

---

**SUMMARY STATUS OF THE 2009 RESEARCH PROGRAM AT  
CENTER ACER**

---



---

**October 2009**

## **SECTION 1: INCREASING THE VALUE OF MAPLE PRODUCTS**

---

### **SCIENTIFIC BASES IN SUPPORT OF A NEW NORTH AMERICAN CLASSIFICATION OF MAPLE SYRUP (PROJECT 388)**

This project is the fundamental research component in defining new maple syrup categories based on taste, chemistry and physicochemical properties. 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.

Status: In progress. Sample analysis is currently underway.

---

### **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, IR, fluorescence, etc.) to obtain spectral imprints and correlate these 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 that spectroscopy had a good potential 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.

Status: In progress.

A. Clément, L. Lagacé, B. Panneton. 2009. Assessment of maple syrup physico-chemistry and typicity by means of fluorescence spectroscopy. J. Food Eng. Accepted Sept. 2009.

---

### **CHARACTERISATION OF MAPLE SAP AND SYRUP PORTRAYING LIGNEOUS PLANT OFF-FLAVOURS (PROJECT 8530)**

Every year, some maple syrups fail inspection due to ligneous plant off-flavour, also called “metabolism”, “woody” or “buddy”. This flavour tends to appear particularly at the beginning of the season and decreases the product quality and its commercial value.

This study will characterise the physicochemical, microbiological and sensory characteristics of sap and syrup samples containing this off-flavour in order to identify possible causes and elaborate measures of controlling or eliminating this off-flavour. The possibility of predicting this defect directly from the maple sap will be investigated in order to facilitate efficient correction measures and attenuate monetary losses to producers.

Status: In progress. Samples have been collected in 2008 and 2009, and an analysis will follow.

---

## **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. It was found that this new technology produced lighter-colored syrups for early and mid-season sap and that off-flavors were more prevalent. The effect of oxygen on the changes observed was evaluated while controlling the impact of the mechanical action and the lowering of temperature due to gas injection.

### **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 a higher prevalence of off-flavors in air injected samples and a reduction 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: Project completed.

Numerous oral presentations have been given throughout the year to diffuse the results. One article has been published in the magazine “Forêts de chez nous” in February 2008, as well as a joint publication with the Proctor Maple Research Center:

N. Martin, T. Perkins, P. Ramacieri, and A. van den Berg. 2009. Technical position paper on air injection. Maple Digest 21A (2): 23-31

<http://www.centreacer.qc.ca/propos/English/Technical%20position%20paper%20-%20Final.pdf>

---

## **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

Status: In progress.

---

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

This project studied the use of an ATP bioluminometer and a 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.

Status: Project completed.

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

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

Status: Project completed.

A master thesis is now available.

---

## **SECTION 2: PROFITABILITY/COST AND PROCESS OPTIMIZATION**

---

### **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 various commercial separation membranes in terms of their selectivity and permeability, and their influence on maple syrup composition and sensory characteristics. It is intended to establish performance criteria required for the partial concentration process of the sap that will ensure product attributes are preserved, and to develop a standardized test to evaluate these performance criteria.

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

A preliminary study, for which sampling was conducted in 2003, of filtrate quality from 100 producers throughout Quebec using various membranes has been completed. The quality of the sap, filtrate, and concentrated sap for early, mid, and late season was determined by sampling these process liquids for each producer.

The report from this preliminary study is now available (in French):

<http://www.centreacer.qc.ca/publications/Procedes/PDF/642-ETP-0608.pdf>

The same study was undertaken in 2007 to update the information obtained in 2003. This work allowed the determination of the effect of commercially used membranes (NF270, NF70, NF90, Mark 1, PVD1, Koch, BW30) on filtrate quality.

Status: In progress.

---

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

The objective of this project is to operate the sap concentration and evaporation systems installed at the ACER Center experimental station in order to study maple syrup production at the industrial scale. The project has three goals:

1. Identification of critical control points through the operational analysis of the evaporator;
2. Experimental validation of the evaporation procedures compiled in the technical manual entitled "Cahier de Transfert Technologique en Acériculture" (CTTA);
3. Exploration of new research avenues.

Batches of maple syrup were produced in 2006, 2007, and 2008, which permitted the evaluation of physico-chemical changes in sap throughout the many steps in the evaporation process. In order to compare 3 different production scales, samples of concentrated sap were conserved, and will further be used to produce syrup at the pilot and laboratory scales.

Status: Ongoing.

A maple fact sheet on electrical conductivity of maple syrup is available (in French):

<http://www.centreacer.qc.ca/publications/infofiches/PDF/312A0309F.pdf>

An article on conductivity has also been published in the magazine "Forêts de chez nous" in October 2009

---

### **PROCESS VALIDATION OF THE ACER CENTER'S PILOT-SCALE EVAPORATOR (PROJECT 141)**

The main objective of this project is to develop an electric pilot-scale evaporator. This device was developed in order to meet the needs for the scale of the experiments used in our research protocols. Numerous process variables will be measured and controlled (heating intensity and localisation, height of the liquid in the pans, pre-treatment conditions, time in the evaporator, etc), which will allow us to make a link between the macroscopic properties of maple sap (pH, Brix, glucose and

microbial concentrations, etc.), the operating conditions, and the characteristics of the final product. In 2008, the validation of the pilot-scale evaporator was completed for the flowing and heating systems. The technological performance with water was evaluated for three heating intensities. Trials with sugar solutions allowed the optimization of the operating procedure for two heating intensities. This project will continue in 2009 with the validation of the maple syrup production method, the compilation and analysis of data, and the diffusion of results.

Status: In progress

---

### **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 15°C.

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 5°C, 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 15°C was used
- ✓ Microfiltration radically diminished the level of yeasts and molds from 104 to 10 ufc/ml which remained constant throughout the storage period.

Status: Project completed.

---

### **STUDY ON THE USE OF ISOPROPYL ALCOHOL AS A SANITIZER FOR SAP COLLECTION SYSTEM (PROJECT 854)**

This project uses ATP bioluminescence to evaluate the performance of Isopropanol as a sanitizer for the maple sap collection system. Protocols are conducted in many sugarbushes to determine the effectiveness of the treatment by comparing treated and untreated tubes. The presence of residues related to this practice will also be addressed along with an evaluation of the best practices associated to transport, storage and manipulation of this chemical.

Status: In progress.

## **SECTION 3: SUSTAINABILITY OF THE MAPLE RESSOURCE AND THE ENVIRONMENT**

---

### **TOWARDS SUSTAINABLE DEVELOPMENT OF MAPLE SUGAR BUSHES: PORTRAIT OF TREE GROWTH IN QUEBEC (PROJECT 742)**

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 database. A total of 3787 sugar maple 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.

Status: Project completed. A final report is available on our website (in French).

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

---

### **TOWARDS SUSTAINABLE DEVELOPMENT OF MAPLE SUGAR BUSHES: OPTIMIZATION OF THE NUMBER OF TAPHOLES (PROJECT 741)**

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 findings 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 the industry and regulating bodies.

The experimental set up was put in place at the ACER Center's experimental sugarbush in 2006 and repeated in 2007. Total sap volume and sugar content was measured for 200 healthy trees (100 gravity, 100 vacuum), with 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.

Status: Project completed. A final report is available on our website (in French).

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

Status: Project completed. A final report is available on our website (in French).  
<http://www.centreacer.qc.ca/publications/physiologie/PDF/581-FIN-1007.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.

Status: Project completed. A final report is available on our website (in French).  
<http://www.centreacer.qc.ca/publications/physiologie/PDF/615-FIN-1007.pdf>

---

## **EXPLORATION OF TAPPING IN THE FALL AS A COMPLEMENT TO TRADITIONAL SPRING TAPPING (PROJECT 7440)**

Weather permitting, it is possible to collect maple sap and transform it into syrup in the fall season. For the past few years, several producers tap their maple trees in the fall, and then re-use the same taps the following spring. Since this practice is not well known and poorly documented, this project seeks to share our knowledge of the subject and to verify whether this mode of operation should be used.

Following our experiments in the fall of 2007 and spring of 2008, we have found that there is no advantage to fall tapping. Rather, the maple sap obtained in the fall was of a lesser amount and had only 50% the concentration of maple sap obtained in the fall. The hypothesis that a higher annual production is possible with fall tapping is thus rejected after this experiment.

Status: Project completed. A final report is available on our website (in French).

<http://www.centreacer.qc.ca/publications/physiologie/PDF/7440-FIN-0208.pdf>

---

## **SECTION 4: REINFORCING TECHNOLOGY TRANSFER AND TARGETING INTERVENTIONS**

### **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 consultants 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 identify the problems surrounding these topics and to propose technological solutions to the problems identified. In 2007, a survey was sent to producers and samples were collected. In 2008, the information gathered was compiled and analysed, which allowed the project to be separated into two parts:

#### A – Sugar sand

The goal of this part of the project is to discern the reasons for the problematic formation of sugar sand in the evaporation process, and to propose strategic solutions to the problems identified. This project will continue in 2009 with a report detailing the findings in the gathered information from the maple syrup producers, as well as a description of the technology currently used to minimize sugar sand formation.

#### B – Energy efficiency in the evaporator

The objective of this part of the project is to generate tools that will be the first step in the process of improving the energy efficiency of fuel oil evaporators used in maple syrup production. In order to do this, a standard protocol was developed. The goal of the protocol is to provide the tools necessary to qualify the energy efficiency of the fuel oil evaporation systems used in the sugarhouse. The document describes the six sections enumerated below:

1. Compilation of the technical characteristics of the fuel oil evaporation systems;
2. Evaporation rate evaluated with pure water (procedure and calculation);
3. Evaporation rate evaluated with maple sap (procedure and calculation);
4. Instantaneous energy efficiency (calculation);
5. Qualification of pre-heating system (procedure);
6. Diagnostic by comparison with reference values.

Along with the protocol, eleven videos illustrating each step of the protocol, as well as excel spreadsheets for automated calculations were made available online. Maple syrup producers thus now have the tools needed for evaluating the energy efficiency of their evaporator and diagnosing their evaporator's performance.

The protocol and videos are now available (in French)

<http://www.centraacer.qc.ca/publications/ProtocolesVideos/ProtocoleVideo.html>

Status: Part A in progress, Part B completed.

---

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

This project is looking at the use of anti-foaming agents during the heat evaporation process of maple sap. 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: In progress

---

### **TRAINING PROGRAM FOR MAPLE CONSULTANTS AND EXTENSION SPECIALISTS (PROJECT 153)**

This program was prepared in order to offer 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, the seventh and final training session was completed. The seven sessions were focused on:

1. The maple resource and management of trees for sap production (and structure of the CTTA) (12 hours);
2. Design and installation of the vacuum tubing system for sap collection (18 hours);
3. Tapping maple trees and management of the vacuum tubing system (12 hours);
4. Storage of maple sap, concentrated maple sap, and filtrate, as well as the partial concentration of maple sap by reverse osmosis (6 hours);
5. Water and maple sap evaporation (12 hours);
6. Cleaning and care of maple syrup production equipment (12 hours);
7. Instrumentation, conditioning, and packaging (small and bulk containers) of maple syrup and other maple products (12 hours).

Status: Project completed.

---

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

Status: Project completed.

Literature reviews on sugar cane and beet sugar are available (in French).

[http://www.centreacer.qc.ca/publications/Interet/PDF/Canne\\_Publique.pdf](http://www.centreacer.qc.ca/publications/Interet/PDF/Canne_Publique.pdf)

[http://www.centreacer.qc.ca/publications/Interet/PDF/Betterave\\_Publique.pdf](http://www.centreacer.qc.ca/publications/Interet/PDF/Betterave_Publique.pdf)