincial level was done (federal level to be scheduled). A final report and scientific papers are to follow.

SCIENTIFIC BASES IN SUPPORT OF A NEW NORTH AMERICAN CLASSIFICATION OF MAPLE SYRUP (PROJECT 388 - PHASE 4)

This project is the fundamental research component in identifying the chemical profiles of newly defined categories based on taste and color. These new categories have been previously determined by statistical analysis of data obtained from the Maple Flavor Wheel project and subsequently from a representative range of samples of North American production (Phases 1 and 2). This work is in support of the IMSI initiative for a revised International Grades and Quality Standards for Maple Syrup. This project is being conducted in partnership with Agriculture and Agri-Food Canada and McGill University. Analysis of the second year of sampling is currently underway. This project will be completed by the end of 2009. A final report and scientific papers are to follow.

ANTI-FOAMING AGENTS USED IN THE MAPLE SYRUP INDUSTRY (PROJECT 8520)

This project is looking at the use of anti-foaming agents during heat evaporation process of maple sap to produce syrup. The main objectives are to:

- Give an overview of the scientific literature concerning the use of anti-foaming agents in the food industry
- Evaluate the context of anti-foaming agents used in Quebec maple syrup industry
- Highlight the basic rules of anti-foaming agent utilization in maple syrup production to build recommendations

Status: A final report expected by the end of 2008

SPECTROSCOPY AS A RAPID TOOL TO EVALUATE MAPLE PRODUCT ATTRIBUTES (PROJECT 437)

This project is conducted in collaboration with Agriculture and Agri-food Canada. In this project, sap and corresponding syrup samples are evaluated in different frequency ranges (UV, visible, near and far IR, fluorescence, etc.) to obtain spectral imprints and correlated with different product characteristics such as sensory characteristics. Ultimately, the objective is to develop a low cost, rapid analysis instrument that can be used for classification and quality control.

Preliminary results showed the good potential of spectroscopy to predict maple syrup characteristics (physico-chemistry and sensory) and help classify syrup based on their major

flavour attributes. A new project is now underway to optimize and refine the spectroscopy method and to expand its application to detect taste defects in the context of maple syrup inspection.

Publications will be available soon.

POTENTIAL USE OF PROBIOTIC BACTERIA FOR THE DEVELOPMENT OF A NEW MAPLE SAP HEALTHY DRINK (PROJECT 432)

This project is conducted in collaboration with Laval University (Québec city). Commercially available probiotic bacteria are introduced in pure maple sap to evaluate the possibility of producing a new maple sap formulation with health promoting properties. The main objectives are:

- Evaluate the effect of different formulation parameters (°Brix, probiotic types and ratio, Temperature, time, etc.) on the survival of probiotic bacteria in maple sap
- Identify the optimal conditions for probiotics survival for a prolonged conservation time in maple sap
- Verify the possibility of isolating probiotic associated bacteria in raw maple sap

Final report and publications expected in 2010.

STUDY ON THE IMPACT OF REVERSE OSMOSIS AND NANOFILTRATION ON THE COMPOSITION AND SENSORY CHARACTERISTICS OF MAPLE SYRUP (PROJECT 642)

The objective is to evaluate the performance of the various commercial separation membranes in terms of selectivity and permeability and their influence on maple syrup characteristics. It is intended to establish the criteria and performance standards for the partial concentration of the sap and recommend performance standards that will ensure product attributes are preserved.

A portrait of filtrate quality from 150 producers throughout Quebec using various membranes from sampling conducted in 2003 has been completed. For each producer, the quality of the sap, filtrate and concentrated sap for early, mid and late season sap was determined.

Experimentation at the pilot plant scale is currently underway to:

-evaluate the performance of the various commercial membranes using both a range of saps as a control and model solutions of sap.

- produce lab scale syrups made with sap concentrated using the different membranes
- Characterize the physical-chemical properties of the concentrates, filtrates and corresponding syrups as well as the sensory evaluation of the latter

Project is to be completed in 2008.

A literature review on membrane process application in the food industry is now available (French) <http://www.centreacer.qc.ca/publications/Procedes/PDF/642-RVL-0508.pdf>

IMPROVING THE CONSERVATION OF MAPLE SAP BY MEANS OF MICROFILTRATION (PROJECT 331)

Recent developments in membrane technology for the food industry can now be considered for the decontamination of sap as these membranes have pore sizes too small to permit the passage of microorganisms (1-100 um in sap) but large enough for the passage of liquid foods (i.e. milk). The objective was to identify a method that extends the conservation of sap in storage tanks without compromising syrup quality.

A study was conducted to evaluate the performance of microfiltration using pilot plant scale equipment with concentrated sap (@ 7 Brix) harvested at different periods in the season (0, 25, 50, 75 and 100%). Both microfiltered samples and controls were subjected to storage at 5 and 15oC.

Key Findings were:

- ✓ The use of microfiltration technology was found to remove 99% of bacteria and yeasts in concentrated sap without any significant changes in the composition and attributes of maple syrup.
- ✓ The bacterial count of the sap stayed below 105 ufc/ml during a storage period of 4 days at 5oC, which was much lower than that of the control sap at time 0.
- ✓ This performance was maintained for only 24 to 36 hours when a storage temperature of 15oC was used
- ✓ Microfiltration radically diminished the level of yeasts and molds from 104 to 10 ufc/ml which remained constant throughout the storage period.

This project has been completed and a final report is available.

TOWARDS SUSTAINABLE DEVELOPMENT OF MAPLE SUGAR BUSHES: PROJECT 742: PORTRAIT OF TREE GROWTH IN QUEBEC

Growth rates for the ecological regions in Quebec where maple syrup production is significant were obtained from the Ministry of Natural Resources of Quebec's databases. A total of 3787 sugar maples diameter measurements dating back to 1970 were analyzed.

Average growth rates were determined for the ecological regions studied and reported. Tree growth rate trends for the past 30 to 40 years were calculated. A general decline is observed.

A final report is available on our website.

<http://www.centreacer.qc.ca/publications/physiologie/PDF/742-FIN-0608.pdf>

TOWARDS SUSTAINABLE DEVELOPMENT OF MAPLE SUGAR BUSHES: PROJECT 741: OPTIMIZATION OF NUMBER OF TAPHOLES.

Quebec's tapping guidelines date back to the time when gravity collection of sap was used. Since then, plastic tubing systems and the use of vacuum has become widespread and the guidelines have not yet been revisited until now. It is also important to take into account growth rates and the new learning with respect to internal stained wood areas which are unproductive for sap production.

The objective was to validate and update the existing tapping guidelines. The study compared the sap yield and sugar content of gravity versus vacuum collection, for 1, 2, 3 or 4, tapholes per tree for each class of diameter. The optimal number of tap holes, taking into account growth rates (regional) and the probability of production of internal stained wood volume was determined. Recommendation for new guidelines will be made if need be from a sustainability point of view, to industry and regulating bodies.

The experimental set up was put in place at Centre Acer's experimental maple bush in 2006 and repeated in 2007. Total sap volume and sugar content was measured for 200 healthy trees (100 gravity, 100 vacuum) 5 diameter classes and 4 tapping intensities for each diameter class.

It has been found that the syrup production from sap collected using a vacuum system (-20'' Hg) was found to be 3 times the quantity of that collected by gravity. No significant sap was obtained beyond 2 taps per tree independent of diameter size. It was determined that only those trees whose diameter was greater than 40 cm(16 inches) may be considered to have 2 taps if their annual growth rate is greater than 2.9 mm (1.16 inches). More than 2 taps will compromise sustainability.

A final report is available on our website.

<http://www.centreacer.qc.ca/publications/physiologie/PDF/741-FIN-0608.pdf>

STUDY OF THE RELATIONSHIP BETWEEN TAPPING DATES AND MAPLE SAP VOLUME AND STAINED WOOD (PROJECT 517)

Over a four-year period, groups of twenty sugar maples were tapped at different dates during the winter. The objective of this study was to verify whether these different tapping dates influence the sap flow, sugar content, syrup production and compartmentalization of wood development. According to the results obtained, there is no difference in yield for any tapping dates tested. From two of the four years, late tapping gave more sap than early tapping, but this potential benefit was lost over the whole season, because early sap collection was not done. Potential losses are even more important if early sap flows are high. For overall syrup production, there was no significant difference observed for the different tapping dates. For compartmentalization, no significant differences were observed for the tapping dates. These results indicate that early tapping would not significantly affect the short and long term productivity of maple syrup production.

Final report available at:

<http://www.centreacer.qc.ca/publications/physiologie/PDF/615-FIN-1007.pdf>

STUDY EXAMINING TREE GEOMETRICS AND ITS RELATION TO SAP VOLUME AND SUGAR CONTENT (PROJECT 581)

The study was conducted to identify dendrometric characteristics of sugar maple which may be related to high sap flow, high sugar content or high syrup yield. Sap was collected and analyzed for sugar content from 300 sugar maples during the sap season in 2001 and 2002 in a virgin sugar bush located near Mont-Laurier and from 77 sugar maples in 2003 and 2004 harvested in the past in Tingwick. Dendrometric characteristics of each maple were measured (diameter at breast height (DBH), diameter and crown height, total height of the tree, crown length at diameter, radial growth), while projected area and crown volume were computed.

Both sites show different dendrometric characteristics and yields. However, as they present degree of redundancy, both were combined for analysis with partial least square method.

DBH is the best variable for predicting for sap sugar content and syrup production, better than all other dendrometric characteristics. For growth period examined, the 30-year one is the best, but its potential is even lower than DBH.

Final report available at:

<http://www.centreacer.qc.ca/publications/physiologie/PDF/581-FIN-1007.pdf>

EXPLORATION OF THE METAGENOME OF SAP MICROFLORA AND ITS IMPACT ON THE QUALITY OF MAPLE PRODUCTS (PROJECT 483)

This is a joint project with Laval University (Québec). The main objective of this fundamental research is to identify the sap microflora and relate it to sap composition and syrup properties. Results of multivariate statistics relating syrup characteristics to sap microflora suggest that certain species of bacteria are associated to the specific maple taste found in maple syrup. These species are related to Pseudomonas bacteria. This effect is however only appreciated above a certain level of bacterial population. Further research are underway to determined among the wide group of Pseudomonas, which subgroups or strains are more likely to enhance maple taste and which conditions most prevail for the observation of this effect. In addition, the possibility to use Pseudomonas strains as bio-control organisms in the sap collection system are studied in order to develop a new strategy for the biological control of the sap collection system and prevent the contamination of sap by undesirable bacteria.

A master thesis is now available and other publications will follow shortly.

EVALUATION OF RAPID ANALYSIS INSTRUMENTS FOR THE MEASUREMENT OF MAPLE SAP QUALITY (PROJECT 433)

This project studied the use of ATP bioluminescence and glucometer as diagnostic tools for evaluating sap quality on site. The final report is available. A joint field trial with the MAPAQ extension personnel was conducted during the 2006 season to familiarize the application of the method and the interpretation of the results.

A maple fact sheet on the glucometer is now available (English)

<http://www.centreacer.qc.ca/publications/infofiches/PDF/231A0508E.pdf>

A second maple fact sheet on ATP bioluminescence will be available soon.

LITERATURE REVIEW OF REFINED SUGAR PRODUCTION AND POTENTIAL PROCESS APPLICATIONS FOR MAPLE SYRUP PRODUCTION (PROJECT 627)

This literature review is available.

http://www.centreacer.qc.ca/publications/Interet/PDF/Canne_Publique.pdf

STARTING AND OPTIMAL OPERATION OF THE CENTRE ACER'S EXPERIMENTAL SUGARBUSH EVAPORATOR (PROJECT 641)

The objective of this project is to operate the sap concentration and evaporation system installed at Centre ACER experimental station in order to study maple syrup production at the industrial scale. The project has 3 phases: critical control points identification through the operational analysis of the evaporator, experimental validation of the information found in technical manual entitled "Cahier de Transfert Technologique en Acériculture" (CTTA) relating to the evaporation procedures and the exploration of new research avenues. Batches of maple syrup were produced in 2007 and 2008, which permitted the evaluation of sap physico-chemical changes throughout the evaporation steps. In order to compare 3 different production scales, samples of concentrated sap will further be used to produce syrup at the pilot and laboratory scales. A report containing the results of this experimentation will be produce in 2008. The update of the section 7 of the CTTA manual is also expected for 2008.

PROCESS VALIDATION OF CENTRE ACER'S MODEL SAP EVAPORATOR (PROJECT 141)

The main objective of this project is to develop a pilot scale model evaporator. This development was undertaken in order to specifically meet the scale of the experimental devices used within our research protocols. In 2007, the manufacturing and assembly of the model evaporator components were completed. Moreover, the validation of the model evaporator began with the flowing system and its adjustment. The project continues with the heating system validation, the evaluation of technological performances of the equipment, the evaporation step adjustment and the maple syrup production method validation. The model evaporator is planned to be ready in 2008.

REVIEW OF INFORMATION RELATING TO SUGAR SAND FORMATION AND ENERGY CONSUMPTION OF MAPLE SYRUP EVAPORATOR (PROJECT 851)

This project was conducted at the request of maple advisors from MAPAQ to study sugar sand formation in the back pan of the evaporator and to improve the energy efficiency of the maple syrup evaporator. The main objective is to gather relevant information from producers in order to describe the problems surrounding these subjects and propose a project to find technological solutions. In 2007, a survey was sent to producers and samples were collected. The project will continue with the results analysis of the survey and an overview of the equipments now being used to reduce sugar sand formation.

In addition, this project has permitted the production of a standard protocol for energy efficiency evaluation of the evaporator. This protocol is now being transferred to maple syrup production advisors and extension specialists and will soon be available for producers in Quebec interested in the energy efficiency of their evaporator.

TRAINING PROGRAM FOR MAPLE CONSULTANTS AND EXTENSION PEOPLE (PROJECT 153)

This activity was prepared in order to offer to maple consultants and extension specialists, a training program based on the CTTA technical manual guidelines. This program was conducted with the collaboration of l'Institut de Technologie Agroalimentaire (ITA) and was financed by the Quebec maple syrup producers association and MAPAQ. In 2008, a training session will be held focusing this time on instrumentation, conditioning and packaging of maple syrup and other maple products.